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1 OVERVIEW CONTENT

1.1 Process Overview

Calibration laboratories accredited by KENAS must demonstrate that they have complied with the requirements of the international standard ISO/IEC 17025:2005. In addition, this specific criterion lays down those specific requirements in the field of Mass Metrology. Calibration laboratories seeking KENAS accreditation in the field of Mass calibration must comply with the requirements stated in this criteria guideline, KENAS Terms and condition documents and applicable government regulations.

1.2 Purpose

The purpose of this document is to define the specific environmental, general and technical requirements to be met by laboratories to be accredited in the field of Mass calibration. This documented is applicable to Kenya Accreditation service (KENAS) in this field.

1.3 Scope

This document covers the application of the ISO/ IEC 17025 for accreditation of Mass laboratories. This document should be read in conjunction with the Rules and Procedures of KENAS.

1.4 Role(s) and Responsibility

Role	Responsibility
Testing and Calibration Team	• Development of draft for Technical Committee Review. • Administration Periodic review
Testing and Calibration Technical Committee	• Technical Draft Review and approval

2 DEFINITIONS / ABBREVIATIONS

The table below defines new or changed terms that are included in or associated with this process.

Term	Definition
CMC	Calibration and Measurement Capability
ISO	International organization for Standardization

KENAS	Kenya Accreditation Service
KEBS	Kenya Bureau of Standards
NMI	National Metrology Institute
OIML	International Organization of legal Metrology
NSB	National Standards Body
TC	Technical Committee
Apparent Mass	The value indicated by the balance i.e. the result of a measurement before correction for systematic error.
Calibration	Specific types of measurement performed on measuring instruments to establish the relationship between the indicated values and known values of a measured quantity.
Capacity	The greatest load a weighing machine is designed to weigh.
Discrimination	The smallest change in mass that can be detected by the weighing machine.
Range	The least and greatest load for which a machine is or can be used, and for which continuous mass values will be displayed with the same resolution.
Repeatability	A measure of a weighing machine's ability to display the same result when repeated measurements are made under the same weighing conditions.
Resolution	The mass value of the smallest scale or digital interval displayed by the weighing machine.
Span	The mass value of the difference between the greatest and least load for which continuous mass values will be displayed with the same resolution.
Sensitivity	The numbers of divisions change in reading per unit mass.
Uncertainty	The amount by which a true value may differ from a measured value, at a given confidence level.
Weight	A material measure of mass, regulated in regard to its physical and metrological characteristics: shape, dimensions, material, surface quality, nominal value, and maximum permissible error.

3 PROCESS INSTRUCTIONS

3.1 Personnel Requirements

3.1.1 The calibration laboratory shall engage staff possessing the technical and professional expertise necessary to perform the calibration. The staff may be full-time, part-time or contracted personnel. The personnel performing the calibration shall satisfy all the requirements defined in clause 5.2 of ISO/IEC 17025:2005. a) The range of products, materials or sample types tested or analyzed

3.1.2 KENAS accredited and applicant laboratories are required to provide training to their calibration technicians and to their authorized signatories to comply with the requirements of ISO/IEC 17025:2005. The calibration laboratory shall evaluate and appraise the calibration technicians to be competent before allowing them to perform calibration work independently.

3.2 Environmental and Accommodation Requirements

3.2.1 To be deemed capable of making adequate measurements, calibration laboratories shall provide an environment with adequate environmental controls appropriate for the level of measurements to be made as required by clause 5.3 of ISO/IEC 17025:2005

3.2.2 Temperature/Pressure: The calibration of weights should be performed at stable ambient conditions under ambient atmospheric pressure at temperatures close to room temperature. Typical recommended values are given in 3.6

3.2.3 Lighting within the laboratory shall be adequate to facilitate the correct performance of the calibration work undertaken. Cognizance shall be taken of the minimum levels of lighting as specified in clause 50 of the Occupational, health and Safety Act (OSHA Act 2007).

3.2.4 Housekeeping: Calibration laboratory shall have adequate space, be free from dust and fumes, free from vibration and acoustic noise and free from any contamination especially in locations where calibration items are calibrated.

3.2.5 The extent to which these environmental factors apply will vary according to the uncertainty to which calibrations are performed.

3.2.6 Where necessary the laboratory shall maintain appropriate records to demonstrate and confirm the environmental conditions within the laboratory.

3.3 Safety Requirements

3.3.1 All Metrology and Calibration laboratories are expected to comply with the Occupational Safety, health Act 2007 and any other health and safety requirements which shall apply.

3.4 General Requirements

3.4.1 Weights shall always be kept clean and shall be made sure that they do not get dirty as any cleaning (except light dusting with a soft brush) may tend to alter the mass of the weight, leading to a need for recalibration. If cleaning shall be essential, over-vigorous rubbing or the use of abrasives and polishes on the weights shall be avoided.

3.4.2 To avoid excessive wear and as a good practice, metal-to-metal contact with the weights shall be avoided.

3.4.3 Laboratories shall have a policy and procedure/s that addresses how weights, both their own references, and weights belonging to its customers are to be handled, cleaned and refurbished.

3.4.4 Any material, cloths or other equipment used for the handling of weights shall be kept clean. The weights shall be stored in a clean, safe and secured environment.

3.4.5 Where weights are used as part of testing equipment, for example in a pressure or force measuring machine, they should be calibrated and used in a manner similar to normal weights. Their values may be expressed in units other than mass, provided that the method of conversion is clearly indicated and understood.

3.4.6 Raw data shall be recorded in a non-erasable ink

3.5 Technical Requirements

3.5.1 Reference weights used for the Calibration of Weighing Instruments:

3.5.1.1 Traceability of Measurement:

Traceability of a measurement result is ensured when the result can be related to a stated reference through a documented unbroken chain of calibrations, each contributing to the measurement uncertainty. The stated reference at the end of the chain is expected to be one or more CMCs held by national metrology institutes (NMIs) and based on practical realizations of the International System of Units.

Calibrations recognized by KENAS as traceable to national standards shall be evidenced by appropriate calibration certificates, and can be provided:

(a) By the National Metrology Institute or the National Standards Laboratory of another country that is covered by a mutual recognition agreement under ILAC or,

(b) By a KENAS accredited calibration laboratory or,

(c) By an accredited calibration laboratory accredited by an overseas body that is party to the international multilateral agreements for accreditation bodies or,

(d) In-house using documented procedures that have been assessed as appropriate by KENAS . This might be through the use of reference standard weights owned by the laboratory, or through the use of a suitable calibrated weighing machine. The reference standard weights should be in a current state of calibration in accordance with (a), (b) or (c) above.

3.5.1.2 Make up Weights

a) All make up weights shall be of a stable material

b) For weighing instruments having a capacity of 1 000 kg or less, make up weight shall not be used for its calibration.

c) For weighing instruments having a capacity larger than 1000 kg, the mass of the standard weights used shall be at least 1000 kg and the make-up weight may not exceed 50% of the capacity of the weighing instrument

3.5.2 Calibration of Weighing Instruments:

3.5.2.1 Repeatability Measurements:

a) At least five readings shall be taken using (where practical) a single standard weight (or other suitable artifact) as close as practical to half the capacity of the weighing instrument.

b) Where the capacity of the weighing instrument exceeds 30 kg, the number of readings may be reduced to a minimum of three.

c) Report at least the nominal load applied and the standard deviation of the repeated weighing

3.5.2.2 Eccentric Measurements:

a) Standard weights (or a suitable artifact) of between one quarter and one third of the weighing instrument's capacity shall be placed alternately in the centre and in the various eccentric positions on the load receptor to determine the deviation (if any) caused by the off-centre loading. At least the nominal load applied and the maximum deviation from the centre, caused by the off-centre loading shall be reported.

b) Where a manufacturer of a weighing instrument specifies a particular load for this test, that load may be used.

c) The eccentric test shall not be carried out in the case of a weighing instrument with a suspended load receptor.

d) Where the load receptor is supported on more than four points, a load as close as practicable to the capacity of the instrument divided by the number of supporting points minus one shall be used.

e) Where a load receptor has a single point of support, the load shall be placed in any position on the load receptor, at a distance of approximately two thirds of the distance from the center to

the edge of the load receptor. In the case of a square or rectangular load receptor, the receptor shall be divided into quarters and the load placed in the center of the quarter.

f) Where a load receptor has four or more supporting points, the surface area shall be divided by the number of supporting points and the load shall be placed in the center of (or evenly spread over) each segment in turn.

g) Where a load receptor is in the form of rails or tracks (e.g. rail vehicle scales or overhead track scales) the load shall be applied at the beginning, in the middle and at the end of the rail or track

3.5.2.3 Accuracy and Linearity

a) The accuracy and linearity shall be tested using at least five different test loads (excluding zero), approximately evenly spread over the weighing range of the instrument. Additional measurements, such as treating each range as a separate instrument, shall be carried out in the case of:

I. Multi-range or multi–interval weighing instruments;

II. Weighing instruments with multi–revolution indicators;

III. Weighing instruments with optically projected indication together with built–in unit weights to increase the capacity.

In the case of non-self-indicating weighing instruments, the accuracy of any travelling or sliding poises and proportional counterpoise weights shall be tested. The actual load applied to reach equilibrium of the beam or steelyard shall be recorded.

Both the actual values of the loads applied and the resultant indication shall be recorded. Where the total of the actual errors or inaccuracies of the standard weights used is less than one quarter of the value of the smallest graduation or readability of the weighing instrument, the nominal values of the loads may be stated instead of the actual values.

3.5.2.4 Uncertainty of Measurement

a) The calibration laboratory shall perform a measurement or series of measurements on an artifact using the same calibration method, apparatus, and personnel that it uses to calibrate its customers' equipment. The laboratory shall be able to identify and quantify all sources of uncertainty that affect the measurement. The laboratory shall attach an overall uncertainty to

the measurement by combining all uncertainty contributions, in their type A and type B components, in the root-sum-squared method.

b) The Laboratories shall supply (and have available) for evaluation all relevant data of the weighing instrument, such as specification sheets, used in the determination of the CMC, along with copies of the Uncertainty of Measurement estimation. All relevant factors shall be considered, and only after confirmation that the contribution is insignificant may they be omitted from the estimation. This process shall be documented.

c) When establishing the uncertainty of measurement of weighing instruments, the Calibration laboratories shall be required to consider as a minimum the following contributors to the uncertainty of the weights:

- The stability of the weights;
- Buoyancy of the weights;
- The repeatability of the weighing instrument;
- The resolution of the weighing instrument;
- Temperature coefficient of sensitivity

Unless records are available the temperature drift assumed shall not be less than 0.5ºC. Where the repeatability of the balance is found to be zero, the repeatability stated by the Manufacturer shall be assumed

3.5.2.5 Calibration Range

Weighing machines shall be calibrated regularly throughout their range. Where a machine is only used over a part of its capacity, calibration may be restricted to this range. In this case, a notice stating the range that has been calibrated should be prominently displayed on the machine.

3.5.2.6 Appropriateness

Weights used for the calibration of weighing machines shall be appropriate to the accuracy of the machine being calibrated. In any case, wherever possible they shall have 95% confidence level uncertainty of calibration less than half the smallest digit size or recorded scale interval of the weighing machine to be calibrated. If groups of weights are to be used together, then this criterion shall be applied to the arithmetic sum of the uncertainties. This will ensure that the uncertainty of the weight(s) used shall not give rise to an undetected error in the calibration of the weighing machine.

3.5.2.7 Zero-Tracking

Some electronic weighing machines have a 'zero-tracking' facility. When a machine has been either 'zeroed' when unloaded, or tarred to show zero when a load has been applied, zero-tracking will keep its indication locked to zero, provided that any incremental load change is not greater than a pre-set amount - often half a digit. This means that if a slow load change may occur at zero indication and would be significant to the measurement, it is important that the zero-tracking facility is disabled, either by changing the software setting or by adding a small weight that is present throughout the weighing.

3.5.2.8 Calibration and check Intervals:

a) The frequency of calibration shall depend on the type of machine and its use. The machine shall be calibrated fully at least once a year, unless sufficient evidence has been obtained to show that the machine has remained well within acceptance limits and that the interval can be extended.

b) Regular checks (intermediate checks) may be required between full calibrations, dependent upon use and intervals between full calibrations. In particular, regular eccentric-load indication tests can be helpful in the early detection of faults developing in the weighing machine. Results of intermediate checks shall be recorded.

c) Full calibrations shall be performed after a significant change In the laboratory's environmental conditions, a change in position of the weighing machine, or following service or repairs carried out on the weighing machine (whether carried out by the user or by a service agent). Intermediate checks, or full calibrations, shall also be performed when there is any reason to believe that any other change has occurred which may affect the accuracy of the weighing machine, or where servicing is planned that can be expected to adjust its characteristics.

3.5.3 Calibration of weights:

3.5.3.1 Weighing in the laboratory shall take place on a weighing bench of adequate construction, which shall facilitate the stable and correct operation of the weighing instrument. The weighing bench design shall take cognizance of vibration, stability, magnetic susceptibility, static charging, and support.

3.5.3.2 Laboratory procedures shall address stabilization times for the calibration of weights.

3.5.3.3 Where an uncertainty of equal to or less than equal to ± 0.00002% (± 2.10^{-7}·M) is quoted, the density of the weights shall either be known (from a prior determination), or determined and a buoyancy correction must be applied. (Typical OIML Class E1)

3.5.3.4 Where an uncertainty of between ± 0.00050 % (± 5.10^{-6}. M) and ± 0.00002% (± 2.10^{-7}.M) is quoted, the density of the weights may be measured or assumed and a buoyancy correction applied. Refer to 3.7 for a table of expected material densities and uncertainties. (Typical OIML Classes E2 to F2)

3.5.3.5 No buoyancy correction shall be applied when weights are calibrated against standards of similar material, (i.e. Brass and Brass), and uncertainties of between ± 0.0002% (2.10^{-6}.M) and ± 0.005 % (5.10^{-5}.M) are claimed. (Typical OIML Classes M1 to M2)

3.5.3.6 No buoyancy correction shall be applied when uncertainties of 0.005% and larger (5.10^{-5}.M) are claimed. (Typical OIML Class M3)

3.5.3.7 When cast iron weights are calibrated, laboratories may not quote uncertainties of less than 0.0016 % (± $1.6.10^{-5}$.M)

3.5.3.8 The calibration laboratory shall where applicable indicate on the calibration certificate the prevailing measurement conditions such as air density, weight density, temperature, and indicate whether these values are assumed or have been measured.

3.5.3.9 When reporting the results, the laboratory may not report on the calibration certificate more significant digits than it is able to measure on the weighing instrument, or more significant digits than have been specified on the certificate of calibration of their standard mass piece used during the calibration.

3.5.3.10 No laboratory shall be accredited to perform on site calibration of weights unless they also have the capability to perform the calibration in their own laboratory, and their measurement capability is based on the equipment which they have in their own laboratory. This equipment shall include but is not limited to standard mass pieces (weights), balances and/or mass comparators.

3.5.3.11 Laboratories accredited to perform the calibration of weights the nominal mass of which exceeds 100 kg shall have suitable ancillary equipment as may be necessary to load and move these weights onto and from the weighing instrument. Such ancillary equipment may include slings, crawl beam, block and tackle, and a fork lift, as appropriate.

3.5.3.12 Laboratories who wish to be accredited for the calibration of weights the nominal mass of which exceed 1 000 kg, and where circumstances prevent the removal of these weights from their place of use, shall provide evidence of the calibration of the weighing instrument/s used to perform the calibration of the weight. Such calibration may be limited to a particular site.

3.5.4 Calibration of Force (Newton) or Non-metric weights:

The laboratory may calibrate weights in non-metric or weights marked in a nominal force in Newton, the results and the associated uncertainty shall be reported in metric units of mass (kg, gram, mg, etc.) together with the conversion factor, and gravity (standard or local) used optionally along with the calculated equivalent value in the non-metric unit. The certificate shall include a statement indicating the source (reference) of the conversion factor used.

3.6 Ambient conditions during calibration (Typical values recommended for obtaining successful results)

Table 1 Temperature

Weight class	Temperature change during calibration
E1	± 0.3 °C per hour with a maximum of ± 0.5 °C per 12 hours
E2	± 0.7 °C per hour with a maximum of ± 1 °C per 12 hours
F1	± 1.5 °C per hour with a maximum of ± 2 °C per 12 hours
F2	± 2 °C per hour with a maximum of ± 3.5 °C per 12 hours
M1	± 3 °C per hour with a maximum of ± 5 °C per 12 hours

Table 2: Humidity

Weight class	Range of relative humidity (hr) of the air
E1	40 % to 60 % with a maximum of ± 5 % per 4 hours
E2	40 % to 60 % with a maximum of ± 10 % per 4 hours
F	40 % to 60 % with a maximum of ± 15 % per 4 hours

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Note 1: It is also important that the difference in temperature between the weights and the air inside the mass comparator is as small as possible. Keeping the reference weight and the test weight inside the mass comparator before and during the calibration can reduce this temperature difference.

Note 2: This is the change in the temperature of the laboratory. Thermal stabilization of balances and weights also requires an appropriate temperature stability of the laboratory for 24 hours before calibration.

Note 3: The upper limit is mainly important when storing the weights.

C.2.1.1 For E1 and E2 class weights, the temperature should be within 18 °C to 27 °C. The environmental conditions should be within the specifications of the weighing instrument.

C.2.1.2 If the air density deviates from 1.2 kg m^{-3} by more than 10 %, mass values should be used in calculations and the conventional mass should be calculated from the mass.

3.7 Estimating the density of weight.

Estimating the density based on the known composition of the alloy from which the weight is manufactured is one of the methods for determining density. For class E2 to M2, the density value and uncertainty value from table below are adequate to estimate the density.

Source OIML R111-1 Edition 2004(E) Table B7

Alloy/Material	Assumed Density	Uncertainty (K=2)
Platinum	21 400 kg/m^3	± 150 kg/m^3
Nickel Silver	8 600 kg/m^3	± 170 kg/m^3
Brass	8 400 kg/m^3	± 170 kg/m^3
Stainless Steel	7 950 kg/m^3	± 140 kg/m^3
Carbon steel	7 700 kg/m^3	± 200 kg/m^3
Iron	7 800 kg/m^3	± 200 kg/m^3
Cast Iron (White)	7 700 kg/m^3	± 400 kg/m^3

Cast Iron (grey)	7 100 kg/m^3	± 600 kg/m^3
Aluminium	2 700 kg/m^3	± 130 kg/m^3

3.8 Calibration Schedule

The schedule of accreditation shall list the types of weighing instruments that the laboratory is competent to calibrate under the parameter 'weighing instruments'. This list may include the following:

- Digital self-indicating;
- Mechanical self-indicating;
- Semi self-indicating;
- Non self-indicating;
- Equal arm balances;
- Automatic scales;
- Hopper scales;
- Conveyor scales;
- Comparators;
- Gram gauges;
- Fruit penetrometers;
- In-motion weighers;
- Crane scales and
- Weighbridges.

Due to the complexity of the calibration of certain types of scale for example equal arm balances,

Crane scales and weighbridges, these types may be listed separately on the schedule of accreditation with dedicated CMC's.

4 REFERENCE AND RELATED DOCUMENTS

Ref	Document Identifier	Document Title
1.	ISO/IEC 17011	Conformity Assessment-General requirements for accreditation bodies accrediting conformity assessment bodies
2.	ISO/IEC 17025	Conformity Assessment – General requirements for Testing and Calibration Laboratories
3.	OIML-R111	International organization of Legal Metrology (OIML), Weights of classes E_1, E_2 , F_1 , F_2 , M_1, M_2, & M_3
3.	KENAS-TS-F-004	Confidentiality Form

5 TRAINING

None required except for notification and awareness to CABs.

6 REVISION HISTORY

Date	Ver	Revised By	Reason For Revision
16/03/2013	01	ADTC	• Initial
16/02/2017	02	ADTC	• Align guideline to the right template. • Incorporate references in the guideline rerefernce section.