HOKLAS Supplementary Criteria No. 2

All Test Categories – Equipment Calibration and Verification

1 Introduction

1.1 This document serves to clarify and interpret the requirements of ISO/IEC 17025:2017, HKAS Policy Document No. 1 and HOKLAS 015 for calibration and verification of equipment related to the accreditation of non-medical and medical laboratories. It should be read in conjunction with the current issue of ILAC-P10, ISO/IEC 17025:2017, HKAS Policy Document No. 1, HOKLAS 015 and other relevant criteria documents.

1.2 In accordance with HOKLAS criteria on metrological traceability for non-medical laboratories (as stated in Section 6.5 of ISO/IEC 17025:2017) and for medical laboratories (as stated in Section 5.3 of HOKLAS 015), all equipment that directly or indirectly affects the result of a test, a calibration or an examination shall be calibrated before being put into service. “Evaluation of measurement data – Guide to the Expression of Uncertainty in Measurement” (JCGM 100:2008) should be referred when measurement uncertainty is determined.

1.3 All HOKLAS accredited laboratories shall comply with the requirements of ILAC-P10 “ILAC Policy on the Metrological Traceability of Measurement Results”.

1.4 This document also sets out the recommendations for calibration or verification of equipment including the calibration intervals and the associated procedures in the following appendices:-

1.5 The recommended calibration intervals in the appendices should in general be the maximum time interval between two successive calibrations provided that:

(a) the equipment is of good quality and of proven stability, and

(b) if any suspicion or indication of overloading or mishandling arises, the equipment shall be checked immediately and thereafter at a fairly frequent interval until there is evidence that the stability of the equipment has not been impaired.

Where the above criteria cannot be met, a shorter calibration interval should be adopted. The laboratory shall determine calibration interval according to the principles as given in section 6 and the recommended intervals as listed in the appendices of this document.

For equipment not included in the appendices, the laboratory shall demonstrate how its calibration requirements conform with the requirements of the related tests.

2 Policy on Metrological Traceability of Measurement Results

2.1 Where metrological traceability is required, measuring equipment and reference standards that require calibration shall be calibrated by one of the following options:

(1) A National Metrology Institute (NMI) whose service is suitable for the

intended use and is covered by the International Committee for Weight and Measures Mutual Recognition Arrangement (CIPM MRA). Services covered by the CIPM MRA can be viewed in the Bureau International des Poids et Mesures Key Comparison Database (BIPM KCDB) which includes the range and uncertainty for each listed service. Some NMIs may indicate that their service is covered by the CIPM MRA by including the CIPM MRA logo on their calibration certificates, however the fixing of the logo is not mandatory and the BIPM KCDB remains the authoritative source of verification. [ILAC Policy 1]

(2) An accredited calibration laboratory whose service is suitable for the intended use (i.e. the scope of accreditation specifically covers the appropriate calibration) and the Accreditation Body is covered by the ILAC Arrangement or by Regional Arrangements recognised by ILAC. Some calibration laboratories can indicate that their service is covered by the ILAC Arrangement by including the ILAC Laboratory Combined MRA mark on the calibration certificate. Irrespective of the ILAC Laboratory Combined MRA mark, the accreditation symbol (or a text reference to the accreditation) of HKAS or its MRA partners should be present on the calibration certificate. [ILAC Policy 2]

(3a) An NMI whose service is suitable for the intended use but not covered by the CIPM MRA. [ILAC Policy 3a]

(3b) A laboratory whose calibration service is suitable for the intended use but not covered by the ILAC Arrangement or by Regional Arrangements recognised by ILAC. [ILAC Policy 3b]

2.2 (3a) or (3b) should only be applicable when (1) or (2) are not possible for a particular calibration. Where option (3a) or (3b) is used, the laboratory shall ensure that appropriate evidence for the claimed metrological traceability and measurement uncertainty are available. This evidence will be assessed by HKAS.

2.3 In regard to metrological traceability provided by reference material producers (RMPs) through certified reference materials (CRMs), the certified values assigned to CRMs are considered to have established valid metrological traceability when:

2.3.1 CRMs are produced by NMIs using a service that is included in the BIPM KCDB [ILAC Policy 4]; or

2.3.2 CRMs are produced by an accredited RMP under its scope of accreditation and the accreditation body is covered by the ILAC Arrangement or by Regional Arrangements recognised by ILAC [ILAC Policy 5]; or

2.3.3 The certified values assigned to CRMs are covered by entries in the Joint Committee for Traceability in Laboratory Medicine (JCTLM) databases [ILAC Policy 6].

Recognising that the accreditation of RMPs is still developing and CRMs may not be available from accredited RMPs, where CRMs are produced by non-accredited RMPs, accredited laboratories shall demonstrate that CRMs have been provided by a competent RMP and that they are suitable for their intended use.

2.4 When metrological traceability to the SI is not technically possible, it is the responsibility of the accredited laboratory to:

2.4.1 choose a way to satisfy metrological traceability requirements by using certified values of certified reference materials provided by a competent producer [ILAC Policy 7a]; or

2.4.2 document the results of a suitable comparison to reference measurement procedures, specified methods, or consensus standards that are clearly described and accepted as providing measurement results fit for their intended use. Evidence of this comparison shall be available [ILAC Policy 7b].
Note: When metrological traceability to solely SI units is not appropriate or applicable to the application, a clearly defined measurand should be selected. Establishing metrological traceability therefore includes both proof of identity of the property measured and the comparison of the results to an appropriate stated reference. The comparison is established by ensuring the measurement procedures are properly validated and/or verified, the measuring equipment is appropriately calibrated and that conditions of measurement (such as environmental conditions) are under sufficient control to provide a reliable result.

3 Calibration Requirements

3.1 Parameters of equipment to be calibrated

Where the values of parameters are specified in the relevant standard specifications, the corresponding instruments shall be calibrated. Where tolerances are given, the measured values should be checked against them. Where tolerances are not specified, the requirements given in section 4 of this document should be followed.

3.2 Calibration procedures and intervals

Where the test standard or specification states the calibration procedure and the calibration interval, these requirements shall be followed.

Otherwise, the laboratory should determine appropriate calibration procedure and interval after considering all relevant factors. For dimensions and weights, a calibration interval of six months is in general acceptable.

3.3 Unspecified parameters

For parameters which may affect equipment operation but are not specified in the test standard or specification, the effect of change (for example, due to wear) should be assessed during regular equipment inspection and functional check. Where necessary, a specific procedure should be derived to assess the effect. It is a good practice to record initial value as a reference for later comparison.

3.4 All equipment calibrations shall be recorded.

4 Verification of a Parameter without Specified Tolerance

4.1 Where the tolerance of a specified parameter is not given in the test standard or specification, the laboratory should determine whether the parameter is critical and how critical it is.

4.2 For a critical parameter, justification for adopting a particular tolerance shall be documented. The justification would be examined by HKAS during an assessment.

For dimensional and angular measurements, the laboratory may select from ISO 2768-1 a suitable tolerance class. As a rough guide, the medium tolerance class in Table 1 and Table 3, for dimensional and angular measurements respectively, is acceptable for most equipment.

4.3 In the case of a non-critical parameter, the implied tolerance may be determined such that the next significant figure would not result in rounding to a value other

than the stated parameter. For example :-

stated parameter	implied tolerance
6 mm	6 mm ± 0.5 mm
3.2 mm	3.2 mm ± 0.05 mm
1.0 kg	1.0 kg ± 0.05 kg
1.000 kg	1.000 kg ± 0.0005 kg

5 Source of Calibration

5.1 Equipment calibration can be performed internally or externally.

5.2 Calibration can be performed internally if the laboratory has the necessary reference standard or reference material, and where applicable, suitably controlled environment and competent staff to perform the calibration. The internal calibration procedure shall be documented and available to HKAS assessors.

5.3 The quality of an in-house calibration shall be equivalent to that provided by a competent calibration laboratory. HKAS may invite an assessor in the calibration field to participate in an assessment to confirm the competence of the in-house calibration staff. There shall be evidence of competence confirmation such as organisation of inter-operator comparison, participation in interlaboratory comparison of calibration activities, or other activities that serve the purpose. In addition, appropriate documented evidence for claimed metrological traceability (e.g. through the use of certified reference materials) and measurement uncertainty shall be available for assessment.

5.4 Calibrations which require equipment not available to the laboratory or demand specialist techniques outside the capabilities and experience of the laboratory staff should be performed externally.

5.5 External calibration shall be performed by a competent calibration body as defined in Clause 2.1 of this document.

6 Calibration Programme and Operation of the Calibration System

6.1 Determination of the calibration programme

The calibration programme applicable to an individual laboratory should be determined by the laboratory management with due regard to the following factors:

(a) Which items of equipment can be calibrated internally and the corresponding calibration interval.

(b) Which items of equipment need to be calibrated by a competent calibration body and the corresponding calibration interval.

(c) For each item of equipment, what ranges and cardinal points should be calibrated, the calibration uncertainty requirements and the conditions under which calibrations should be performed. These should be determined based on the requirements of the tests or measurements for which that item of equipment is being used. Laboratories should document such requirements and provide them to external calibration laboratories when soliciting calibration services.

(d) When determining the calibration intervals, the following should be taken into consideration:
- HOKLAS recommendations;
- manufacturer recommendations;
- frequency of use;
- equipment condition;
- equipment stability and previous calibration and maintenance history;
- the accuracy and precision requirements of the tests for which that item of equipment is being used (e.g. where the test standard or specification states the calibration intervals, they should be followed);
- the likely influence of the working environment, e.g. corrosion, dust, vibration, frequent transportation and rough handling;
- the availability and reliability of the laboratory internal equipment checking system (e.g. where in-service checks are not carried out between calibrations, the calibration interval must be shortened).

For new test equipment, it is advisable to specify a shorter calibration interval. When successive calibration results demonstrate that the characteristic of a piece of equipment is stable, its calibration interval may be extended. Supporting data shall be retained to justify the extension of calibration interval and available to HKAS for assessment. To facilitate the determination of calibration intervals, laboratories are recommended to plot curves of equipment drifts against time.

For more information for determination of equipment recalibration intervals, please refer to ILAC-G24 / OIML D 10.

The calibration programme should be documented and reviewed regularly.

6.2 Designated officers of the laboratory shall be assigned the responsibility for the calibration of equipment and the management of reference materials.

6.3 After an instrument is calibrated, the laboratory shall assign a staff member to check whether the characteristics of the instrument as shown in the calibration results are within the acceptable tolerance. Out of tolerance instruments shall be repaired and recalibrated before use. Alternatively, such instruments may be downgraded for less demanding purposes provided that they are appropriately labelled.

6.4 The suitability of the calibration programme and the adequacy of the calibration system will be examined and discussed during assessments.

APPENDIX A

COMMON EQUIPMENT

This Appendix lists the recommended calibration requirements for common equipment. These are general recommendations applicable to all Test Categories for which a laboratory is accredited.

Where specific requirements are given in other Appendices, those requirements should take precedence.

Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
ACCELEROMETER		
(i) Reference	Five years (check annually)	
(ii) Working	Two years	
ACOUSTIC CALIBRATOR	One year Inter-instrument comparison every six months	
ANEMOMETER	Two years	
AUTOCLAVE	Initial verification (on-commissioning) and after significant repair (including after annual overhaul)*	Temperature measurement at strategic sites Verifying the pressure attained and heating profiles of 'typical loads' to ensure effectiveness of sterilisation
	Monthly check*	Effectiveness of sterilisation (with biological indicators)
	Each use*	Effectiveness of sterilisation either by chemical indicator or by print out from the autoclave with temperature and time record
BALANCE and SCALE (See Note 1 at end of this appendix)	a. Calibration every three years*	'The Calibration of Weights and Balances' published by NMIA"
	b. Verification:	
	Each weighing*	zero check
	Each day of use*	One-point check using a known mass.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is confirmed competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
	Every six months*	Repeatability check using a known mass.
BAND PASS FILTER SET	Two years	
BAROMETER (Fortin)	Five years	(i) Cleanness of mercury (ii) Vacuum space (iii) one-point check
BATH FOR CALIBRATION	a. Initial complete temperature survey b. Check temperature distribution at one temperature every five years.	
BEAT FREQUENCY OSCILLATOR	One year	
CALIBRATION UNIT FOR AUDIO-FREQUENCY VOLTMETER	a. Check annually. b. Determine the AC/DC transfer error of thermal element and multiplier every five years.	
CENTRIFUGE	One year*	Speed checking by calibrated tachometer (mechanical stroboscope or light cell type) (where operating speed specified) Temperature calibration (where applicable)
DENSITY BOTTLE (PYKNOMETER)	One year*	AS 2378 BS 733-2 App A; IP 190
DENSITY METER	a. Initial calibration. b. Calibration after a change in test temperature. c. Weekly check with air and double distilled water*	ASTM D4052
DIAL GAUGE	Two years*	AS 2103 BS 907 ISO 463
DIE AND CUTTER For preparation of test specimen such as dumb-bell rubber specimen	a. Frequent examination for damage. b. Full dimensional check whenever resharpened	

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
EXTENSOMETER		
(a) Level and mirror types	Five years	AS 1545 Grade D (for proof stress tests load-extension curves for pre-stressing wires)
(b) Micrometer screw type	Five years	
(c) Dial indicator type	Two years	AS 1545 Grade B (for modulus of elasticity determinations)
(d) Recording type with electrical output	Two years	(BS EN 10002-4)
FLOWMETER		
(a) Rotameter (Reference)		
High flow (≥ 1 l/min)	Two years*	ASTM D3195
Low flow (< 1 l/min)	Two years*	Soap bubble flowmeter
(b) Rotameter (Working)	Check before use in each time*	Soap bubble flowmeter
(c) Orifice plates, Venturi nozzles	Initial	ISO TR 15377 ISO 5167-1 ISO 9300
	Six months*	Visual inspect tip and other parts for damage, wear or contamination
(d) Wet test meter	One year*	ASTM D1071
(e) Anemometer	Two years	Check dimensional compliance in accordance with ISO 3966 Annex A
(f) Pitot tube	Initial* On use*	Inspect tip for damage, blockage, etc., in accordance with ISO 3966

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
FORCE TESTING MACHINE (tension, compression, universal)		
TYPE 1 - Mechanical Force Measuring System		AS 2193 BS 1610-1
(a) Dead weight	Five years	BS 1610-3
(b) Knife edge, lever and steelyard	Five years	ISO 5893 (rubbers and plastics only)
(c) Pendulum dynamometer	Two years	ISO 7500-1
(d) Elastic dynamometer (e.g. spring, ring with dial gauge)	Two years	ISO 7500-2 EN 10002-2
Note: Chain testing and similar machines in frequent use	One year	
TYPE 2 - Hydraulic or Pneumatic Force Measuring System		
(a) Mechanical system incorporating a pneumatic or a hydraulic link, e.g., proportional cylinder	Two years	
(b) Bourdon tube or diaphragm pressure gauge as force indicator	Six months	
(c) Type (b) fitted also with a master gauge which can be disconnected during normal testing	One year (plus frequent check by user of working gauge against master gauge)	
(d) Bourdon tube or diaphragm gauge used only as a null detector for a mechanical system	Two years	
(e) Bourdon tube with electrical transducer	Two years	
TYPE 3 - Electrical Force Measuring System	Two years	
FREQUENCY ANALYSER (Acoustic Measurement)	Five years	
FREQUENCY RESPONSE TRACER (Acoustic Measurement)	One year	

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
FREQUENCY STANDARD		
(a) For acoustic measurement	Two years	
(b) For time and frequency measurements	One year	
FURNACE		
For use at specified temperature	One Year*	BS 4309 AS 2853
FURNACE FOR CALIBRATION	Initial complete temperature survey Check temperature distribution at one temperature every five years.	
GAS STERILISER	Regular check with biological indicators at representative locations in typical loads	Effectiveness of sterilisation*
GAUGE BLOCK		
(a) Used as reference standard	Four years	BS 4311-1
(b) Used as working equipment	Two years*	ISO 3650
HARDNESS TESTER FOR METAL	(See Note 2 at end of this Appendix)	
Brinell, Vickers and Rockwell machine including portable tester	Refer to the requirements of respective standards	ISO 6506-2 (Brinell) ISO 6507-2 (Vickers) ISO 6508-2 (Rockwell)
HARDNESS TESTER FOR PLASTICS AND EBONITE		
(a) Dead weight tester for plastics	Three years	ISO 48 Method N, H, L & M ISO 7619-1
(b) Meter (durometer) for rubber	Frequent check using reference hardness block*	

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
HYDROMETER		
(a) Reference	Initial	AS 2026; IP 160; ASTM E126
(b) Working - glass	One year against reference or with freshly prepared solutions of known density*	ISO 649-2
- metal	Six months*	
HYGROMETER		
(a) with electric impedance sensor	Two years	
(b) with chilled mirror sensor	Six years	
IMPACT TESTING MACHINE (Pendulum type)		
(a) Charpy, Izod and Universal testers for metals	Refer to requirements of respective standards	AS 1544.4; BS 131-7; BS EN 10045-2; BS EN ISO 148-2
(b) Charpy and Izod testers for plastics	Refer to requirements of respective standards	AS 1146.3; BS EN ISO 13802
IMPEDANCE MATCHING NETWORK (Acoustic measurement)	Five years. Check annually	
LENGTH MEASURING DEVICE		
(a) Reference steel rules	Initial	For making measurements which will not affect test results, rules and vernier callipers from reputable manufacturers may be used without calibration
(b) Working rules and vernier callipers	Monthly or less depending on use* (zero and general condition)	
LINEAR VARIABLE DIFFERENTIAL TRANSDUCER (LVDTS)	Daily or whenever used* Two years* (complete calibration)	Check against length standard such as a micrometer

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
MANOMETER		
(a) Reference	Ten years Check fluid every three years	Check against reference
(b) Working	Three years*	
MICROMETER	One month (zero, one point and condition of anvils)*	Against gauge blocks. See also BS 870; BS 959; ISO 3611
MICROPHONE (LS1P or LS2P)	Check every three months. Calibrate annually or when 1 dB change is detected, whichever is the sooner.	
MICROPHONE AMPLIFIER	Check response annually	
NEUTRAL DENSITY FILTER	Ten years	
OVEN (Temperature of load space should be monitored by appropriate temperature sensor throughout use)		
(a) Ageing	Five years (temperature variation, recovery time, rate of ventilation)	
(b) Drying	Three years (temperature variation and evaporation rate in working space)*	BS 2648, AS 2853, AS 1289.0
(c) Vacuum	Five years (temperature variation, evaporation rate, pressure in working space)*	AS 2853 and AS 1289.0
PENETRATION CONE AND NEEDLE	Five years	ASTM D217; IP 50; ASTM D5; ASTM D1321. Visually inspect needle tips prior to use.
PHOTOCELL	Check linearity of response every six months. Check spectral response annually with colour filters; calibrate every five years or when apparent filter transmittances change significantly.	
PHOTOMETRIC TEST PLATE For luminance measurement	Five years	

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
PRESSURE AND VACUUM GAUGE		
(a) Test gauges for calibration of working gauges	One year	AS 1349; BS EN 837-1
(b) Working gauges subject to shock loading	Six months or less depending on use*	
(c) Working gauges not subject to shock loading	One year*	
PRESSURE GAUGE TESTER		
(a) Dead weight	Ten years	
(b) Manometer	Ten years	
PROVING DEVICE FOR CALIBRATION OF FORCE TESTING MACHINE		
TYPE 1 - Elastic devices		
(a) Dial gauge for deflection	Two years	
(b) Micrometer screw for deflection measurement (mechanical or optical indication)	Five years	
(c) Electrical deflection measurement	Two years	
TYPE 2 - Proving lever	Five years	
TYPE 3 - Weight	Ten years	
PSYCHROMETER, ASSMANN HYGROMETER and SLING TYPE PSYCHROMETER	Ten years (complete) Six months (compare thermometers at room temperature with wick dry)*	AS 2001.1 Appendix C
PYRHELIOMETERS	Five years	
PYROMETER		
(a) Reference	Three years	BS 1041-5
(b) Working	Six months*	

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
QUARTZ CONTROL PLATE	Ten years	
RADIOMETER	Calibrate after one hundred tests	
REFERENCE BALLAST	Five years	
REFERENCE GLASS FILTER		
(a) Spectrophotometry	Five years	
(b) Colorimetry	Five years	
(d) Luminous transmittance	Five years	
REFRACTIVE INDEX STANDARD		
(a) Liquid	Five years	
(b) Solid	10 measurements or 10 years, whichever is the sooner.	
SIEVE	Six months	Sieves should comply with the Grade B requirements of AS 1152 unless the test method specifies otherwise. Sieves supplied with a record card as prescribed in ISO 3310-1, 2 or 3 are accepted as complying with AS 1152 requirements. (See Appendix B, AS 1152). Laboratories requiring more than one set of sieves should have a reference set meeting the above requirements and one or more working sets. Working sieves should be given a performance check against the reference set using material typical of the samples normally subjected to sieve analysis in the laboratory.
SOUND LEVEL METER	One year Check every three months*	
SOUND POWER SOURCE	Five years	

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
STANDARD LAMP Luminous flux, luminous intensity, illuminance, spectral radiance, spectral irradiance	Five years or after each 20-hour period of burning	
STOPWATCH / TIMER (For verifying test duration)	Three months*	Comparisons against time and frequency broadcasts from short-wave stations such as JJY (Japan) at 2.5, 5, 8, 10, and 15 MHz for at least ten minutes; or Comparisons against timing signals broadcasted by Radio Television Hong Kong or announced by Hong Kong Observatory.
TACHOMETER		
(a) Reference	Five years	BS 3403
(b) Working	One year*	
TAPE RECORDER (for Acoustic Measurement)	Five years Check annually*	
THERMOHYGROGRAPH	One week against calibrated hygrometer or psychrometer when used to determine actual RH and temperature* One month against calibrated hygrometer or psychrometer when used only as indicator of RH and temperature variations*	AS 2001.1 Appendices C & D
THERMOCOUPLES		
(a) Reference (Preferably noble metal type)	Three years (complete) Six months (one-point)*	BS 1041-4; BS EN 60584-1; ASTM E220; ASTM E230
(b) Working	In general, same as for reference thermocouples. Working thermocouples subject to frequent stress and strain should be checked more frequently depending on their physical condition and the inhomogeneity effect.	Thermocouples used in high temperatures have definite life spans that must be taken into consideration.

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
THERMOMETER		
(a) Liquid-in-glass		
(1) Reference	Ten years (complete) Six months (zero-point)*	ASTM E77;
(2) Working	Initial check at sufficient points to cover the expected working range followed by single-point checks at six-monthly intervals*	Check against a calibrated reference thermometer; IANZ Technical Guide No. 3
(b) Electronic	Three years (complete) Six months (one-point)*	
(c) Platinum resistance	Ten years (complete) Check ice-point before use or at least every 6 months	
(d) A.C. resistance bridge	Five years (resistance ratios)	
THICKNESS GAUGE (for compressible materials)	Two years	Dial gauge, dimensions and pressure of plunger base
VELOCITY TRANSDUCER	Calibrate sensitivity and frequency response every two years. Check every six months*	
VISCOMETER		
(a) U-tube		
(1) Reference	Ten years (against standard oils) *	ASTM D2162
(2) Working	Two years (using quality oil against reference tubes or standard oils)*	ASTM D2162/D445; IP 71
(b) Others		
(1) Brookfield	Two years (using standard oils) plus one-months checks using manufacturers' oils, covering the normal range of operation of the instrument*	ASTM D2556
(2) Ferranti	Three months (using standard oils)*	
(3) Zahn	One year (using standard oils)*	

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Type of equipment	Recommended maximum period between successive calibrations	Recommended calibration method
VOLUMETRIC APPARATUS		
(a) Volumetric glassware (pipettes, burettes, volumetric flasks, distillation receivers) when used for tests where the error contribution from glassware to the overall accuracy required is significant or where methods specify glassware meeting nominated standards.	Initial (on commissioning)*	AS 2162.1; BS 1797; ISO 4787
(b) Specialised glassware (water traps, sulphonation flasks, centrifuge tubes, etc.)	Initial*	AS 2162.1; BS 1797
(c) Piston operated volumetric apparatus (micropipettes)	Initial* 6 months*	Check volume delivered. For adjustable devices check volume delivered at several settings (refer to AS 2162.2 or ISO 8655-1, 2, 3, 4, 5 and 6)
WEIGHTS		
(a) Reference weights of integral construction (i.e. consist of a single piece of material), stainless steel or nickel chromium alloy	Five years initial; Ten years subsequent	ASTM E617, OIML R111
(b) Working weights, , stainless steel or nickel chromium alloy	Three years*	ASTM E617, OIML R111
(c) Working weights, not stainless steel or nickel chromium alloy	One year*	ASTM E617, OIML R111
Weights used for routine calibration of balance are considered working weights.		

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is confirmed competent to perform such calibrations.

NOTE 1 - ADDITIONAL REQUIREMENTS FOR CALIBRATION OF BALANCES

(1) In performing balances calibration, laboratory personnel may select on-site calibration or off-site calibration. On-site calibrations mean the calibration staff members conduct the calibration at the location where the balance is in use. Off-site calibrations mean the calibration is performed away from the location where the balance is in use (e.g. in another section of the same laboratory or in an external calibration laboratory).

(2) The selection of on-site calibration or off-site calibration depends on many factors such as the desired accuracy of the balance which is indicated by the ratio between balance capacity and balance resolution. For any balance with capacity/resolution ratio exceeding 30000, the balance shall be calibrated on-site and off-site calibration is not allowed. For any balance with capacity/resolution ratio at or below 30000, the balance can be calibrated off-site. Nevertheless, the calibration service provider is required to ensure that the difference in calibration results at different locations will not be larger than the associated calibration uncertainties. For a balance with capacity 5kg and resolution 1g, the capacity/resolution ratio is 5000 (5000/1=5000<30000), i.e. the calibration can be carried out either on-site or off-site. For a 5-kg capacity balance with 1mg resolution, the capacity/resolution ratio is 50000 (5000/0.1=50000>30000), i.e. the calibration shall be carried out on-site.

(3) When a balance has to be used away from the laboratory e.g. when performing site test. The operator shall determine the acceptability of such arrangement based on the above principle, i.e. whether the balance capacity/resolution ratio is greater than 30000 and also on the assessment of the performance of the balance at different locations.

NOTE 2 - ADDITIONAL REQUIREMENTS FOR HARDNESS TESTING ON METALS

(1) Laboratories shall carry out a performance check test at the start of each day on which hardness tests are to be performed.

(2) Hardness blocks with assigned values from established block manufacturers (such as Vickers, Avery, Wilson and Yamamoto) may be used.

(3) The check should be carried out using forces close to those involved in the tests to be conducted on that day. So far as is practicable, the hardness values should also match those involved on that day. Laboratories shall have an adequate range of blocks to cover the range of hardness and the forces normally encountered.

(4) Laboratories are encouraged to have an accredited metrology laboratory to carry out a limited calibration on their blocks at the forces applied in the laboratory but which are not included in their original calibration, but it is recognised that in practice there will be occasions when a laboratory has to use a force for which the block has not been calibrated.

(5) For Vickers and Rockwell hardness tests, laboratories may use uncalibrated indenters, provided those indenters have been checked by performance tests on hardness blocks with assigned values and by inspection at a magnification of at least 50 times.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is confirmed competent to perform such calibrations.

APPENDIX B

EQUIPMENT FOR TESING OF ELECTRICAL AND ELECTRONIC PRODUCTS

The following table sets out recommended maximum periods between successive calibrations for a number of reference standards and measuring instruments used in electrical and electronic testing.

Table 1 Reference Standards and Measuring Instruments

Type of equipment	Recommended maximum period between successive calibrations
ATTENUATOR	Three years (frequency response)
BRIDGE	Five years (full calibration) Check against laboratory standard annually
CAPACITOR	Five years Inter-instrument comparison annually
DIGITAL METER	One year
INDUCTOR	Five years Inter-instrument comparison annually
INSTRUMENTS, INDICATING AND RECORDING	Five years Inter-instrument comparison every six months, or more frequently as required
INSTRUMENT and RATIO TRANSFORMER	Ten years
INSTRUMENT TRANSFORMER TEST SET	Five years (full calibration)
POTENTIOMETER	Five years
RESISTOR	Five years Inter-instrument comparison annually
RF POWER MEASURING EQUIPMENT	Three years

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations
SIGNAL GENERATOR	One year (frequency accuracy, output level and attenuator ratio)
STANDARD CELL	Two years Inter-cell comparison at least six-monthly
TIME, TIME INTERVAL and FREQUENCY STANDARD	Calibration intervals dependent on equipment frequency, type and accuracy required. This may be as frequently as daily if the highest possible performance is required.
TRANSFER STANDARD, AC-DC	Eight years Inter-instrument comparison immediately after calibration and then every four years
VOLTAGE CALIBRATING TRANSFORMER	Ten years
VOLT RATIO BOXE	Five years Inter-instrument comparison annually
WATTHOUR METER (ELECTRO-MECHANICAL)	Two years Inter-instrument comparison every three months
WATTMETERS AND WATTHOUR METER (ELECTRONIC)	One year with regular inter-instrument comparisons - interval is to be based on history of performance

Table 2 Equipment Used in Electrical Safety Tests

Type of equipment	Recommended maximum period between successive calibrations
BALL PRESSURE TEST APPARATUS	Initial verification of dimensions and weight * Yearly inspection for damage and wear * More frequent inspection is required if the test apparatus is frequently used
ENVIRONMENTAL CHAMBER	Five years, including temperature variations, recovery rate and rate of ventilation*
FIXTURES AND DIMENSION GAUGE	Initial verification of compliance with specifications* Yearly inspection for damage and wear* Fixtures and gauges having moving parts should be inspected more frequently Precision gauges subject to wear should be calibrated three-yearly

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations
FORCE AND TORQUE GAUGE	Yearly complete calibration* Six-monthly repeatability check*
GLOW-WIRE TEST APPARATUS	Initial check and periodic verification for dimensional compliance for the glow-wire* Three-monthly verification of the force applied to test samples* Calibration of the temperature measurement thermocouples should be carried out in accordance with Appendix A
LEAKAGE CURRENT MEASURING NETWORK	One year* The input impedance and the frequency response accuracy should be checked
SPRING OPERATED IMPACT HAMMER	Initial verification of compliance with specification, including impact energy and hardness of the impact head Yearly calibration of impact energy Six-monthly inspection for wearing of impact head*
SURGE GENERATOR	One year*
TEMPERATURE RECORDER	Five-yearly complete calibration Inter-instrument comparison every six months* Recorders having a higher resolution have to be calibrated more frequently. (This is applicable only when the temperature measurement sensors and the recorder are calibrated separately. Temperature sensors, including thermocouples, should be calibrated in accordance with Appendix A. When the sensors and recorders are calibrated together as an integral instrument, the calibration requirements for electronic thermometer in Appendix A should be followed.)
TEST FINGER	Three-yearly complete calibration for dimensional compliance Six-monthly inspection for damage and wear*

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Table 3 Equipment Used in EMC Tests

Type of equipment	Recommended maximum period between successive calibrations
ANECHOIC CHAMBER	One year*
ANTENNA	Two years More frequent calibration may be required for antennae used outdoors or subject to rough handling
ABSORBING CLAMP	One year
ELECTROMAGNETIC FIELD PROBE	One year
ELECTROMAGNETIC INTERFERENCE (EMI) RECEIVER	One year
ELECTROSTATIC DISCHARGE (ESD) GUN	Yearly calibration for electrical characteristics For the discharge electrodes, initial verification for dimensional compliance and six-monthly inspection for damage and wear*
FAST TRANSIENT BURST GENERATOR	One year *
LINE IMPEDANCE STABILIZATION NETWORK (LISN)	One year*
OPEN AREA TEST SITE	Six months*
SPECTRUM ANALYSER	One year
VOLTAGE DIP GENERATOR	One year*

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

APPENDIX C

EQUIPMENT RELATED TO DIMENSIONAL METROLOGY

The following table sets out the maximum recommended period between initial calibration and the first recalibration, and the maximum period between subsequent recalibrations provided that the first two calibrations indicate that the item is stable. The calibration interval for each specific item will be examined during the assessments of the laboratory. Factors such as general condition and frequency of use shall be taken into account.

Item	Maximum period between initial calibration and the first recalibration (years)	Maximum period between subsequent calibrations (years)
ANGLE GAUGES		
(a) reference	4	8
(b) working	2	4
DIVIDING HEADS	5	8
GAUGE BLOCKS		
(a) reference	4	8
(b) working	2	4
HEIGHT SETTING MICROMETERS AND RISER BLOCKS	3	3
LENGTH BARS		
(a) reference	4	8
(b) working	2	4
LEVELS (precision)	4	4
LINEAR (precision)	5	10
OPTICAL FLATS	3	6
OPTICAL PARALLELS	3	6
PRECISION POLYGONS	5	10
ROLLERS AND BALLS	4	8
ROUNDNESS STANDARDS	5	10
ROUGHNESS STANDARDS	4	4

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Item	Maximum period between initial calibration and the first recalibration (years)	Maximum period between subsequent calibrations (years)
SCREW CHECK PLUGS FOR RING GAUGES	3	6
SCREW PITCH REFERENCE STANDARDS	3	6
SETTING CYLINDERS	3	6
SETTING RINGS	3	6
SQUARES		
— try squares	2	5
— block squares	4	8
SURFACE PLATES		
— cast iron	3	5
— granite	4	8
THREAD MEASUREMENT CYLINDERS	4	6
THREAD MEASUREMENT VEE PIECES	2	5

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

APPENDIX D

ANALYTICAL INSTRUMENTS FOR CHEMICAL TESTING

1. Introduction

1.1 Analytical instruments used in chemical testing are frequently calibrated by comparative techniques, that is, the response signals of the instrument are related to the concentrations or amounts of the analyte through the use of reference materials. Many types of analytical instruments require calibration before use and calibration thus forms an integral part of the analytical procedures.

1.2 Correct use combined with proper calibration may not necessarily ensure an instrument is performing adequately. Where appropriate, periodic checks on the performance characteristics should be carried out. These instrument performance characteristics include, for example, response, stability and linearity of sources, sensors and detectors, the separation efficiency of chromatographic systems, the alignment and wavelength accuracy of spectrometers, etc. The purpose of these checks is to verify the performance of the instruments against the specified requirements of the tests for which the instruments are being used.

1.3 This Appendix sets out specific calibration and performance check requirements for analytical instruments used for chemical testing. Laboratories should refer to Sections 6.4 and 6.5 of ISO/IEC 17025:2017 and other sections of this supplementary criteria for general requirements on calibration of equipment. Equipment in common with other testing fields are listed in Appendix A.

1.4 The laboratory should document and implement a calibration and/or performance checks programme appropriate to the circumstances involved. The performance characteristics to be checked as well as the acceptance criteria for and frequency of checks should be based on the requirements of the tests concerned taking into consideration the recommendations given in Table 1 and factors given in clause 3.1 of this appendix. It is the responsibility of the laboratory to demonstrate that the programme is suitable for the circumstances involved.

1.5 Since standard practice for operation of analytical instruments are generally unavailable or highly specific to a particular application, the laboratory shall document its practice for use of analytical instruments. This should include, as appropriate, a description of the operation of the instrument, procedures and acceptance criteria for calibration and performance checks, frequency of use and nature of quality control samples, and maintenance procedures.

1.6 Calibration and performance checks can normally be conducted by the staff of a laboratory. The laboratory should, however, ensure that sufficient reference materials and required equipment are available, and the persons involved should possess the required skills, experience and training.

1.7 The laboratory shall ensure that all calibration and/or verification of analytical instruments are traceable to national or international standards of measurement or to reference materials produced by competent producers (see HOKLAS Supplementary Criteria No. 1).

2. Calibration

2.1 Normally, either the manufacturers of the instruments and/or the test standards themselves specify the calibration procedures and requirements. These instructions should be followed, if available. In some cases, check samples are used during analyses to confirm the validity of the calibration. Re-calibration of instruments should be carried out when such checking procedure indicates that previous calibrations are no longer valid. Further requirements on calibration for chemical testing are given in respective HOKLAS supplementary criteria.

2.2 Acceptance criteria for calibration and criteria for re-calibration should be based on the test standards, if available, or determined by the requirements of the tests concerned. These criteria shall be documented and strictly adhered to.

2.3 Acceptance criteria for calibration should include a criterion for the acceptability of the calibration function and, when applicable, a criterion for the performance of instruments. An example of the former criterion is correlation coefficient of a linear calibration graph whilst the latter may include, for example, the slope of the calibration graph or the magnitude of the detector response at a specific level of analyte. The latter instrument performance check (IPC) during calibration should not be confused with that described in Clause 3 below. This IPC should be regarded as a routine start-up check on the usability of instruments as distinguished from the verification of equipment against requirements of tests.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

3. Performance check

3.1 It is inappropriate to specify a rigid frequency for performance checks since the frequency depends on a number of factors including :-

- type of equipment;
- manufacturer's recommendation;
- trend data obtained from previous performance checks records;
- recorded history of maintenance and servicing;
- extent and severity of use;
- tendency to wear and drift;
- frequency of cross-checking against other reference standards;
- environmental conditions (temperature, humidity, vibration, etc.);
- accuracy and permissible limits of errors.

3.2 Acceptance criteria for performance checks should be based on the requirements of test standards, if available, taking into consideration recommendations given by the manufacturers of the instruments. Test standards may sometimes explicitly state the acceptance criteria for various performance characteristics but, frequently, such acceptance criteria have to be derived from the requirements of test standards. For instance, the detection limits of an instrument may have to be derived from the specification limits of the standards.

3.3 Instruments shall be taken out of service when results of performance checks fall outside the acceptance criteria. Suitable corrective measures and servicing should be taken when results of performance checks indicate that there is a system degeneration. An instrument should not be put back into service unless subsequent checks indicate that its performance fulfils the acceptance criteria.

3.4 The performance characteristics to be checked depends on the type of the instrument. Table 1 lists those performance characteristics of common analytical instruments that require to be checked.

4. Calibration and Performance Check Frequency

4.1 Table 1 sets out the normal frequencies for calibrations and performance checks of common analytical instruments. The frequencies, when given, are recommended maximum periods. They serve as a starting point for initial selection of re-calibration/performance checks intervals.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

4.2 Intervals of calibration/performance checks should be reviewed regularly and adjustments of these intervals may be made based on experience. However, any revision of frequency shall be justified (e.g. changes of usage, environment, required accuracy, etc.). The guidelines given in ILAC-G24 / OIML D 10 for the determination of recalibration period should be followed.

4.3 Test standards may sometimes specify a shorter calibration/performance check intervals than that listed in Table 1, in such cases, the frequency recommended by the test standards shall be followed. In addition, if major mechanical or electronic maintenance is carried out, appropriate checks should be conducted when the instrument is re-commissioned.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Table 1 Calibration and Performance Checks Requirements for Analytical Instruments

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
BOMB CALORIMETERS	6 months or after any significant part of the system has been changed	Determine the effective heat capacity using certified benzoic acid. Refer to ISO 1928.
CONDUCTIVITY METERS	6 months	Determine cell constant using potassium chloride standard solutions appropriate to each desired measuring range. Refer to ISO 7888, OIML R 56 & OIML R 68.
DISSOLVED OXYGEN METERS	Calibrate at saturation on each day of use and after relevant change of ambient conditions. Calibrate the zero if necessary. Check linearity if there is a problem with the instrument.	Calibrate the zero and at saturation. Check linearity. Refer to ISO 5814 and manufacturer's instructions.
pH METERS	Calibrate on use	Calibrate the instrument with two standard buffers on use, appropriate to the anticipated pH of the sample being measured. Refer to ISO 10523 and manufacturer's instructions.
TURBIDIMETERS	Calibrate on use	Calibrate the apparatus using formazine standard solutions. At least five points with each measuring range should be used for plotting the calibration graph. Refer to ISO 7027 or APHA 2130 B and manufacturer's instructions

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
CHROMATOGRAPHS	Calibrate on use.	
	Check performance yearly	(a) Gas chromatographs – check the following, as appropriate: i. Overall system checks, precision of repeat sample injections, carry-over; ii. Column performance (capacity, resolution, retention); iii. Detector performance (detection limit and linearity); iv. System heating/ thermostatting (accuracy, precision, stability, ramping characteristics); v. Autosampler (accuracy and precision of time routines). Refer to OIML R 82, OIML R 83 & OIML R 113 (b) Liquid chromatographs – check the following, as appropriate : i. Overall system performance; ii. Detector sensitivity; iii Mobile phase delivery system (precision, accuracy, pulse-free) Refer to OIML R 112. iv. Gradient performance checks for LC systems adopting solvent programming. Refer to LCGC Asia Pacific

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
SPECTROMETERS AND SPECTROPHOTOMETER	Calibrate on use. Check performance yearly	(a) UV/Visible - Check wavelength accuracy, stray radiation, absorbance accuracy and zero absorbance line flatness. Refer to AS 3753. (b) Infra-red - Check wavenumber accuracy, wavenumber reproducibility and beam balance. Refer to ASTM E932. (c) Atomic Absorption - Check precision, sensitivity and detection limit of metals of interest. Refer to OIML R 100. (d) Atomic Emission using arc/spark discharge - Check precision and background equivalent concentration. Refer to AS 2883. (e) Inductively Coupled Plasma Atomic Emission - Check repeatability, background equivalent concentration and detection limit. Refer to AS 3641.2 or OIML R 116. (f) X- Ray Fluorescence - Check precision, counter resolution, dead time. Refer to AS 2563 or OIML R 123

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Annex I
(Informative)

Bibliography

Part 1 General Principles of Equipment Calibration

Laboratory staff responsible for equipment calibration and verification are strongly advised to consult the following references.

1. EURACHEM/CITAC Guide [Edition 2016] - Guide to Quality in Analytical Chemistry. An Aid to Accreditation

2. ISO 10012 Measurement management systems - requirements for measurement process and measuring equipment

3. ISO Guide 33 Reference materials – Good practice in using reference materials

5. ISO/TS 13530 Water quality - Guidance on analytical quality control for chemical and physicochemical water analysis

6. Guide to the Expression of Uncertainty in Measurement (JCGM 100:2008) (http://www.bipm.org/utils/common/documents/jcgm/JCGM_100_2008_E.pdf)

Part 2 Recommended Practices for Specific Equipment

The following references contain description of the operation, calibration and/or performance check procedures. Operation staff of laboratories are strongly advised to familiarize themselves with these references.

A. UV/Visible Spectrophotometers

1. AS 3753 Recommended practice for chemical analysis by ultraviolet/visible spectrophotometry

2. ASTM E131 Standard terminology relating to molecular spectroscopy

3. ASTM E169 Standard practices for general techniques of ultraviolet visible quantitative analysis

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

4. ASTM E275 Standard practice for describing and measuring performance of ultraviolet and visible spectrophotometers

5. ASTM E925 Standard practice for monitoring the calibration of ultraviolet-visible spectrophotometers whose spectral bandwidth does not exceed 2 nm

6. ASTM E958 Standard practice for estimation of the spectral bandwidth of ultraviolet-visible spectrophotometers

B. Infra-red Spectrometers

1. ASTM E932 Standard practice for describing and measuring performance of dispersive infrared spectrometers

C. Atomic Absorption Spectrometers

1. AS 2134 Recommended practice for chemical analysis by atomic absorption spectrometry: AS 2134.1 Flame atomic absorption spectrometry, AS 2134.2 Graphite furnace spectrometry and AS 2134.3 Vapour generation AAS

2. AS 3550.6 Waters Determination of filtrable calcium - Flame atomic absorption spectrometric method

3. ASTM E1184 Standard practice for determination of elements by graphite furnace atomic absorption analysis

4. APHA 3111 Metals by flame atomic absorption spectrometry

5. APHA 3112 Metals by cold-vapour atomic absorption spectrometry

6. APHA 3113 Metals by electrothermal atomic absorption spectrometry

7. APHA 3114 Arsenic and selenium by hydride generation/atomic absorption spectrometry

D. Atomic Emission and X-Ray Fluorescence

1. AS 2563 Iron ores – Wavelength dispersive X-ray fluorescence spectrometers - determination of precision

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

2. AS 2883 Analysis of metals - Procedures for the setting up, calibration and standardization of atomic emission spectrometers using arc/spark discharge

3. AS 3641.1 Recommended practice for atomic emission spectrometric analysis Part 1 Principles and techniques

4. ASTM E135 Standard terminology relating to analytical chemistry for metals, ores and related materials

5. ASTM E305 Standard practice for establishing and controlling atomic emission spectrochemical analytical curves

6. ASTM E826 Standard practice for testing homogeneity of a metal lot or batch in solid form by spark atomic emission spectrometry

E Inductively Coupled Plasma

1. AS 3641.2 Recommended practice for atomic emission spectrometric analysis Part 2 Inductively coupled plasma excitation

2. APHA 3120 Metals by plasma emission spectroscopy using inductively coupled plasma source

F. Gas and liquid chromatographs

1. ASTM D1945 Standard test method for analysis of natural gas by gas chromatography

2. ASTM D4626 Standard practice for calculation of gas chromatographic response factors

3. ASTM E260 Standard practice for packed column chromatography

4. ASTM E355 Standard practice for gas chromatography terms and relationships

5. ASTM E516 Standard practice for testing thermal conductivity detectors used in gas chromatography

6. ASTM E594 Standard practice for testing flame ionization detectors used in gas or super critical fluid chromatography

7. ASTM E682 Standard practice for liquid chromatography terms and relationships

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

8. ASTM E685 Standard practice for testing fixed-wavelength photometric detectors used in liquid chromatography

9. ASTM E697 Standard practice for use of electron-capture detectors in gas chromatography

10. ASTM E840 Standard practice for using flame photometric detectors in gas chromatography

11. ASTM E958 Standard practice for estimation of the spectral bandwidth of ultraviolet-visible spectrophotometers

12. ASTM E1151 Standard practice for ion chromatography terms and relationships

13. LCGC Asia Pacific, Vol. 8, March 2005 Gradient Performance checks (available on: http://www.chromatographyonline.com/lcgc-asia-pacific-03-01-2005)

G. Temperature Chambers

1. HKAS IN003 Guidance on calibration and performance verification of temperature chambers

2. IEC 60068-3-5 Environmental testing: Supporting documentation and - confirmation of the performance of temperature chambers

3. Guideline DKD-R 5-7 “Calibration of Climatic Chambers”

Remark: For dated references in the whole Appendix D (including Annex I), only the edition cited applies. For undated references cited, the latest edition (including any amendments) applies.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

APPENDIX E

EQUIPMENT FOR CONSTRUCTION MATERIALS TESTING

This appendix lists the items of equipment and their calibration requirements within the Construction Materials Test Category in the test areas covering aggregates, bituminous materials, concrete and steel. Specific calibration requirements for other test areas are included in respective Supplementary Criteria listed as follows:

Supplementary Criteria No. 15	Non-destructive tests for welding of steel and metal
Supplementary Criteria No. 16	Foundation tests
Supplementary Criteria No. 17	Building components and related tests
Supplementary Criteria No. 18	Soil and rock testing
Supplementary Criteria No. 19	Diagnostic tests on concrete
Supplementary Criteria No. 47	Accreditation of Fire Testing

For construction materials testing equipment, the criteria in this appendix should be read first over any other appendices in this supplementary criteria. Where conflicting criteria exist, the requirements of this appendix shall take precedence. The calibration periods listed here are the maximum acceptable, and shorter time periods may be required due to frequency of use and storage conditions.

Environment

General policy on environment is covered under section 6.3 of ISO/IEC 17025: 2017.

In addition to the comments therein it is possible for an accreditation to be granted for tests conducted under more than one set of environmental conditions provided that these are :

- In accordance with the standard concerned and
- The test report indicates clearly which criteria have been adopted.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Equipment

Criteria are contained elsewhere in this Supplementary Criteria in respect of other items under different Test Categories. Several of the construction materials standards do however contain details of items of equipment peculiar to the test method concerned. Calibration and maintenance of these items should generally satisfy one of the following:-

- Where the standard concerned gives a calibration procedure, this procedure shall be followed and the maximum period between successive calibrations shall be that specified in the standard.

- Where no calibration procedure is given in the standard but tolerances on dimensions or mass are provided, a check against the specified values shall be made and recorded at least once every 12 months unless a calibration interval is given in the standard.

- Equipment for which no detailed criteria or tolerances are given should be regularly inspected.

Solutions

There are many instances where solutions are required in connection with both the physical and chemical testing of materials.

It is not practical to give detailed guidance on the storage and shelf life of these but laboratories involved should either;

- Make up fresh solutions as and when required, where the standard concerned gives a calibration procedure but without a calibration interval, the calibration interval shall be 6 months, or

- Initiate a programme for ascertaining the shelf life of the solutions concerned.

In the case of distillation and/or de-ionizing of water, the equipment concerned should be checked for satisfactory performance at least once every 6 months.

Reference Materials

Reference materials called up in standards shall be obtained from the sources stated in the standard and stored in the prescribed manner. Specific HOKLAS policy on reference materials is covered under clause 2.4 of this document.

Specific HOKLAS Calibration Criteria

The following table sets out the maximum periods between successive calibrations for equipment to be used in connection with testing of aggregates, bituminous materials, concrete, steel, and soils within the Construction Materials Test Category. Specific HOKLAS policy for calibration is covered under section 3 – 6 of this document.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
BALANCE (Reference)	2 years	By a 'competent calibration body' as defined in clause 2.1 of this document
	6 months*	Repeatability check using reference masses of higher grades
	1 month*	One-point check using reference masses to balance capacity
BALANCE (Working)	(a) 3 years or immediately following servicing	Calibrate using reference masses in accordance with the national standard method or other equivalent standards
	(b) 6 months*	Repeatability check using reference masses in accordance with a standard method. Adjust the balance and carry out a full calibration if the required testing accuracy is exceeded
	(c) Each day of use*	One-point check using a known mass at or close to a frequently encountered value or the balance capacity for a specified range
	(d) Each weighing*	Zero check after tare
CALLIPERS (Vernier or digital readout)		
(Accuracy equal to and better than 0.01mm)	2 years	By a 'competent calibration body' as defined in clause 2.1 of this document
(Accuracy between 1 mm and 0.01mm)	1 year*	Calibrate using reference gauge blocks or callipers checker. A sufficient number of readings shall be taken covering the expected working range.
(Accuracy not better than 1mm)	Initial only	Callipers from reputable manufacturers may be used.
(Callipers of any accuracies)	Before each use*	Zero check

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
DIAL GAUGE		
(Accuracy equal to and better than 0.01mm)	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document
(Accuracy not better than 0.01mm)	1 year	Calibrate using reference gauge blocks or a micrometer type calibrator for compliance with BS 907 or AS 2103
LINEAR DISPLACEMENT MEASURING DEVICE (LVDT, digimatic gauge, Demec gauge or any other transducer types)		
(Accuracy equal to and better than 0.01mm)	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document
	Before each use*	One-point check using gauge block
(Accuracy not better than 0.01mm)	1 year	Calibrate the measuring device together with the same readout unit as is used for test using reference gauge blocks or a micrometer type calibrator. The readout unit can be an electrical display unit, digital display unit or data logging system.
	Before each use*	One-point check using gauge block
MASS (Working-hanger weights)	1 year*	Calibrate using a calibrated reference balance
MICROMETER		
(Accuracy equal to and better than 0.01mm)	2 years	By a 'competent calibration body' as defined in clause 2.1 of this document
(Accuracy not better than 0.01mm)	1 year*	Calibrate using reference gauge blocks. A sufficient number of readings shall be taken covering the expected working range.
Micrometer of any accuracies	Before each use*	Zero Check

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
OVEN	(a) 3 years or immediately following servicing or each change in temperature setting*	Check temperature variation in working space using different calibrated thermocouples at the same time [refer to HKAS IN003] and also check evaporation rate for compliance with the requirements of AS 2853 and AS 1289.0 or other relevant standard methods
	(b) 6 months*	Check temperature at centre of usable oven space inside an empty oven using a calibrated thermocouple. Ten readings shall be taken at 3-minute intervals with the oven set at the working temperature range.
PRESSURE GAUGE CALIBRATOR (Reference standard)		
Dead weight tester	5 years	By a 'competent calibration body' as defined in clause 2.1 of this document
Manometer	5 years	By a 'competent calibration body' as defined in clause 2.1 of this document
PRESSURE GAUGE (Reference) (Electrical transducer type)	2 years	By a 'competent calibration body' as defined in clause 2.1 of this document
PRESSURE GAUGE (Working gauge)		
Bourdon tube or hydraulic type	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document
Transducers types	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document
RULE	2 years*	Check against reference length standard with a higher accuracy. Check at a minimum of 5 points over the entire length.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
SIEVE		
(Reference woven wire cloth sieves, for performance checking of test sieves)	Initial only	Sieves with recognized manufacturer's certificates which certify conformance with ISO 3310-1 shall be used. Reference sieves shall be downgraded to test sieves after 30 passes.
(Perforated plate test sieves – apertures larger than or equal to 4mm)	300 passes but not exceeding 6 months*	Check aperture and bridge width using calibrated callipers, optical projection, or other appropriate devices in accordance with ISO 3310-2.
(Woven wire cloth test sieves – apertures less than 4mm)	300 passes but not exceeding 6 months*	Check aperture using optical projection or other appropriate equipment in accordance with ISO 3310-1. Alternatively, check performance of apertures using certified reference samples or performance check samples with reference sieves in accordance with BS 812-100 or BS 1377-1. Sieves with manufacturer's certificates which certify conformance with ISO 3310-1 may be used directly without initial checking.
THERMOCOUPLE (for checking ovens)	3 years	By a 'competent calibration body' as defined in clause 2.1 of this document
	6 months*	One-point check, at ice point or some other appropriate temperature
THERMOMETER - (Mercury-in-glass)		
(Accuracy equal to and better than 0.5°C)	5 years	By a 'competent calibration body' as defined in clause 2.1 of this document
	6 months*	One-point check, at ice point or some other appropriate temperature
(Accuracy not better than 0.5°C)	5 years*	Calibrate over the expected working range using a calibrated thermometer and suitable calibration bath
	6 months*	One-point check, at ice point or some other appropriate temperature.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
THERMOMETER – (Electronic, digital and platinum resistance)	3 years	By a 'competent calibration body' as defined in clause 2.1 of this document
	6 months*	One-point check, at ice point or some other appropriate temperature
TIME MEASURING DEVICE		
(a) Accuracy equal to or better than 0.5 second	1 year*	Calibrate against reference time standard in accordance with relevant calibration standard
(b) Accuracy not better than 0.5 second	3 months*	Check against time given by radio time (RTHK) signal for at least half an hour
VACUUM GAUGE		
(a) Mechanical or hydraulic	2 years	By a 'competent calibration body' as defined in clause 2.1 of this document
(b) Transducer	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document
VOLUMETRIC GLASSWARE (burettes, pipettes, volumetric flasks including measuring cylinders)	Initial only*	Check by weighing the amount of distilled water that the vessel contains or delivers at a measured temperature, applying any temperature corrections necessary using the Tables in BS1797. The mass of water shall be determined to within 0.01%. The checking shall be repeated a sufficient number of times to obtain the average volume. Where a vessel is to be used at a particular graduation mark only, checking may be limited to that mark but the vessel must be labelled to indicate clearly the limited checking.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
	AGGREGATES	
ABRASION MACHINE	1 year*	Check dimensions of moulds, trays and plates; speed of rotation of machine and mass of weights in accordance with BS 812-113 or other relevant standard methods
ACCELERATED POLISHING MACHINE	1 year*	Check rate of flow of flowmeter, rotational speed of rad wheel, planes of rotation of tyred and road wheels, free force of rubber wheels, and rubber tyred and road wheel dimensions in accordance with BS 812-114 or other relevant standard methods
ELONGATION GAUGE	1 year*	Check with a calibrated calliper or micrometer
FRICTION TESTER	1 year*	Check dimensions and mass of rubber slider in accordance with requirements in BS 812-114 or other relevant standard methods
	Before each use*	Check specimen contact angle of rubber slider and verticality of column in accordance with requirements in BS 812-114 or other relevant standard methods
OPEN-ENDED STEEL CYLINDER (for determination ten per cent fines value)	Initial*	Check surface hardness values of cylinder, plunger and base plate in compliance with requirements in BS 812-111, CS3 or other relevant standard methods
	1 year*	Check dimensions of cylinder, plunger and base plate in compliance with requirements in BS 812-111, CS3 or other relevant standard methods

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
	AGGREGATES	
IMPACT TESTING DEVICE	1 year*	Check dimensions of cylindrical steel cup and metal hammer, mass of circular metal base and metal hammer, and fall of hammer in compliance with requirements in BS 812-112, CS3 or other relevant standard methods
STEEL SPHERES (FOR DETERMINATION OF LOA ANGELES VALUE)	1 year*	Check dimension and weights in compliance with requirements in BS 812-105.1, CS3 or other relevant standard methods
THICKNESS GAUGE (for determination of flakiness index)	1 year*	Check with a calibrated calliper or micrometer

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
BITUMINOUS MATERIALS		
CENTRIFUGE (for extraction of binder)	1 year*	Check the operating speeds using a calibrated tachometer
TACHOMETER	5 years	By a 'competent calibration body' as defined in clause 2.1 of this document
MARSHALL TESTING MACHINE		
(a) Stability – load measurement	6 months	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in BS 1610 or BS EN 10002 or other equivalent standards
(b) Flow – displacement measurement	1 year*	Refer to previous section on dial gauge or linear displacement measuring device

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
CONCRETE AND ITS CONSTITUENT MATERIALS		
CEMENT FINENESS TESTING APARATUS		
(a) Lea & Nurse	1 year*	By use of 'certified reference material' as defined in clause 3.2 of HOKLAS 022:2017
(b) Rigden or Blaine	3 months*	By use of 'certified reference material' as defined in clause 3.2 of HOKLAS 022:2017
CHLORIDE ION PENETRATION TESTER		
(a) Voltage measuring device	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in relevant standards
(b) Current measuring device	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in relevant standards
(c) Reagent NaCl and NaOH	Freshly made*	Reagents to be at least of analytical grade
COMPACTING FACTOR APPARATUS	1 year*	Check compliance with requirements in accordance with CS1or other equivalent standards

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
CONCRETE AND ITS CONSTITUENT MATERIALS		
COMPRESSION TESTING MACHINE		
(a) Load rate	1 month*	By use of a calibrated timing device against criteria for tests in accordance with CS1 or other equivalent standards
(b) Load verification	6 months or after relocation of the machine (Note: An additional check at 3 months shall be performed if the two previous checks have indicated a change of machine grading)	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in BS 1610, BS EN 10002, BS EN 12390-4 or other equivalent standards
(c) Machine plattens auxiliary plattens and spacer blocks		
(i) Surface condition	1 month*	Visual inspection check for signs of wear and damage
(ii) Flatness, parallelism	1 year*	Check compliance with requirements in accordance with CS1 or other equivalent standards
(d) Performance	6 months or after relocation of the machine	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in BS 1881, CS1 or other equivalent standards
(e) Strain cylinders (for checking the performance of the machine)	2 years	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in NIS 0409, BC415 or other equivalent standards
(f) Proving devices (for calibration of force testing machines)	2 years	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in BS 1610, BS EN 10002-3, BS EN ISO 7500 or other equivalent standards

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
CONCRETE AND ITS CONSTITUENT MATERIALS		
CREEP TESTING APPARATUS (Load verification with a servo-controlled system)	Before each test if last calibration exceeds one year	By a 'competent calibration body' as defined in clause 2.1 of this document
CURING TANK (CUBE OR OTHER SAMPLE)	6 months*	Check the efficiency of circulation and temperature distribution at 60% capacity, with different reference thermometers at minimum 9 points at the same time
	Each day of use *	Check the max/min temperature
CUBE MOULD		
Dimensions, flatness, squareness and parallelism	6 months*	Check compliance with requirements in accordance with CS1 or other equivalent standards
CYLINDER (Reference-check the cylindricity of concrete core)	5 years	By a 'competent calibration body' as defined in clause 2.1 of this document or by means of appropriate calibrated reference devices
FLOW CONE	1 year*	Check apparatus in accordance with ASTM C939 Clause 8 using a calibrated time measuring device
FLOW TABLE	1 year*	Check apparatus in accordance with requirements in BS1881-105 clause 3.1

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Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
CONCRETE AND ITS CONSTITUENT MATERIALS		
MIST CURING ROOM	6 months*	Check temperature using different calibrated reference thermometers at a minimum of 9 points at the same time or check maximum temperature fluctuation using a calibrated reference thermometer at minimum of 9 points, and check humidity distribution to ensure no dry surfaces. Compare the effectiveness with equivalent tank cured specimens.
	Each day of use*	Check the max/min temperature Check wetness of surfaces
PFA FINENESS TESTING APARATUS (check aperture size of standard sieve)	6 months*	By use of 'certified reference materials' as defined in clause 3.2 of HOKLAS 022:2017
SLUMP		
(a) Cone	1 year*	Check compliance with requirements in accordance with CS1 or other equivalent standards
	1 week*	Check ovality of base and top in accordance with requirements in CS1 or other equivalent standards
(b) Rod	1 year*	Check compliance with requirements in accordance with CS1 or other equivalent standards

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
	STEEL	
ANCHOR BOLT PULL OUT AND PROOF LOAD TESTER		
Load verification or force transducer	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in a relevant standard
BENDING TESTING MACHINE		
(a) Load rate	1 month*	By use of a calibrated timing device against criteria for tests in accordance with CS1 or other equivalent standards
(b) Formers	1 month*	Visual inspection for wear
EPOXY COATED BAR		
(a) Coating thickness gauge	1 year*	By use of a reference device with known thickness in accordance with relevant standards
(b) Holiday detector	1 year*	By use of a reference device with some known properties in accordance with relevant standards
EXTENSOMETER (for rebars and structural steel)	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in BS 3846:1970, BS EN ISO 9513 or other equivalent standards

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of Equipment	Recommended maximum period between successive calibrations	Calibration procedures or guidance documents and equipment requirements
	STEEL	
EXTENSOMETER (for coupler and strand)		
(a) Mechanical type	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in relevant standards
(b) Optical and transducer types	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in relevant standards
HARDNESS TESTER	Refer to Appendix A	
IMPACT TESTER		
Charpy V or U notch machine	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in relevant standards
TENSILE TESTING MACHINE		
(a) Load rate	1 month*	By use of a calibrated timing device against criteria for tests in accordance with BS 18 or other equivalent standards
(b) Load verification	6 months or after relocation of the machine (Note: An additional check at 3 months shall be performed if two previous checks have indicated a change of machine grading.)	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in relevant standards .
(c) Specimen gauging equipment	Spot check*	Spot check on prepared samples.
TORQUE WRENCH (For checking of power-operated and hand-operated friction bolts)	1 year	By a 'competent calibration body' as defined in clause 2.1 of this document and in accordance with requirements in relevant standards

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

APPENDIX F

EQUIPMENT FOR PHYSICAL AND MECHANICAL TESTING OF TOYS AND OTHER CONSUMER PRODUCTS

The recommended calibration requirements for equipment used in toy testing are detailed below.

Type of equipment	Recommended period between successive calibrations	Calibration procedure and requirements
FORCE AND TORQUE MEASURING EQUIPMENT USED FOR TOY TESTING SUCH AS PUSH PULL GAUGE, TORQUE GAUGE AND TENSION GAUGE		
(a) Portable spring type with dial gauge	One year (complete)* Six months* (repeatability of zero)	Check the dial gauge mechanism for repeatability of zero with fast and slow movement in tension and compression, or clockwise and anticlockwise directions where appropriate
(b) Non-portable spring type with dial gauge	Two years* (complete) Six months* (repeatability of zero)	
FIXTURES including accessibility probes, small parts cylinder, bite test clamp, rattle test fixture, flexure tester, compression test disc, tyre removal metal hooks, metal cylinders, straight rods, pins, steps construction for tumble tests, etc.	Initial calibration for dimensional compliance * Yearly inspection for damage and wear *	
IMPACT MEDIUM FOR DROP TEST	Initial calibration for hardness of medium * Yearly inspection for damage and wear *	
PROJECTILE VELOCITY TESTER	Two years *	Calibrate the distance between the starting and stopping sensor and the accuracy of the timer. Verify the software for calculating the velocity from the distance and time readings.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended period between successive calibrations	Calibration procedure and requirements
SHARP EDGE TESTER	Initial calibration* (complete) One month* (force calibration) Six months * (inspection of mandrel condition)	Calibrate in accordance with the requirements of relevant toy testing standards, such as those for mandrel diameter, rotation speed, surface hardness, surface roughness and force. Mandrel force calibration may be performed using a calibrated dead weight.
SHARP POINT TESTER	Initial calibration * Six months * (inspect the end cap for wear)	Calibrate in accordance with the requirements of relevant toy testing standards, such as those for dimensions of gauging slot, thickness of end cap, micrometer graduation and force of spring.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

APPENDIX G

EQUIPMENT FOR MEDICAL AND BIOLOGICAL TESTING

Laboratory shall have a documented and recorded programme of preventive maintenance and calibration, which, at a minimum, follows the manufacturer's recommendation.

Laboratory equipment calibration and check programs should cover:

- commissioning of new equipment (including initial calibration and checks after installation);
- operational checking (checking during use with reference standards or reference materials);
- periodic checking (interim but more extensive checking, possibly including partial calibration);
- scheduled maintenance by in-house or specialist contractors;
- complete recalibration

The table in this Appendix sets out recommended maximum periods between successive calibrations/performance checks for medical and biological testing equipment that are not covered in Appendix A where general recommendations for equipment common to all Test Categories such as temperature measuring devices, balances, weights, timers, autoclaves, gas sterilizers, ovens, centrifuges, piston operated volumetric apparatus (micropipettes), etc, are given.

It must be stressed that these periods are generally considered to be the maximum appropriate in each case providing that the other criteria as specified below are met:

- that the equipment is of good quality and of proven adequate stability, and

- that the laboratory has both the equipment capability and staff expertise to perform adequate internal checks, and

- that if any suspicion or indication of overloading or mishandling arises, the equipment will be checked immediately and thereafter at fairly frequent intervals until it can be shown that stability has not been impaired.

Where the above criteria cannot be met, appropriately shorter intervals may be specified.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
AUTOMATED SYSTEM (analyzer, flow cytometer, automated system for blood culture, tissue processor, blood gas analyzer, etc.)	One year or as recommended by manufacturer, whichever is earlier.	Follow manufacturer's recommendation
BIOLOGICAL SAFETY CABINET / LAMINAR FLOW CABINET / FUME HOOD (include exhaust vented dissection table)	One year	● Filter efficiency and integrity ● air velocities, airflow rate measurement ● air velocity indicator and alarm indicator check and recalibration, if necessary ● airflow patterns ● UV efficiency (where applicable)
FRIDGE / FREEZER FOR BLOOD AND BLOOD PRODUCTS#	Daily*	● Alarm function test ● Continuous monitoring of temperature variation during use; maximum/minimum thermometers should also be used to ensure temperature stays within range during use if temperature recorder to allow continuous monitoring is not used.
	Each month*	● Alarm back-up battery check (where applicable)
	Every six months*	● Alarm activation temperature check (high and low) ● Power failure alarm testing ● One point temperature check against a calibrated thermometer
	One year*	● 2 point check of temperature probe ● Temperature gradient within loading space (refer to HKAS IN003) ● Temperature recorder calibration ● Temperature alarm re-activation check
MICROSCOPE (light, fluorescent, electron)	One year or as recommended by manufacturer	Follow manufacturer's recommendation

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
pH METER	Calibrate on each use *	Calibrate against two buffer solutions at pH range of use
SPECTROPHOTOMETER (UV/visible)	One year or as recommended by manufacturer, whichever is earlier.	Check wavelength accuracy, bandpass, absorbance, stray light error, linearity of response, repeatability and matching of cells
TEMPERATURE and/or ATMOSPHERE CONTROLLED EQUIPMENT (incubator, CO_2 incubator, anaerobic cabinet, fridge, freezer, temperature controlled chamber for Biochemical Oxygen Chamber, etc. excluding equipment for blood and blood products)	Daily*	● Continuous monitoring of temperature variation during use; maximum/minimum thermometers should also be used to ensure temperature stays within range during use if temperature recorder to allow continuous monitoring is not used. ● Atmospheric check for CO_2, and anaerobic cabinet
	Every 6 months*	One point temperature check against calibrated reference thermometer
	One year*	Temperature gradient within loading space [excluding furnace and water/oil bath] (refer to HKAS IN003) , calibration of atmospheric meter (where appropriate)
THERMAL CYCLER (PCR machine, Real time PCR machine, etc)	One year or as recommended by manufacturer.	● Temperature verification and optical signal (where applicable) at all reaction wells ● Temperature and time calibration
UV-TRANSILLUMINATOR (gel documentation post PCR)	One year or as recommended by manufacturer.	● UV-light source and filter verification ● UV-calibration by digital radiometer or ● Follow Manufacturer's recommendation (where applicable)
WATER/OIL BATH	During use*	Continuous monitoring of temperature variation during use

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.

Type of equipment	Recommended maximum period between successive calibrations	Calibration procedure or guidance documents and equipment requirements
	Every 6 months*	One point temperature check against calibrated reference thermometer at point of use
	One year*	Temperature gradient within loading space when the incubation temperature is specified in the test standard

Reference:

AS 3864.2 - 2012 Medical refrigeration equipment - For the storage of blood and blood products Part 2: User-related requirements for care, maintenance, performance verification and calibration.

Items marked * in the table are those which can be carried out by the staff of a laboratory if it is suitably equipped with calibrated reference equipment, and where applicable, a suitably controlled environment, and the staff is competent to perform such calibrations.