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LAB 23

Edition 3 January 2023

Traceability for equipment used in acoustical testing

Contents

Changes since last edition

Various changes throughout.

1. Introduction

1.1 The requirements for the control of equipment calibration and metrological traceability are given in *ISO/IEC 17025*[1] *General requirements for the Competence of Testing and Calibration Laboratories.* Several guidance publications providing interpretation, application, detail and limitations are listed in UKAS Publications (M4).

1.2 Metrological traceability is required for all equipment used for tests and/or calibrations, including equipment for subsidiary measurements (e.g. for environmental conditions) having a significant effect on the accuracy or validity of the result of the test, calibration or sampling. Calibration may not be required for subsidiary equipment where the result is unaffected or where the equipment is monitored by calibrated equipment during the measurement.

1.3 Metrological traceability is defined within the Vocabulary of Metrology (VIM)[52]. In ISO/IEC 17025[1] the term “traceability” is equivalent to the VIM’s “metrological traceability”. To avoid repetition, the term “traceability” is used henceforth in this document.

1.4 In general, calibration of equipment needs to be traceable to national measurement standards. When using external calibration services, a valid certificate should be obtained from a calibration laboratory that demonstrates competence, measurement capability and traceability. A calibration

certificate bearing the UKAS accreditation symbol or reference to UKAS accreditation (or identity of the national standards laboratory or mark of an accreditation body which is a signatory to EA or ILAC multilateral agreement) for the relevant calibration/verification will be sufficient evidence.

1.5 This publication (LAB 23) provides guidance for testing laboratories needing to meet the traceability requirements contained within ISO/IEC 17025[1] as applied to acoustical testing. This guidance may also be applied to other conformity activities where acoustic measurements or testing is involved (e.g. inspection and product certification). By following this guidance, testing laboratories will be able to demonstrate at assessment that they meet these requirements. Alternative methods may be used provided they are shown to give an equivalent outcome.

1.6 This publication must be read in conjunction with UKAS Publication *TPS 41 UKAS Policy on Metrological Traceability*[65] and ILAC Document *ILAC-P10 ILAC Policy on Metrological Traceability of Measurement Results*[54].

2. General requirements

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

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

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

2.4 **Appendix A** lists key items of reference equipment and working equipment used to carry out a wide range of acoustical tests and details a programme of calibrations and checks which would normally be considered suitable. Table 2 also indicates the level of traceability generally considered appropriate, and for which items external certificates of various forms are advised. Table 2 in Appendix A is **not** an exhaustive list of all items of equipment requiring periodic recalibration or checking but may be of assistance as a guide when establishing or reviewing a calibration system.

2.5 It must be borne in mind that the calibration and checking guidance given in this publication **does not** supersede the requirements of a nationally published test method.

3. Sources of traceability

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

3.2 Calibrations and checks carried out on acoustic test equipment may be conveniently classified into four general levels as listed in Table 1:

Level	ILAC P10[54] Section 2	TPS 41[65] Section 2	Traceability
1 a)	1)	2.1.1	A national metrology institute (NMI), or a designated institute, whose service is suitable for the intended use and is covered by the CIPM MRA for those services. Institutes included in the CIPM MRA, including quantities and CMCs, can be viewed at: http://www.bipm.org/en/cipm-mra/participation/signatories.html.
	2)	2.1.2	A calibration laboratory whose service is suitable for the intended use, and which is accredited for those services by an Accreditation Body that is included in the ILAC Arrangement or by Regional Arrangements recognised by ILAC. The schedules for UKAS accredited calibration laboratories can be viewed at: www.ukas.com.
1 b)*	3a)	2.2.1	A national metrology institute, or a designated institute, whose service is suitable for the intended use but is not covered by the CIPM MRA.
	3b)	2.2.2	A calibration laboratory whose service is suitable for the intended use but not covered by the ILAC Arrangement or by Regional Arrangements recognised by ILAC.
2		4	A calibration carried out in-house which can demonstrate the requirements of section 4. of TPS 41 have been implemented and are assessed by UKAS within assessment/ surveillance activities.
3			A check, which may be carried out in-house, performed by competent staff using appropriately calibrated equipment to a documented procedure.
4			A visual check, where the item is inspected to provide assurance that the equipment meets the requirements of the appropriate standard, but no measurements are required.

Table 1 - Sources of Traceability

3.3 Typically, a calibration carried out by a laboratory accredited by UKAS for the measurements concerned and for which a UKAS calibration certificate is issued will satisfy Level 1 a) in Table 1. It is recognised acoustic test equipment is manufactured both in the UK and overseas, a calibration certificate from an overseas National Metrology institute or accredited calibration laboratory meeting the requirements of Level 1 a) in Table 1 will also be sufficient.

3.4 It is emphasised that the extent of the calibration obtained should be sufficient in terms of quantities and coverage to demonstrate properly the performance of the equipment, otherwise traceability of results may not be assured.

3.5 Where it is not possible to obtain a calibration from either of the sources described within Level 1 a), the sources of traceability from Level 1 b) may be acceptable providing additional assurance is obtained. Further information can be found in UKAS *Publication TPS 41*[65].

3.6 Neither source from Level 1 b) shall be chosen on purely economic grounds (such as the cost of using a particular organisation) or on logistical grounds (such as the need to employ an overseas organisation to obtain traceability). These are a last resort if Level 1 a) routes are unavailable. Furthermore, these services have not been subject to peer review or recognised accreditation. An organisation using such services is responsible for ensuring appropriate evidence of claimed traceability and measurement uncertainty is available. Further information can be found in UKAS *Publication TPS 41*[65].

4. In-house calibrations

4.1 Refer to section 4 of UKAS publication TPS 41 UKAS Policy on Metrological Traceability[65].

5. Calibration and check procedures

5.1 Before equipment is placed into service, a suitable calibration or check is needed to confirm traceability and compliance with the respective standard requirements.

5.2 When determining the calibrations and/or checks appropriate for an item of equipment, the capability of the laboratory and requirements of the calibration must be kept in mind. Measurement uncertainty must be considered when determining compliance with the specified accuracy and tolerance requirements of a standard. The actual accuracy required will be determined by calculating uncertainty budgets for particular calibration regimes using defined calibration apparatus. Guidance on where this should be performed is given in Appendix A.

5.3 If a statement of conformity is required to a specification or standard for the calibration, the specification or standard, measurement uncertainty and decision rule shall be clearly defined, discussed and agreed with the calibration laboratory unless inherent in the specification or standard to which the calibration is being performed. Further information can be found in *UKAS Publication LAB 48 Decision Rules and Statements of Conformity*[64] *and* ILAC Document *ILAC-G8 Guidelines on Decision Rules and Statements of Conformity*[56].

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

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

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

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

6. Maintenance of traceability and calibration intervals

6.1 A calibration programme is necessary in order to maintain traceability of equipment on a continuous basis. The intervals between calibrations will depend on various factors including but not limited to the measurement uncertainty required; past history of the equipment; results of previous calibrations; frequency of any necessary maintenance; the frequency of the use of the equipment; frequency of cross-checking against other equipment or of intermediate checks; recommendations of the manufacturer; environmental condition to which the equipment has been exposed, stored and transported.

6.2 Most items of acoustical equipment require periodic re-calibration or checking as the accuracy or conformance to specification may change with time, e.g., linearity and filter characteristics. It is important that the re-calibration or check is undertaken before any probable change in accuracy or conformance with specification has occurred that is of significance to the use of the equipment.

6.3 When determining re-calibration and check intervals, the applicable test methods in published standards and manufacturer's instructions should be referred to for initial guidance. The requirements set by these publications, together with any calibration criteria set by the test specification, will determine the interval finally set.

6.4 Consideration should also be given to the expected use of the equipment, e.g. sound level meters used on site and regularly left in a vehicle may suffer temperature extremes, the output level of sound level calibrators can drift over time and profiles of tapping machine hammers wear due to use. Where there is doubt regarding an individual item's ability to meet the above criteria, the calibration and/or check interval may have to be reduced to ensure continued accuracy and performance. It is important that calibration intervals are periodically reviewed. In some instances, the calibration interval may be extended for an individual piece of equipment, e.g. when a stable calibration history has been established. Calibration intervals should not be extended without justification. **Calibration intervals may not, however, be relaxed if they are a mandatory element of the test method.**

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

(a) Is of good quality and known stability

(b) Has achieved satisfactory performance at previous calibrations and checks

(c) Is checked before first use or as defined in 6.1, and at appropriate intervals thereafter to show stability has not been impaired following suspected or indicated mishandling, overloading, damage, obstruction or malfunctioning

6.6 To ensure that calibrations and checks are carried out at the appropriate frequency, a forward planning system is usually essential. The planning system needs to provide adequate notice of a pending calibration or check to ensure that it is carried out by the due date. This is particularly important where items are to be calibrated externally and time may be required to organise the calibration and have it carried out.

6.7 To confirm that changes have not occurred in-between re-calibrations, interim checks are recommended.

6.8 When a fresh calibration has been obtained, the data provided shall be reviewed to confirm that the declared performance is still met and determine any drift from previous calibrations. It may be necessary to reconsider the calibration interval or the suitability of the equipment and if any previous test or calibration work has been affected in accordance with the outcome of such a review.

6.9 Further information regarding calibration intervals is available in *ILAC-G24*[58].

7. Records

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

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

7.3 The use of proforma record sheets for in-house calibrations or checks is recommended as this ensures that all necessary information is recorded. When preparing a pro-forma, care should be taken to ensure that space is provided for all components of the calibration or check and all applicable details.

7.4 The use of diagrams and tables indicating acceptable values and actual values may be useful, particularly where dimensional checks are made. Diagrams may also be helpful, showing, for example, the location of sound sources and microphone positions.

7.5 When simple measurements or visual checks are required before the first test and/ or after the last test e.g. levelness of tapping machines and hammer height from floor surface; or pre- and post-test calibration of the sound level meter, it is acceptable and often most appropriate to record the check on the relevant test work sheet rather than a separate form.

7.6 For some tests, e.g. sound insulation measurements of commercially available components, it may be necessary to obtain an authoritative certificate or statement of compliance to design specification to show as evidence that the item has been tested by the most appropriate test method.

8. Measurement uncertainty

8.1 Laboratories performing in-house calibrations (Level 2) on measuring equipment (i.e. any equipment which is used to take measurements or used as a reference source) are required to estimate the measurement uncertainty for each in-house calibration method. Guidance on where this is required is given in Appendix A.

8.2 Laboratories undertaking acoustical testing are expected to estimate the uncertainty of measurement for each method of testing. Where a test specification identifies pass/fail criteria, uncertainties will normally be needed to apply these criteria.

8.3 Any statements of conformity to be reported (e.g. pass/fail, in-tolerance/ out of tolerance) either in a calibration certificate or a test report, needs to take into consideration the measurement uncertainty and decision rule to be applied to determine if a specification has been achieved or not and take into consideration the level of risk associated with the decision rule applied. Further information can be found in UKAS Publication *LAB 48 Decision Rules and Statements of Conformity*[64]; ILAC Document *ILAC-G8 Guidelines on Decision Rules and Statements of Conformity*[56]*;* and UKAS Publication *LAB 12 The Expression of Uncertainty in Testing*[61]*.*

8.4 To determine the uncertainty associated with a test or calibration, the procedure should first be broken down into its component measurements. The significant sources of all uncertainties

should then be identified and quantified. In most cases, uncertainties may then be combined by an appropriate method to produce an overall uncertainty value.

8.5 Sources of uncertainties associated with a test or calibration, include those relating to the equipment used to make each specific measurement, and any peripheral measurement such as room temperature, pressure or humidity. The uncertainty associated with each piece of equipment used to carry out the test or calibration will in many cases be available from its current calibration certificate. Where this is not applicable, information may be available from the manufacturer.

8.6 Every time a measurement is taken, random effects from various sources contribute uncertainty to the value of the reading taken. These include variability resulting from imprecise definition of the calibration, uncertainty in discrimination, random fluctuations in the measured parameter, and variations in background noise.

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

8.8 Systematic effects also contribute uncertainty, and source associated with a calibration include those relating to the equipment used to make each specific measurement and any peripheral measurements, such as room temperature. The uncertainty associated with each piece of equipment used to carry out the calibration will in most cases be available from its current calibration certificate. It is important that calibration certificates contain the data required to evaluate sources of measurement uncertainty or are supplemented with the data required.

8.9 Where this is not applicable, information which may be acceptable to UKAS may be available from the equipment manufacturer. In some cases, it will be practical to eliminate or minimise many of the sources of uncertainty, e.g. by applying corrections from the external calibration report and by carrying out the calibration at the same temperature as that used for calibrating the reference equipment.

8.10 More detailed guidance on the expression of uncertainty and confidence in measurements may be found in the UKAS publication M3003, *The Expression of Uncertainty and Confidence in Measurement*[59].

9. Auxiliary equipment and computer systems

9.1 Where auxiliary equipment is connected to a testing machine to provide a sound level measurement, e.g. an extension cable between the microphone & pre-amplifier and the sound level meter, it is considered an integral part of the sound measuring system. Such additional equipment shall be verified as part of the sound measurement system (Level 1 calibration) or as a separate item (Level 1 or Level 2 calibration). The laboratory shall include the effect of the auxiliary equipment on the total measurement uncertainty of the sound level meter with the microphone and pre-amplifier connected directly. Computer and/or sound level meter software/firmware used for test control and/ or data capture, processing, storage, presentation of test data and calculation of test results should be validated before use. Documentary evidence shall be retained to demonstrate that test control parameters embedded within the software/ firmware comply with the requirements of the test standard or method.

APPENDIX A Guidelines for calibration of equipment used in acoustical testing facilities

A.1 This Table has been prepared as a **guide** to the effective calibration and checking of items of equipment used in acoustical testing and, as such, it is the expected standard to which laboratories should work. Note that further guidance on calibration for specific items may be available: consult UKAS Publications (M4) for current UKAS publications.

A.2 **The Table does not list all items of equipment that may be used, and the absence of an item in the table does not necessarily indicate that calibration is inappropriate. UKAS reserve the right to update the contents of this document at any time.**

A.3 For many pieces of equipment there are no defined calibration protocols, e.g. amplifiers, level recorders and tape recorders. Where such equipment is used, the laboratory should review the role of each piece of equipment and demonstrate an adequate control/measurement capability for the use to which the instrument is put.

A.4 For convenience the Table is divided into four sections:

- Acoustics
- Audiometric
- Electrical
- General

In each section, items are listed alphabetically.

A.5 The Table provides guidance on:

a) The minimum level of traceability considered appropriate. See section 3 of this publication
b) The maximum interval considered appropriate. See section 6 of this publication.

A.6 The specified level of traceability is the minimum considered appropriate. An organisation may choose to achieve a higher level of traceability for calibration, e.g. Level 1 rather than Level 2. A lower level than specified is not normally acceptable.

A.7 The specified calibration interval is the maximum considered appropriate to equipment in regular use, unless an extended interval is justified. Where a piece of equipment is not in regular use, it should be calibrated within the specified period before use.

A.8 Good working practice may also include checks/setting up before use, e.g. using a calibrator on a sound level meter before use.

A.9 Where a national or international standard is referenced, unless otherwise stated, the most recent version of the standard applies.

A.10 A sound level meter microphone which can no longer provide consistent or accurate results due to drift or damage, will invalidate the verification to BS 7580[4] or periodic tests of either IEC 61672 Ed 1[8] or Ed 2[12] as appropriate. However, it may be possible to replace the microphone only when the following conditions are met:

(a) Only use microphones which are specified within the sound level meters instruction manual making sure the microphone selected maintains the Class/Type of sound level meter required for the measurement method
(b) The microphone must have a current and valid calibration certificate
(c) Ensure that the sensitivity of the microphone is no greater than the sound level meters manufacturers normal tolerance limits.
(d) The effects on the measurement uncertainty of the sound level meter when using the replacement microphone is evaluated and can demonstrate the sound level meter continues to conform with the relevant parts of IEC 60651[13]/60804[14][15] or IEC 61672-1[6][9].

(e) The Sound Level Meter with the replacement microphone is adjusted to the correct level and sensitivity when the sound calibrator is applied. Reference to equipment manuals and calibration certificates will be required to determine the level and sensitivity.

(f) The replacement microphone with the sound level meter must undergo verification to BS 7580[4] or periodic testing to IEC 61672-3 Edition 1[8] or Edition 2[12] as applicable, when whichever of the calibration certificates for the microphone or sound level meter expire soonest.

A.11 Where analysers or data acquisition systems use one or more microphones these should use the same microphone type. In order to maintain conformance with the relevant parts of IEC 60651[13]/60804[14][15] or IEC 61672-1[6][9] and the measurement methods, only microphones specified by the manufacturer of the analyser or data acquisition system for use with these systems should be used. It is advised to refer to the guidance from the manufacturer of the analyser or data acquisition system for appropriate microphone selection. Microphones which have not been specified by the manufacturer may not have been tested with the analyser or data acquisition system to demonstrate conformance with IEC 60651[13]/60804[14][15] or IEC 61672-1[6][9] or have undergone pattern evaluation testing to IEC 61672-2 Ed 1[7] or Ed 2[11]. It is the testing laboratories responsibility to ensure they can demonstrate the analyser or data acquisition system conforms. Each channel must be verified to BS 7580[4] or have periodic checks to IEC 61672-3 Ed 1[8] or Ed 2[12] as applicable to the application the system is being used. ISO 3744[47][48] requires the complete measuring set-up including extension cables to be included within the verification to BS 7580[4] or periodic checks to IEC 61672-3 Ed 1[8] or Ed 2[12] as appropriate. For those tests that requirement is compulsory.

A.12 Building acoustics standards normally require the use of random incidence microphones or the addition of a filter which provides the sound level meter/free field microphone combination with a frequency response similar to that of a random incidence microphone. Sound level meters built to IEC 61672-1:2013[6][9]. fitted with this facility, may be verified using the procedure in IEC 61672-3:2013[12]. Other sound level meters fitted with this facility should have a separate check carried out to verify the operation of the filter (2 years, Level 3).

A.13 The level of calibration or verification that a tape recorder should be subjected to depends upon its function in the measurement chain. If it is being used to store a signal that is then going to be replayed before being analysed, then the recorder plays a significant part in the chain, and should be dealt with the same rigor as the detection and analysing equipment. In addition, the effect of wear and instability in mechanical parts on performance should be checked at an interval depending upon use. If the device is used to store, or in the case of a level recorder, display a final analysed result, then the linearity, frequency response and time stability require checking and calibration.

A.14 It is necessary to check the date of manufacture of the sound level meter and the edition of the standard to which the sound level meter was built, to determine which editions of IEC 61672-3 Ed 1[8] or Ed 2[12] the sound level meter should be verified against. Older sound level meters conforming to IEC 60651[13] and or IEC 60804[14][15] should be verified to BS 7580 Part 1[4]

Notes:

1 Table 2 details maximum calibration and check intervals, but each item of equipment requires appropriate calibration and/ or checking before it is placed into service. Actual calibration intervals may need to be shortened depending upon the stability, environment and use of the equipment which should be monitored and reviewed regularly.

2 Where a Level 1 calibration is indicated by Table 2, certificates from other sources may be acceptable (see 1.4, Section 3 and Table 1)

3 Where an item is calibrated in-house and is defined as a calibration rather than a check, the measurement uncertainty and supporting uncertainty budget is required for that specific calibration procedure. The extreme right-hand column of Table 2 indicates where an uncertainty budget should be determined. If using a calibration laboratory, an uncertainty budget will not be required from the calibration laboratory, but the calibration certificate issued must include the measurement uncertainty for all reported measurements.

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

5 UKAS reserves the right to update information within this document (LAB 23) at any time.

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics					
Calibrators including pistonphones and multi-frequency calibrators	(a) Required accuracy ≤ 0.25 dB	Calibrate level, frequency and distortion (refer to appropriate issue of IEC 60942[18][19])	1 year	Level 1	Measurement Uncertainty
	(b) For calibration of ear simulator system channel. Required accuracy ≤ 0.25 dB	Calibrate level, frequency and distortion (refer to appropriate issue of IEC 60942[18][19]) using WS1P and/ or WS2 microphone as appropriate for ear simulator	1 year	Level 1	Measurement Uncertainty
	(c) Required accuracy ≥ 0.25dB	Calibrate level, frequency and distortion (refer to appropriate issue of IEC 60942[18][19])	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
Dosemeters	Personal	Verify linearity, integration time etc (refer to IEC 61252[20])	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
Filters	Analogue & Digital	Verify filter skirts and centre frequency (refer to appropriate issue of IEC 61260[21] [24])	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Floor tapping machines *		Verify conformance to BS EN ISO 10140-5[43] (ISO 140-7*[50]; ISO 16283-2[45]) for all periodic checks	2 years	Level 1	Measurement Uncertainty No
		Check impact repetition rates	At appropriate intervals depending upon usage. Not exceeding 1 year.	Level 3	No
		Check tapping machine level and drop heights using tapping machine height gauge or appropriate working gauge block	At appropriate intervals dependent upon usage or before use	Level 4	
		Once only checks (Re-check if tapping machine is repaired/ modified)	Once (or when repaired/ modified)	Level 3	No

*Annex A of ISO 140-7:1998 contains a known error regarding the limits for the velocity at impact. The limits within ISO 10140-5 and ISO 16283-2 apply.

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Frequency counters	For in-house calibration	Calibrate	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
Head & Torso Simulator (HATS)		Manufacturer's certificate of conformity with microphone(s) and pinna(e)	2 years	Level 3	No
		Calibrate microphone(s) and attached sound level meter/ analyser with calibrator before and after use.	(depending on use)	Level 4	No
		Verify each channel of sound level meter/analyser with an input level appropriate to the microphone sensitivity.	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget
Microphones	Reference	Calibrate	2 years (depending on use)	Level 1	Measurement Uncertainty
Microphones	Working	Calibrate	2 years (depending on use)	Level 2	Measurement Uncertainty & Uncertainty Budget

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Microphones	Stand-by/ replacement	Calibrate See Note A.10	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget
Microphones	For in real ear testing (MIRE)	Calibrate level and frequency response (see BS EN ISO 11904-1[25])	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget
Multi-channel analysers (see also Sound Level Meters)	Calibrate For noise measurement work	Verify all channels in use to relevant parts of IEC 60651[13]/60804[14][15] or periodic tests to IEC 61672-3 Ed 1[8] or Ed 2[12] as appropriate	2 years	Level 1	Measurement Uncertainty
Recorders See Note A.13	(a) Analogue tape	Calibrate linearity, frequency response and time stability	1 year	Level 3	No
	(b) Digital tape	Calibrate linearity, frequency response, A/D converter and time stability	1 year	Level 3	No
	(c) Level	Check linearity, frequency response and time stability.	2 years	Level 3	No

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Signal generators	Pure tone	Check frequency and distortion	1 year	Level 3	No
Signal generators	Random	Check spectral characteristics	1 year	Level 3	No
Sound intensity meters		Calibrate (refer to ISO 9614[33][34][35])	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
Sound Level Meters manufactured to IEC 60651[13]/60804[14][15]	Calibrate When results are in final report or used to verify base conditions	Verify to BS 7580[4] for: (1) UKCA/ UKNI Noise related Regulations	2 years	Level 1	Measurement Uncertainty
		(2) Reference devices	2 years	Level 1	Measurement Uncertainty
		(3) Working meters	2 years	Level 2 (subject to UKAS approval)	Measurement Uncertainty & Uncertainty Budget
		Check the sound pressure level/ expected sensitivity using the associated sound calibrator. (see also notes A.12 and A.14)	Before use	Level 4	No

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Sound Level Meters manufactured to IEC 61672-1:2002[6] or IEC 61672-1:2013[9]	Calibrate When results are in final report or used to verify base conditions	Verify to IEC 61672-3 Ed 1[8] or Ed 2[12] as appropriate: (1) UKCA / UKNI Noise related Regulations	2 years	Level 1	Measurement Uncertainty
		(2) Reference devices	2 years	Level 1	Measurement Uncertainty
		(3) Working meters	2 years	Level 2 (subject to UKAS approval)	Measurement Uncertainty & Uncertainty Budget
		(4) For measurement of ear simulator sound pressure level or vibratory force level	2 years	Level 1	Measurement Uncertainty
		Check the sound pressure level/ expected sensitivity using the associated sound calibrator (see also notes A.12 and A.14)	Before use	Level 4	No

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Sound level meters or analysers fitted with a multiplexer with several microphone channels (See Note A.11)	Calibrate When results are in final report or used to verify base conditions	As for single channel or multi-channel sound level meters or analysers. Refer to manufacturer's guidance for appropriate microphone selection and ensure that the spread of microphone sensitivities is no greater than the manufacturer's normal tolerance limits.	2 years	Level 1	Measurement Uncertainty
Sound Level meters – Multi-channel analysers (See Note A.11)	Calibrate For general noise measurement work	Refer to manufacturer's guidance for appropriate microphone selection and ensure the spread of microphone sensitivities is no greater than the manufacturer's normal tolerance limits. Verify all channels as for single channel sound level meters.	2 years	Level 1 Or Level 2 (subject to UKAS approval)	Measurement Uncertainty Measurement Uncertainty & Uncertainty Budget
	For measurement of ear simulator sound pressure level/ vibratory force level, frequency, distortion, spectrum and time waveforms.	Calibrate each channel level linearity, frequency response linearity, frequency accuracy, distortion, and noise to manufacturer's specification	2 years	Level 1	Measurement Uncertainty
Sound Level meters – Multi-channel analysers (and multi- channel sound level meters and building acoustics analysers)	Calibrate For building acoustics work	Verify all channels in use with specified microphones as for single channel sound level meters (including supplementary verification of filters and reverberation time). Also see note A.11 & A.12)	2 years	Level 1 Or Level 2 (subject to UKAS approval)	Measurement Uncertainty Measurement Uncertainty & Uncertainty Budget

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Sound sources – Fan Type	(a) Reference	Calibrate	2 years	Level 2	Measurement Uncertainty
	(b) Working	Calibrate	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget
		All - Check Fan Speed	At appropriate intervals depending upon usage. Not exceeding 1 year.	Level 3	No
Sound sources - Reference	Loudspeaker	Calibrate	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
Sound sources – Loudspeaker For Building Acoustics work to:	ISO 16283[44][45][46]	Test directional radiation as in A.2 of ISO 16283-1[44], or B.2 in ISO 16283-2[45], or C.2 in ISO 16283-3[46].	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget
	Approved Document E[67]/ ISO 140[49][50]	Test directional radiation as in A 1.1.3 of ISO 140-4[49]	Once	Level 3	No

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Acoustics (Continued)					
Sound sources – white noise/ pink noise generator/ amplifier/ loudspeaker combination	For sound insulation measurement	Test to ensure that the system is steady with a continuous spectrum in the frequency range required over the typical measurement cycle (the time taken to measure both source and receiving room sound pressure levels)	At appropriate intervals depending upon usage. Not exceeding 1 year.	Level 3	No
True rms indicating devices for acoustic purposes	Including SLMs/analysers used with an electrical input	Verify to relevant parts of IEC 60651[13]/60804[14][15] or periodic tests to IEC 61672-3 Ed 1[8] or Ed 2[12] as appropriate	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget
Audiometric					
IEC 60318-1[29] Ear Simulator (Artificial Ear)	For measurement of supra-aural and circumaural earphones	(1) Pressure sensitivity response to WS2P microphone	2 years	Level 1	Measurement Uncertainty
		(2) Verification of acoustic transfer impedance to IEC 60318-1[29]	2 years	Level 1	Measurement Uncertainty
IEC 60318-3[30] Ear Simulator (Acoustic Coupler)	For measurement of supra-aural earphones	(1) Pressure sensitivity response of WS1P microphone	2 years	Level 1	Measurement Uncertainty
		(2) Verification of acoustic impedance response to manufacturers specifications	2 years	Level 2	Measurement Uncertainty & Uncertainty Budget

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Audiometric (Continued)					
IEC 60318-4[31] Ear Simulator (Occluded Ear Simulator)	For measurement of insert earphones	Verification of acoustic impedance response to IEC 60318-4[31]	2 years	Level 1	Measurement Uncertainty
IEC 60318-6[32] Ear Simulator (Mechanical Coupler)	For measurement of bone vibrators	(1) Force sensitivity response to requirements of IEC 60318-6[32]	2 years	Level 1	Measurement Uncertainty
		(2) Verification of mechanical impedance level to IEC 60318-6[32]	2 years	Level 1	Measurement Uncertainty
Ear Simulator System Channel	For audiometric transducer measurements	Verify the expected ear simulator acoustical sensitivity using the associated sound calibrator. Microphone type (WS1P or WS2P) and any volumetric correction for ear simulator should be taken into account.	Before use	Level 4	No
		Verify the channel frequency response using an appropriate transducer (earphone, bone vibrator) or equivalent electrical input signal.	Weekly	Level 4	No

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Electrical					
Attenuators	Independent	Calibrate	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
Voltmeters	AC/DC	Calibrate	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
General					
Anemometer		Calibrate	1 Year	Level 1	Measurement Uncertainty
Barometers	(a) Mercury Transportation of mercury is restricted, seek further advice from www.gov.uk	Calibrate	5 years	Level 2	Measurement Uncertainty & Uncertainty Budget
	(b) Aneroid or Electronic	Calibrate	1 years	Level 2	Measurement Uncertainty & Uncertainty Budget
Compass		Check	1 year	Level 3	Measurement Uncertainty

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
General (Continued)					
Hygrometers	(a) Reference	Calibrate	1 year	Level 1	Measurement Uncertainty
	(b) Working	Calibrate	1 year	Level 2 (Level 2 subject to UKAS approval)	Measurement Uncertainty & Uncertainty Budget
Length measuring devices	*1 Gauge blocks*				
	(a) Reference	Shall comply with the relevant grade of BS EN ISO 3650[36] and BS 4311-1[37]	5 years	Level 1	Measurement Uncertainty
	(b) Working	Calibrate against appropriate calibrated reference equipment	2 years	Level 1	Measurement Uncertainty
	(c) Floor Tapping Machine Height Gauge	Check distance against appropriate calibrated reference equipment e.g. callipers, micrometer, gauge block	1 year	3	No

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
General (Continued)					
Length measuring devices (Continued)	*2 Micrometers* (a) Reference	Calibrate	1 year	Level 1	Measurement Uncertainty
	(b) Working	Calibrate Or	1 year	Level 1	Measurement Uncertainty
		Calibrate against calibrated gauge blocks meeting the appropriate grade requirements of BS EN ISO 3650[36]. **Includes** check of anvils of flatness and parallelism	At appropriate intervals depending upon usage. Not exceeding 1 year.	Level 2 (Level 2 subject to UKAS Approval)	Measurement Uncertainty & Uncertainty Budget
	3 Callipers (a) Reference	Calibrate	1 year	Level 1	Measurement Uncertainty
	(b) Working	Calibrate or	1 Year	Level 1	Measurement Uncertainty
		Calibrate against calibrated gauge blocks meeting the appropriate grade requirements of BS EN ISO 3650[36]. **Includes** check of measurement faces for flatness and parallelism.	At appropriate intervals depending upon usage. Not exceeding 1 year	Level 2 (Level 2 subject to UKAS Approval)	Measurement Uncertainty & Uncertainty Budget

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
General (Continued)					
Length measuring devices (Continued)	*4 Steel rules*				
	(a) Reference	Calibrate	5 years	Level 1	Measurement Uncertainty
	(b) Working – (required accuracy not better than or equal to 1 mm e.g. 2 mm	Calibrate Confirmed to BS 4372[39] Or	5 Years	Level 1	Measurement Uncertainty
		Calibrate Confirmed or not confirmed as BS 4372[39], check against reference using suitable visual aid	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
		All rules – check readability and wear	Before use	Level 4	No
	5 Measuring Tapes (a) Reference tapes	Calibrate	5 years	Level 1	Measurement Uncertainty
	(b) *Working tapes*	Calibrate	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget

Table 2 **Item**	**Type**	**Calibration Details**	**Maximum Interval between Calibration**	**Minimum Level of Certificate**	**Measurement Uncertainty / Uncertainty Budget Required**
General (Continued)					
Length measuring devices (Continued)	*6 Electronic/ Laser distance meter*				
	(a) Reference	Calibrate	5 years	Level 1	Measurement Uncertainty
	(b) Working	Calibrate	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
Tachometers	(a) Reference	Calibrate	2 years	Level 1	Measurement Uncertainty
	(b) Working	Calibrate	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
General (Continued)					
Thermocouples See UKAS LAB 11[60]	(a) Reference	Calibrate Refer to BS 1041-4[42] for selection of appropriate type	1 – 4 yearly depending upon requirement of test method, use or type	Level 1	Measurement Uncertainty
	(b) Working	Calibrate against reference thermocouple or liquid-in-glass thermometer, as appropriate for test standard or method. Immersion length during calibration should be the same when used for testing.	At appropriate intervals, depending upon test standard or method, usage, type and conditions of use	Level 1	Measurement Uncertainty
	(c) Working	Calibrate against reference thermocouple or liquid-in-glass thermometer, as appropriate for test standard or method. Immersion length during calibration should be the same when used for testing.	At appropriate intervals, depending upon test standard or method, usage, type and conditions of use	Level 2	Measurement Uncertainty & Uncertainty Budget

Table 2

Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
General (Continued)					
Thermometers See UKAS LAB 11[60]	(a) Reference: liquid-in-glass	Calibrate for precision and range of measurement required and Check at ice-point (or dependent upon use, some other reference point)	5 years 1 year	Level 1 Level 3	Measurement Uncertainty No
	(b) Reference: platinum resistance	Calibrate for precision and range of measurement required	1 – 5 yearly depending on requirement of test method, use or type	Level 1	Measurement Uncertainty
	(c) Working: platinum resistance	Calibrate for precision and range of measurement required	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
	(d) Working: liquid-in-glass temperature tolerance <± 0.5 ^{O}C	Calibrate against a calibrated reference thermometer ensuring that the immersion depth is as specified And Check at ice point or another reference point	Initially, then 5 yearly 6 monthly for first year then annually	Level 2 (Level 2 subject to UKAS approval) Level 3	Measurement Uncertainty & Uncertainty Budget No

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
General (Continued)					
Thermometers (Continued) See UKAS LAB 11[60]	(e) Working: liquid-in-glass temperature tolerance ≥± 0.5 ^{O}C	Use a BS 593[40] thermometer (with unique serial number) or calibrate against a suitable reference thermometer ensuring that the immersion depth is as specified. Calibrate against a calibrated reference thermometer ensuring that the immersion depth is as specified And Check at ice point or another reference point	5 yearly; re-calibrate on replacement 6 monthly for first year then annually	Level 2 (Level 2 subject to UKAS approval) Level 3	Measurement Uncertainty & Uncertainty Budget No
Time measuring devices	(a) Required tolerance < ± 0.5 sec	Calibrate appropriately according to required accuracy	1 year	Level 1	Measurement Uncertainty
	(b) Required tolerance ≥ ± 0.5 sec	Check against BT speaking clock or Greenwich Mean Time website	1 year	Level 3	No
Volumetric	Measuring cylinders	Calibration to be appropriate to application. See UKAS LAB 15[63] for more details	1 year	Level 1	Measurement Uncertainty

General (Continued)

Table 2 Item	Type	Calibration Details	Maximum Interval between Calibration	Minimum Level of Certificate	Measurement Uncertainty / Uncertainty Budget Required
Weighing machines	(a) Laboratory balances, platform scales, etc	Calibrate	1 year	Level 1	Measurement Uncertainty
		Calibrate See UKAS LAB 14[62] For more details	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget
		Zero and single/multi-point check (as appropriate)	Daily/ before use	Level 3	No
	(b) Spring balances	Check with working masses at suitable points	Daily/ before use	Level 3	No
Weights	(a) Reference: Class E1 and E2	Calibrate	2 years	Level 1	Measurement Uncertainty
	(b) Reference: Class F1, F2 and M1	Calibrate	1 year	Level 1	Measurement Uncertainty
	(c) Working: Class E1 and E2	Calibrate See UKAS LAB 14[62] For more details	Dependent upon use (maximum 2 years)	Level 2	Measurement Uncertainty & Uncertainty Budget
	(d) Working: Class F1, F2 and M1	Calibrate See UKAS LAB 14[62] For more details	1 year	Level 2	Measurement Uncertainty & Uncertainty Budget

APPENDIX B References

(The list includes both current and previous versions at the time of issue. Previous test methods may still be cited in current legislation, regulation or other sources, and older equipment may need to be calibrated against the version relevant at the time of manufacture).

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[28] BS ISO 4869-6:2019, Acoustics. *Hearing Protectors – Determination of sound attenuation of active noise reduction earmuffs*

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