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LAB 24

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Measurement Traceability and Calibration in the Mechanical Testing of Materials

Contents

Changes since last edition

Standard references have been revised. The word 'metallic' has been removed from 'metallic materials' throughout the document so that it can be applied to other materials such as composites and plastics. A statement has been added that in-house calibrations will be subject to assessment at least once in the four-year cycle. Reference to humidity control has been added. The indirect calibration of dual certified Charpy Impact machines has been addressed. Other general editorial changes also made.

1. Introduction

1.1 The requirements for the control of equipment calibration and measurement traceability are given in ISO/IEC 17025. Several guidance publications providing interpretation of the requirements for particular items of equipment and forms of measurement are included in the *UKAS Publications list*.

1.2 This publication (LAB 24) provides guidance for laboratories needing to meet the requirements as applied to mechanical testing of materials. By following this guidance, laboratories will be able to demonstrate at assessment that they meet these requirements. Alternative methods may be used provided they are shown to give an equivalent outcome.

1.3 In general, calibration of equipment needs to be traceable to national measurement standards. When using external calibration services, a valid certificate should be obtained from a calibration laboratory that demonstrates competence, measurement capability and traceability. A calibration certificate bearing the UKAS accreditation symbol or reference to UKAS accreditation [or identity of the national standards laboratory or mark of an accreditation body which is a signatory to EA or ILAC multilateral agreement] for the relevant calibration/verification will be sufficient evidence.

2. Terminology

2.1 For the purposes of this publication the following terms apply:

2.2 **Calibration**: specific types of measurement performed on measurement standards, reference materials and measuring instruments to establish the relationship between the indicated values and known values of a measured quantity. The term covers calibrations carried out using appropriate reference equipment at any location.

2.3 **Check**: specific types of inspection and/or measurement performed on materials and equipment to indicate compliance or otherwise with stated criteria. The term covers checks carried out at any location.

2.4 **Repeatability**: *r* is the value below which the absolute difference between two or more single test results obtained with the same method on replicate test samples, under the same conditions, (same operator, same apparatus, same laboratory and a short interval of time), may be expected to lie with a specified probability; which, in the absence of other indicators, is 95%.

2.5 **Reproducibility**: *R* is the value below which the absolute difference between two or more single test results obtained with the same method on replicate test samples, under different conditions (different operators and/or different apparatus and/or different laboratories and/or different time), may be expected to lie with a specified probability which, in the absence of other indications, is 95%.

2.6 **Measurement Uncertainty**: a statement of the limits of the range within which the true value of a measurement is expected to lie at a given level of confidence (see UKAS publication M3003, *The Expression of Uncertainty and Confidence in Measurement*).

3. General

3.1 The laboratory's programme for the maintenance and calibration of equipment will typically comprise periodic cleaning, servicing, calibration and safety checks (where applicable). Performance and compliance checks may also be necessary as part of the calibration aspect of the programme.

3.2 Standards often define the accuracy to be achieved and include specifications for equipment considered suitable for use. In order to ensure that the equipment available complies with the requirements of a particular test method, each item must be suitably calibrated and/or checked. These calibrations and/or checks can be achieved in a number of ways depending on the parameters being measured, the specified tolerances and the capability of the laboratory.

3.3 When establishing a calibration programme, aspects of measurement traceability, procedures, intervals and records for both calibration and checks, need to be considered for each item of equipment in relation to the particular test method for which it may be used. These key components are considered in this publication in order to assist mechanical test laboratories to establish a suitable equipment verification programme.

3.4 Appendix A lists key items of reference equipment and working equipment used to carry out a wide range of tests on materials and details a programme of calibrations and checks which would normally be considered suitable. The table also indicates the level of traceability generally considered appropriate (see paragraph 4.2), and for which items external certificates of various forms are advised (see paragraphs 7.2 and 7.6). Appendix A is **not** an exhaustive list of all items of equipment requiring periodic recalibration or checking but may be of assistance as a guide when establishing or reviewing a calibration system.

3.5 The calibration and checking guidance given in this publication **does not** supersede the requirements of a nationally published test method.

4. Measurement Traceability

4.1 The means of establishing traceability of measurement to national standards will vary between different items of equipment depending on a number of factors such as the complexity of the measurement, the accuracy of the measurement, and the capability of the laboratory.

4.2 Calibrations and checks carried out on equipment used for testing materials and products may be conveniently classified into four general levels as listed below:

(a) *Level 1*: A calibration carried out by a laboratory accredited by UKAS for the measurements concerned and for which a UKAS calibration certificate is issued. *Certificates from other calibration bodies may be acceptable provided that full traceability to national standards is demonstrated*.

(b) *Level 2*: A calibration, which may be carried out in-house, performed to a documented method by competent staff, using appropriate reference standards/equipment. The reference standards/ equipment will need to be calibrated by a laboratory that can demonstrate competence, measurement capability and traceability, eg, a UKAS accredited calibration laboratory. In-house calibrations will be subject to UKAS assessments initially and at least once in a four year accreditation cycle. UKAS may increase the frequency of assessments if required. *(Refer to UKAS Publication TPS 41 UKAS Policy on Metrological Traceability)*.

(c) *Level 3*: A check, which may be carried out in-house, performed by competent staff using appropriately calibrated equipment to a documented procedure.

(d) *Level 4*: A visual check, where the item is inspected to provide assurance that the equipment meets the requirements of the appropriate standard, but no measurements are required.

4.3 When determining the programme of calibrations and/or checks appropriate for an item of equipment the capability of the laboratory and requirements of the calibration must be kept in mind. As a guide, any instrument or reference standard used should have an accuracy **10 times** better than that of the device being calibrated. The actual accuracy required will be determined by calculating the expanded uncertainty for particular calibration regimes using defined calibration apparatus. Guidance on where this should be performed is given in Appendix A. As an example, a device having a ±0.5% tolerance might be calibrated using a standard having an uncertainty of ±0.05%. There may, however, be exceptions to this rule where a factor of 2 or 5 may be acceptable.

4.4 Many items of equipment are assemblies of component pieces of apparatus and calibrations or checks may be required on the item as a whole, the individual components or a combination of both. A number of levels of calibration or check may therefore be required on the one item.

4.5 Following assessment of a laboratory's equipment calibration and check system, a higher level of traceability may be necessary than that undertaken by the laboratory to achieve the accuracy required in the accredited tests. This situation may arise where the capabilities required to perform the calibration in-house, e.g. environment, equipment, staff, are not available to the laboratory.

5. Calibration and Check Intervals

5.1 Before equipment is placed into service, a suitable calibration or check is needed to confirm compliance with the respective standard requirements. Most items of equipment also require periodic recalibration or checking, as the accuracy or value may change with use/time. It is important that the recalibration or check is undertaken before any probable change in accuracy or value has occurred that is of significance to the use of the equipment. To confirm such changes have not occurred in between calibrations, interim checks may also be required.

5.2 To assist laboratories to develop their calibration and check programme, the table in Appendix A contains periods between successive calibrations or checks which have been defined in published standards or are considered to be acceptable. Normally, these intervals are the **maximum** acceptable for each specified type of equipment provided that the equipment:

(a) is of good quality and known stability;

(b) has achieved satisfactory performance at previous calibrations and checks;

(c) is checked before first use or as defined in 5.1, and at appropriate intervals thereafter to show stability has not been impaired following suspected or indicated mishandling, overloading or malfunctioning;

5.3 When determining recalibration and check intervals, the applicable test methods in published standards, UKAS publications and manufacturer's instructions should be referred to for initial guidance. The guidance set by these publications and the compliance of each item of equipment with the criteria detailed under paragraph 5.2, will determine the interval finally set. Where there is doubt regarding an individual item's ability to meet the above criteria, the calibration/check interval for that piece of equipment may have to be shortened to ensure continued accuracy and performance. In some instances, this calibration interval may be extended for an individual piece of equipment, e.g., when a stable calibration history has been established. **Calibration intervals may not, however, be relaxed if they are a mandatory element of the test method**.

5.4 To ensure that calibrations and checks are carried out at the appropriate frequency a forward planner should be prepared. A planner may take one of a number of forms. A wall calendar, which identifies the items requiring attention in each month, is just one example of a forward planner. Whatever form the system takes it needs to provide adequate notice of a pending calibration or check to ensure it is carried out by the due date. This is particularly important where items are calibrated externally and considerable time may be required to organise the calibration, to have it carried out and to evaluate the results before the item is returned to service.

5.5 In the instance where a published National/International test standard requires calibration of equipment to a related calibration standard that has been up-issued, UKAS will allow a transition period from the date of publication, depending on the activity, such that testing to the latest revision of the test standard is allowed while the equipment remains calibrated to a previous revision. This maximum period is shown in parentheses in the column for the calibration interval (transition period). In the exceptional circumstance where a significant technical change is made to the traceability of the calibration method the laboratory may not be allowed to transition until the calibration has been performed to the latest revision of the standard.

In any event the laboratory can only perform testing in accordance with the revision of the test standard shown on the schedule of accreditation unless the laboratory holds accreditation under a flexible scope approach.

e.g. testing in accordance with BS EN ISO 148-1:2016 using equipment calibrated in accordance with BS EN ISO 148-2:2008 will be allowed up to November 2018, 2 years after publication.

6. Calibration and Check Procedures

6.1 Laboratories should normally have and follow documented procedures for all calibrations and checks. [Exceptions may be allowed for measuring equipment when it is technically unnecessary to require a detailed procedure]. Documented procedures may be published Standards, instrument manufacturer's instructions or in-house methods. It may be necessary to supplement published procedures with in-house methods.

6.2 The appropriate selection and correct execution of these procedures by trained and authorised personnel is fundamental to achieving confidence in the results of the calibrations or checks.

7. Records

7.1 For ease of use, laboratories may wish to hold a number of associated records rather than one large document or file. A records system might for instance consist of an equipment register, calibration/check forward planner and calibration/check and maintenance files, which may be in hard copy or other suitable laboratory information management system. It is essential that these records are available to the staff performing the checks or recalibrations.

7.2 When an external calibration is required (paragraph 4.2a, Level 1), it is the responsibility of the laboratory to check each certificate (provided by a UKAS accredited supplier or otherwise) in order to ensure that the corresponding item of equipment is suitable for use. In particular, the certificate must be checked to ensure that the equipment has been calibrated over the appropriate range and with the required uncertainty for the test method. Any queries should be raised with the calibrating body or, where necessary, UKAS.

7.3 The use of pro-forma record sheets for in-house calibrations or checks (paragraph 4.2b, level 2 and paragraph 4.2c and d, levels 3 and 4) is recommended as this ensures that all necessary information is recorded. When preparing a pro-forma, care should be taken to ensure space is provided for all components of the calibration or check and all applicable details.

7.4 The use of diagrams and tables indicating acceptable values and actual values may be useful, particularly where dimensional checks are made. Diagrams may also be helpful in other areas, e.g. to indicate the placement of temperature measuring devices during a check of the temperature distribution within the working space of an oven.

7.5 Where a simple measurement or visual check of an item is required before each use (e.g. rotation of bending fixture rollers) it is acceptable and often most appropriate to record the check on the relevant test work sheet rather than on a separate form.

7.6 For some items, parameters, such as the material of manufacture, are specified in the test method for which calibrations are not required. In such cases, when an item is purchased, an authoritative certificate or statement of compliance to the design specification will be needed as evidence that the item is designed and manufactured to meet the requirements of the test method.

8. Measurement Uncertainty

8.1 Laboratories testing materials are expected to estimate the measurement uncertainty for all calibrations carried out in-house (Level 2) on measuring equipment (i.e., equipment which is used to take measurements such as length, force, extension, temperature and mass). Guidance on where this is required is given in Appendix A.

8.2 To determine the uncertainty associated with a calibration the procedure should first be broken down into its component measurements. The significant sources of all uncertainties should then be identified and quantified. In most cases, uncertainties may then be combined by an appropriate method to produce an overall uncertainty value.

8.3 Every time a measurement is taken, random effects from various sources contribute uncertainty to the value of the reading taken. These include variability resulting from imprecise definition of the calibration (e.g. poor accessibility for taking a length measurement), uncertainty in discrimination (e.g. interpolation on a scale) and random fluctuations (e.g. fluctuation in an influencing parameter such as temperature).

8.4 The uncertainties arising from random effects are principally evaluated from repetitive measurements by statistical methods (a Type A evaluation). Information contained in Standards on repeatability and reproducibility may be useful when evaluating these uncertainties.

8.5 Systematic effects also contribute uncertainty, and sources associated with a calibration include those relating to the equipment used to make each specific measurement and any peripheral measurements, such as room temperature. The uncertainty associated with each piece of equipment used to carry out the calibration will in most cases be available from its current calibration certificate. Where this is not applicable, information which may be acceptable to UKAS may be available from the equipment manufacturer. In some cases, it will be practical to eliminate many of the sources of uncertainty, e.g. by applying corrections from the external calibration report and by carrying out the calibration at the same temperature as that used for calibrating the reference equipment.

8.6 More detailed guidance on the expression of uncertainty and confidence in measurements may be found in the UKAS publication M3003, *The Expression of Uncertainty and Confidence in Measurement*.

9. Auxiliary Equipment and Computer Systems

9.1 Where additional equipment is connected to a testing machine to provide a record of force measurements, e.g. a chart recorder or computer, it is considered as an integral part of the force measuring system. Such additional equipment should be verified as part of the force measurement system (Level 1 calibration) or as a separate item (Level 1 or 2 calibration). The laboratory should include the effect of the auxiliary equipment on the total measurement uncertainty of the testing machine.

9.2 Control of test temperature and humidity is a requirement of a number of mechanical test standards or methods and in such cases the conditions should be controlled using appropriate equipment and suitable measuring equipment that has been calibrated over the working range.

9.3 Temperature control equipment should be capable of maintaining the temperature of the test specimen within the limits required by the test standard or method. It should also be capable of providing a steady, even rate of heating/cooling and should prevent temperature overshoot.

9.4 Humidity control equipment should be capable of maintaining the humidity of the test and conditioning environment within the limits required by the test standard or method for both conditioning and for test when required.

9.5 Computer software used for test control and/or data capture, processing, storage and presentation of test data should be validated before use. Documentary evidence should be retained to demonstrate that test control parameters embedded within the computer software comply with the requirements of the test standard or method (e.g. strain rate, loading rate, displacement rate, heating rate and frequency).

9.6 When force, extension and other data produced during mechanical testing are processed by automatic means, documented evidence should be retained to demonstrate that the equipment is capable of providing accurate and repeatable results. Any changes made to the software or embedded data should be controlled and documented.

10. Test Specimen Preparation

10.1 UKAS accredited mechanical testing laboratories should have procedures available to ensure test specimen preparation, whether carried out in-house or sub-contracted, is adequately specified and controlled. Procedures for machining, grinding or polishing test specimens should be documented to a level to ensure they are not subject to unacceptable metallurgical or mechanical damage as a result of thermal or mechanical working. Particular attention should be paid to checking the axiality of the test specimens manufactured for uniaxial testing. Suitable records should be maintained of all dimensional checks carried out to ensure test specimens comply dimensionally with the requirements of the test standard or method.

10.2 For some test specimens, surface texture is of particular importance. Where this is the case, an assessment should be made of the surface texture as required by the test standard or method and the results recorded and retained. Measurement of surface texture should be made using suitably calibrated equipment.

10.3 Residual stresses in surface or near surface layers can have a significant effect on material properties, particularly the fatigue life. When carrying out tests that are particularly sensitive to this effect, e.g. Titanium and Nickel alloys consistent and appropriate machining practice is essential to obtaining reliable and consistent results. Suitable quality checks should be incorporated in the machining process and records of these checks retained as appropriate.

Appendix A – Table Detailing Calibration and Checking of Equipment Used by Mechanical Test Laboratories

A.1 This table has been prepared as a **guide** to the effective calibration and checking of items of equipment used to carry out tests on materials. Where more than one type of a particular item is listed (e.g. reference or working thermometers; weights) guidelines are given for each specified type. Note: further guidance on calibration requirements for specific items may be available. Consult *UKAS Publications list* for current list of UKAS publications.

A.2 **The table does not list all items of equipment that may be used and the absence of an item in the table does not necessarily indicate that calibration or check procedures are not appropriate.**

A.3 For ease of use, the table is divided into five sections relating to specific areas relating to mechanical testing. These are headed 'Compression and Tensile', 'Creep and Stress Rupture', 'Hardness', 'Impact', 'Measuring Instruments (Dimensional)', 'Measuring Instruments (Temperature)' and 'Miscellaneous Laboratory Equipment'.

A.4 The table specifically provides guidance on the:

(a) Minimum level of traceability considered appropriate for each type of calibration/check;

(b) Maximum period between successive calibrations that is considered to be appropriate;

(c) The type of certificates or records that shall be held by the laboratory;

(d) Measurement Uncertainty requirements.

A.5 The specified level of traceability is the minimum considered appropriate. An organisation may choose to achieve a higher level of traceability for a calibration/check, but not a lower one, e.g. Level 1 rather than Level 2.

A.6 The specified calibration interval is the maximum considered appropriate and may not normally be extended.

A.7 Where the calibration/check requirement for a particular item of equipment (i.e. 3rd column of table) refers to items of equipment used to carry out the calibration/check, many of these auxiliary items are themselves listed as separate entries in the table.

Notes:

1. This table details calibration and check intervals, but each item of equipment requires appropriate calibration and/or checking before it is placed into service.

2. Where a UKAS calibration certificate is indicated by the table, certificates from other sources may be acceptable (see para 1.3).

3. Where an item is calibrated in-house and is defined as a calibration rather than a check, an uncertainty budget should normally be determined for that specific calibration procedure. The extreme right-hand column of the table below indicates where an uncertainty budget should be determined.

4. Calibrations must cover the **full range** for which the equipment is to be used or specified.

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Compression and Tensile						
Force measuring devices	(a) Compression testing machines	Calibrate against BS EN ISO 7500-1	1	Should not exceed 1 year (2 years)	UKAS	Yes
		Check rate of loading and that compression platens or cages meet the specifications given in the relevant test standard or method	3	Annual	In-house	No
	(b) Tensile testing machines	Calibrate in accordance with the relevant standard, e.g. BS EN ISO 7500-1 or ASTM E4	1	Annual (2 years)	UKAS	Yes
	c) Tensile & Compression testing machines	Check rate of loading and straining where rates are specified by test standard or method	3	Annual	In-house	No
		Verify that the rate of crosshead speed being displayed by the load frame test program is correct	3	Annual	In-house	No
Extension measuring devices	(a) Extensometer	Calibrate in accordance with the relevant Standard, e.g., BS EN ISO 9513 ASTM E83, over entire extension range or working range. Classification or grading must satisfy requirements of test standard or method for the property being determined.	1	Should not exceed 1 year (2 years)	UKAS	Yes

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Extension measuring devices (cont'd)	(b) Strain gauges	Instrumentation used for measurements with resistance strain gauges	1	Annual or before use, whichever is the greater period	UKAS	Yes
		Instrumentation used for measurements with resistance strain gauges	2*	Annual or before use, whichever is the greater period	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes
		Traceability of calibration has to be established by indirect methods which demonstrate that the gauge factor can be reproduced for a strain gauge from a batch of gauges to be used for testing	2	Annual or before first use of a batch	In-house	No
Axial alignment		Where a test standard specifies a maximum bending moment for the load train (including adaptors) using relevant standard (e.g. ASTM E1012)	3	Before first use and then at period specified by the standard. If not specified, period to be determined through life history of part and degradation.	In-house	No
Creep and Stress Rupture						
Force measuring devices		Calibrate in accordance with the relevant standard, e.g. BS EN ISO 7500-2 or ASTM E4	1	1 year or as defined in the test standard or method (2 years)	UKAS	Yes
		or				
		Calibrate in accordance with the relevant standard, e.g., BS EN ISO 7500-2 or ASTM E4	2*	1 year or as defined in the test standard or method (2 years)	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes
Extension measuring devices	Extensometer	Calibrate in accordance with the relevant Standard, e.g., BS EN ISO 9513 or ASTM E83, over entire extension range or working range. Classification or grading must satisfy requirements of test standard or method	1	1 year or as defined in the test standard or method (2 years)	UKAS	Yes

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Extension measuring devices (cont'd)		Calibrate in accordance with the relevant Standard, e.g. BS EN ISO 9513 or ASTM E83, over entire extension range or working range. Classification or grading must satisfy requirements of test standard or method.	2*	1 year or as defined in the test standard or method (2 years)	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes
Axial alignment		Where a test standard specifies a maximum bending moment for the load train (including adaptors) using relevant standard (e.g. ASTM E1012)	3	Before first use and then at period specified by the standard. If not specified, period to be determined through life history of part and degradation.	In-house	No
Hardness						
Refer to current UKAS Publication LAB 25 Traceability of Hardness Measurements						
	Test machine (Brinell, Vickers, Knoop & Rockwell)	Calibrate in accordance with the relevant Standard e.g. BS EN ISO 6506-2, 6507-2, 4545-2 & 6508-2 or ASTM E10, E92, E384 & E18	1	1 year or as defined in the test standard or method (2 years)	UKAS	Yes
	Reference Blocks (Brinell, Vickers, Knoop & Rockwell)	Calibrate in accordance with the relevant Standard e.g. BS EN ISO 6506-3, 6507-3, 4545-3 & 6508-3 or ASTM E10, E92, E384 & E18	1	Should not exceed 5 years (3 years)	UKAS	Yes
Impact						
	(a) Test machine (Charpy)	Calibrate in accordance with the relevant standard, e.g., BS EN ISO 148-2 or ASTM E23[1, 2]	1	1 year (2 years)	UKAS	Yes
	(b) Test machine (Izod)	Calibrate in accordance with the relevant standard, e.g., BS 131-4 or ASTM E23	1	1 year (2 years)	UKAS	Yes

[1] Both BS EN ISO 148-1 and ASTM E23 permit the use of a 2mm or 8mm radius striker. The indirect calibration of the machine must use reference test samples that are commercially available of the highest energy for the usable capacity of the machine and certified for the radius of the striker installed. The traceability of the reference samples for the indirect calibration is detailed in the relevant standard.

In addition, if the striker is changed between calibrations, a limited direct verification and an indirect verification using reference samples for the installed striker radius is required before commencing testing. ISO 148 requires the use of certified reference test pieces, and although ASTM E23 does not, the laboratory must maintain records to demonstrate that the samples used are controlled through statistical analysis and the values and tolerances set are meaningful and suitable for validation of the machine.

[2] For dual certified machines:
Historically the difference between the machines used for ISO and ASTM testing has been the striker radius and from 2016 both standards recognise and allow the use of either an 8mm or 2mm striker. The annual direct verification shall address the requirements of both standards. The tolerances for the striker and anvils shall meet the most stringent requirements of either standard. Indirect calibrations shall comply with statement above ([1]).

NOTE: It should be understood that for some materials, tests carried out with 2mm and 8mm strikers can give different results.

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Measuring Instruments (Dimensional)						
Length measuring devices	*1 Gauge blocks*					
	(a) Reference	Shall comply with the relevant grade of BS EN ISO 3650 and BS 4311-1	1	5 yearly	UKAS	Yes
	(b) Working	Calibrate against appropriate calibrated reference equipment	2*	2 yearly	UKAS	Yes
	2 Micrometers					
	(a) Reference	Calibrate externally	1	Annual	UKAS	Yes
	(b) Working	Calibrate externally or	1	Annual	UKAS	Yes
		Calibrate against calibrated gauge blocks meeting the appropriate grade requirements of BS EN ISO 3650. <u>Includes</u> check of anvils for flatness and parallelism.	2*	Annual	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes
	3 Calipers					
	(a) Reference	Calibrate externally	1	Annual	UKAS	Yes
	(b) Working	Calibrate externally or	1	Annual	UKAS	Yes
		Calibrate against calibrated gauge blocks meeting the appropriate grade requirements of BS EN ISO 3650. <u>Includes</u> check of measurement faces for flatness and parallelism.	2*	At appropriate intervals, depending upon usage. Not exceeding 1 year.	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Length measuring device (cont'd)	*4 Steel rules*					
	(a) Reference	Calibrate externally	1	5 yearly	UKAS	Yes
	(b) Working	Engineers' rule not confirmed as BS 4372 check against reference using suitable visual aid	2	Annual	In-House	Yes
		All rules - check for readability and wear	4	Before use	In-house	No
	5 Feeler gauges	Calibrate with appropriate calibrated reference equipment	2	Annual	In-house	No
	6 Straight edge/ Engineer's square					
	(a) Reference	Calibrate externally	1	5 yearly	UKAS	Yes
	(b) Working	Carry out appropriate checks to satisfy the relevant standards	3	Annual	In-House	No
	7 Dial gauges and displacement transducers	Calibrate against a calibrated micrometer device or in a comparator frame using calibrated gauge blocks or calibrated length bars in an appropriate environment	2	Annual	In-house	Yes
Measuring Instruments (Temperature)						
Thermocouples	(a) Reference	Calibrate externally Refer to BS 1041-4 for selection of appropriate type	1	1-4 yearly depending upon requirement of test method, use or type	UKAS	Yes
	(b) Working	Calibrate against reference thermocouple or liquid-in-glass thermometer, as appropriate for test standard or method. Immersion length during calibration should be the same as when used for testing.	1	At appropriate intervals, depending upon test standard or method, usage, type and conditions of use.	UKAS	Yes
	(b) Working	Calibrate against reference thermocouple or liquid-in-glass thermometer, as appropriate for test standard or method Immersion length during calibration should be the same as when used for testing.	2*	At appropriate intervals, depending upon test standard or method, usage, type and condition	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Thermometers	(a) Reference: liquid-in-glass	Calibrate for precision and range of measurement required and	1	5 yearly	UKAS	Yes
		Check at ice point (or dependent upon use, some other reference point)	3	Annual	In-house	No
	(b) Reference: platinum resistance	Calibrate for precision and range of measurement required	1	1-5 yearly depending on requirement of test method, use or type	UKAS	Yes
	(c) Working: platinum resistance	Calibrate against reference PRT or reference thermometer	2*	Annual	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes
	(d) Working: liquid-in-glass temperature tolerance < ± 0.5 °C	Calibrate against a calibrated reference thermometer ensuring that the immersion depth is as specified and	2*	Initially, then 5 yearly	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes
		Check at ice point or another reference point	3	6 monthly for first year of use and annually thereafter	In-house	No
	(e) Working: liquid-in-glass temperature tolerance ≥ ± 0. 5 °C	Use a BS 593 thermometer (with unique serial number) or calibrate against a suitable reference thermometer ensuring that the immersion depth is as specified and	2*	5 yearly; re-calibrate or on replacement	In-house *(Note: Level 2 calibration subject to approval by UKAS)	Yes
		Check at ice point or other reference point	3	6 monthly for first year of use and annually thereafter	In-house	No

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Miscellaneous Laboratory Equipment						
Bend fixtures	(a) Rollers	Visual examination of condition and suitability	3	Daily/before use	In-house	No
		Dimensional check against the requirements of relevant test standard or method	3	Annual	In-house	No
	(b) Formers	Visual examination of condition and suitability	3	Daily/before use	In-house	No
		Dimensional check against the requirements of relevant test standard or method	3	Annual	In-house	No
Microscope Magnification	(a) Stage Micrometer	External Calibration	1	When new	UKAS	Yes
	(b) Microscope	Magnification Check	2	Annual	In-house	No
Hygrometers		External calibration	1	Annual	UKAS	Yes
		Internal calibration	2*	Annual *(Note: Level 2 calibration subject to approval by UKAS)	In-house	Yes
Muffle furnace		Check temperature profile in working space	3	Initial and after maintenance or repair	In-house	No
		Recalibrate or check as appropriate for the accuracy required by the test method, i.e., recalibrate using calibrated reference thermocouple or	2	Annual	In-house	No
		Check temperature profile using substances of known melting point or other suitable indicator	3	Annual	In-house	No
Ovens (conventional)	(a) Required temperature tolerance < ± 2 °C	Check temperature profile in working space with a calibrated reference thermometer or calibrated reference thermocouple	3	Initial and after maintenance or repair	In-house	No
		Check temperature at the midpoint of the working space with calibrated reference thermometer or calibrated reference thermocouple	3	At appropriate intervals, depending on usage (Max - annually)	In-house	No

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Ovens (conventional) (cont'd)	(b) Required temperature tolerance ≥ ± 2 °C	Check temperature profile in working space with a BS 593 thermometer or calibrated thermocouple	3	Initial and after maintenance or repair	In-house	No
		Check temperature at the midpoint of the working space with BS 593 thermometer or calibrated thermocouple	3	At appropriate intervals, depending upon usage (Max - annually)	In-house	No
pH meter		Check with at least two standard buffer solutions of appropriate pH	3	Daily/before use	In-house	No
Test mandrels, cones and wedges		Visual examination of condition and suitability	3	Daily/before use	In-house	No
		Dimensional check against the requirements of relevant test standard or method	3	Annual	In-house	No
Time measuring devices	(a) Required tolerance ≤ ± 0.5 sec	Calibrate appropriately according to required accuracy	1	Annual	UKAS	Yes
	(b) Required tolerance > ± 0.5 sec	Check against BT speaking clock OR Greenwich Mean Time website	3	Annual	In-house	No
Water baths, tanks, etc, constant temperature	(a) Required temperature tolerance < ± 2 °C	Check bath or tank temperature with an appropriate calibrated thermometer or calibrated continuous recording device	3	During use	In-house	No
		Check temperature profile with a calibrated thermometer; refer to the relevant test standard or method for individual requirements	3	Initial and after maintenance or repair	In-house	No
	(b) Required temperature tolerance ≥ ± 2°C	Check bath or tank temperature with a BS 593 traceable or calibrated max/min thermometer	3	During use	In-house	No
		Check temperature profiles; refer to the relevant standard method for individual requirements	3	Initial and after maintenance or repair	In-house	No

Item	Type	Calibration or check	Level	Interval (transition period)	Type of Certificate	Uncertainty budget required?
Weighing machines	(a) Laboratory balances, platform scales, etc	External calibration	1	Annual	UKAS	Yes
		Zero and single/ multi-point check (as appropriate)	3	Daily/before use	In-house	No
	(b) Spring balances	Check with working masses at suitable points	3	Daily/before use	In-house	No
Weights	(a) Reference: Class E1 and E2	External calibration	1	Bi-Annual	UKAS	Yes
	(b) Reference: Class F1, F2 and M1	External calibration	1	Annual	UKAS	Yes
	(c) Working: Class E1 and E2	Internal calibration	2	Dependent upon frequency of use (Max - 2 Years)	In-house	Yes
	(d) Working: Class F1, F2 and M1	Internal calibration	2	Annual	In-house	Yes

Appendix B – References

(Versions correct at time of issue)

ILAC P10:07/2020 ILAC Policy on Traceability of Measurement Results

EA-4/02 M: 2013 Evaluation of the Uncertainty of Measurement in Calibration

ILAC P14:09/2020 ILAC Policy for Uncertainty in Calibration