Specific Accreditation Criteria Calibration ISO/IEC 17025 Annex

Acoustic, ultrasonic and vibration measurement

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Acoustic, ultrasonic and vibration measurement

This document provides interpretative criteria and recommendations for the application of ISO/IEC 17025 for both applicant and accredited facilities conducting acoustic, ultrasonic and vibration measurement.

Applicant and accredited facilities must also comply with ISO/IEC 17025 the NATA ISO/IEC 17025 Standard Application Document (SAD) and the NATA Calibration ISO/IEC 17025 Appendix.

This annex is divided into two sections; the first provides additional guidance and recognition of the general requirements that are applicable to all types of measurements in this discipline, while the latter provides additional guidance and recognition of the requirements that are specific to individual types of measuring equipment. For ease of use and to avoid fragmentation of the guidance, the clauses of ISO/IEC 17025 have not been applied.

General Requirements

Facilities are to ensure a suitable CMC is stated in the Scope of Accreditation for the main measurement parameters for each instrument type. For activities such as the calibration of Sound Level Meters a separate CMC may be stated for acoustic measurements and ‘electrical signal input’ measurements as applies to the calibration test standard. Where an applicable standard incorporates maximum test uncertainties the facility must demonstrate that for each test the uncertainties do not exceed the maxima.

Accommodation and environmental conditions

As many instruments are sensitive to temperature, pressure and humidity variations, all instruments must be allowed to come to equilibrium with the ambient environment before a calibration commences.

Note: Instruments with larger masses and specialist materials (such as artificial mastoids) may need many hours to equilibrate before reliable measurements can be made.

Anechoic and reverberant rooms

Records of the evaluation of rooms must be kept and must include a description of room size, volume and construction, ambient noise and vibration levels, environmental conditions, microphone placements and measurement techniques and must also provide a statement of uncertainty of measurement and the frequency range over which measurements can be performed satisfactorily. The low frequency cut-off frequency must be stated together with the deviation from anechoicity at each working frequency.

Note: Refer to ISO 3741 and ISO 3745 for additional information.

Field sites

Sites used for measurement of sound and vibration levels must be adequately described, preferably with an attached map of the site location. Measurement sites must be identified, the period of measurement reported and temperature, humidity and weather conditions recorded.

Calibration method

The recommended calibration interval for a measurement system is the shortest interval of each of the components of the system. For example, a system consisting of a reference accelerometer (3-year interval), a charge amplifier (1-year interval), a reference capacitor (5-year interval), and a voltmeter (1-year interval), would have a recommended re-calibration interval of 1 year. Alternatively each component may be calibrated individually according to the NATA-recommended guidelines: for example, a measurement system comprising a reference accelerometer and a conditioning amplifier may be calibrated either (i) as a system (in $V/(m.s^{-2})$) every year, or (ii) as individual instruments with the accelerometer calibrated in $C/(m.s^{-2})$ every three years, and the conditioning amplifier calibrated every year in V/C.

The facility should minimise the frequency of use of any internal reference artefacts to avoid compromising the stability. Where necessary a working standard artefact should be used for more frequent use and an internal calibration procedure established. Calibration records of working or reference artefacts should be recorded to establish a history of stability. A calibration check should be made of the working standard before use.

Specific requirements for types of measurement equipment

Sound level meters

Due to regulatory and industry requirements, NATA will continue to accredit facilities calibrating Sound Level Meters to the superseded and/or withdrawn standards IEC 60651, AS 1259.1, IEC 60804 and AS 1259.2 following the minimum requirements of Test of Periodic Verification published in Annex A of OIML R 88. Annex A OIML R 88 tabulates the clauses of IEC 60651 and IEC 60804 required for periodic verification, which can also be applied to the equivalent clauses given in AS 1259 parts 1 and 2.

Sound Level Meters that have been type-approved to Part 2 Pattern Evaluation Tests of IEC 61672 *Electroacoustics - Sound Level Meters* are to be normally calibrated following IEC 61672 *Electroacoustics - Sound level meters* - Part 3: Periodic tests, unless the calibration facility can demonstrate a customer need for reporting to the superseded and/or withdrawn standards IEC 60651, AS 1259.1, IEC 60804 and AS 1259.2 due to regulatory or industry requirements as indicated above.

Continuation of accreditation to the superseded standards will be subject to evaluation of the industry requirements by the Calibration Accreditation Advisory Committee.

New facilities wishing to gain accreditation for the calibration of sound level meters must first show competence in testing to IEC 61672-3 before gaining accreditation to the superseded standards.

Personal sound exposure meters

Annex B of AS/NZS 2399, *Acoustics - Specifications for personal sound exposure meters* should be used as a guide for the periodic testing of sound exposure meters. For periodic testing some concession to reduced integration times is acceptable in order to have the activity cost-effective. Periodic testing of sound exposure meters must include a range linearity test at least as low as 85

dB. For devices which do not display a sound pressure level, sufficient integration time must be allowed to determine a resolution of 0.1 Pa^2hrs or equivalent Leq (with a minimum of 0.3 Pa^2hrs being recorded in each individual measurement). An acoustic frequency response in octaves from 63 Hz to 8 kHz must be conducted.

Using the instructions given in clauses 6 to 11 of AS/NZS 2399 periodic testing of sound exposure meters shall include:

- indication at reference conditions before and after any adjustments, Annex B1.5 of AS/NZS 2399;
- acoustic frequency weighting as outlined in Annex B3 of AS/NZS 2399;
- linearity of response to steady signals over the full stated dynamic range as outlined in Annex B2 of AS/NZS 2399, preferably at 63 Hz, 1 kHz and 8 kHz but as a minimum a test of linearity at 4 kHz;
- response to short duration signals as outlined in Annex B4 of AS/NZS 2399;
- response to unipolar pulses as outlined Annex B5 of AS/NZS 2399;
- latching over load indicator as outlined in B6 of AS/NZS 2399.

Additionally, if the sound exposure meter includes a facility to measure C-weighted Peak levels as required in Australian noise standard NOHSC1007 2000, the applicable test from IEC 61672-3 may be used to demonstrate correct operation.

Acoustic filters

Modern sound level meters often incorporate constant percentage octave-band or fractional-octave–band filters used for the analysis of complex noise signals. Some filter sets may be dedicated stand-alone units.

Facilities performing verification of filter performance must use AS/NZS 4476 Octave-band and fractional-octave-band filters Appendix C as a guide to testing taking into account the situation described in a) or b) below.

a) Where the filter equipment comprises analogue components, all filters in the set must be tested as required by AS/NZS 4476 clauses 4.4 and 5.3 and Appendix C.

b) Where the filter function is implemented in a digital algorithm within host equipment such as a sound level meter, some concession to the breadth of testing is acceptable to avoid unnecessary testing. Once initially tested, unless the firmware version changes in a manner likely to cause a change in the function, the filter set does not require periodic re-testing.

In the case of b) for a digital filter the minimum tests to be performed on the set are:

- relative attenuation (insertion loss) at the centre frequency of all filters in the set;
- level linearity of filter response according to clauses 4.6 and 5.5 of AS/NZS 4476 at the centre frequency of a selection of 3 filters, the lowest filter below but closest to 31.5 Hz, the highest filter above but closest to 16 kHz and a filter chosen in the middle of the frequency range of the set;

- relative attenuation according to clauses 4.4 and 5.3 of AS/NZS 4476 of the same three filters chosen above.

Statistical noise level analysers

Modern sound level meters often incorporate a statistical analyser to give information about the statistics of a time varying noise signal. Some analysers may be dedicated stand-alone units.

Facilities performing verification of statistical analyser performance must use DIN 45657 as a guide to testing taking into account the situation described in a) or b) below.

a) Where the analyser equipment comprises a stand-alone unit built of analogue components, the complete tests described in DIN 45657 must be carried out to include three ramped down/up amplitude cycles with one cycle centered on the dynamic range limits and the two other cycles at displaced levels either side of the main cycle. The ramped amplitude must comprise steps no greater than the resolution of the analyser and be over the dynamic range of the instrument with no less than 1 second between step changes.

b) Where the analyser is implemented in a digital algorithm within host equipment such as a sound level meter, some concession to the breadth of testing is acceptable to avoid unnecessary testing. Once initially tested, unless the firmware version changes in a manner likely to cause a change in the function, the statistical analyser function does not require periodic re-testing.

In the case b) for a digital implementation the minimum test to be performed on the function is:

- Ln performance using a single down/up ramped amplitude cycle using steps no greater than the least count of the host instrument and with at least 1 second between step changes and between limits no more than 10 dB from the under-range and overload levels.

Audiometers

All facilities performing verification of audiological equipment must test to AS IEC 60645.1-2002 *Electroacoustics – Audiological equipment*. The Scope of Accreditation must indicate the 'type' of audiometer within its capability.

Artificial mastoids

Artificial mastoids are sensitive to ambient conditions and should be allowed to come to equilibrium with the environment before testing. IEC 60318-6:2007 should be used as a guide, although the artificial mastoid's impedance must meet the specifications in IEC 60318-6:2007, Table 1. The force sensitivity (e.g. in units of dB re 1 V/N, or dB re 20 μPa/μN) as a function of frequency should also be stated. Calibration reports of artificial mastoids must include reference to the calibration of the impedance head used in the calibration. This head provides the traceability to the measurements.

Acoustic calibrators and pistonphones

To be accredited for field acoustics measurements, a suitably calibrated sound calibrator or pistonphone must be available to perform checks on a sound level

meter before and after a set of field measurements. When using a pistonphone to check a sound level meter's acoustic sensitivity, compensation for ambient air pressure must be made with a calibrated barometer.

Facilities performing verification of acoustic calibrators and pistonphones must use Annex B of AS/IEC 60942 *Electroacoustics - Sound Calibrators* as a guide.

Tests shall include:

- sound pressure level;
- output frequency;
- total distortion, if included;
- where supplied, correct indication of an additional barometer.

Microphones

Microphones should be stored in a dry ambient environment (e.g. in boxes with sachets of drying agents or in a desiccator).

Facilities performing frequency response testing using an acoustic coupler or an electrostatic actuator shall use IEC standards IEC 61094 parts 5 and 6 as a guide.

Vibration calibrators

Facilities performing verification of field vibration calibrators should refer to a standard appropriate to the intended use of the field measurement equipment such as ISO 8041 Human response to Vibration, Annex A.

Vibration transducers (accelerometers, velocimeters and geophones and vibrometers)

Facilities performing the calibration of vibration transducers should follow ISO 16063-11 or -21, or ISO 16063-41 for laser vibrometers for guidance. The units given in the calibration report should be appropriate for the intended usage of the transducer and in accordance with the agreement between the customer and the calibration facility. Calibration in SI units is preferred but not always suitable for the client. The Scope of Accreditation must always include a measurement capability in SI units.

Vibration transducers, accelerometers, and vibrometers are to be calibrated at a minimum of two frequencies and two levels that cover the range of use (as far as practicable). Triaxial accelerometers must be calibrated for each axis. .

Interpolation to obtain values between calibration points must be accompanied by evidence of method validation. ISO 16063-11 or -21 should be followed, or ISO 16063-41 for laser vibrometers.

If applicable, transducers should be calibrated in the orientation that they are specified to operate in (e.g. horizontally or vertically with respect to gravity).

Piezo-electric accelerometers

Piezo-electric or charge type transducers should, where possible, be calibrated with the conditioning amplifier such as the charge amplifier that will be used with the transducer in practice. Where the charge amplifier is not part of the transducer calibration it must be calibrated separately as a unit.

Powered accelerometers and vibration transducers

Vibration transducers that are externally powered such as servo accelerometers, strain gauge based or IEPE/CCLD internal impedance conversion types should, wherever passible, be calibrated with the power supply specified for the device which must be clearly stated on the calibration certificate. If the power supply cannot be provided with the transducer for calibration (e.g. it's built into a larger, non-portable system) then the vibration transducer may be calibrated separately, with an appropriate check made of the power supply. For example, by using a calibrated transducer simulator for IEPE type supplies.

If the vibration transducer has a sensitivity proportional to supply voltage (e.g. some bridge types), then the supply voltage must also be calibrated.

Self-generating vibration transducers

Self-generating vibration transducers, such as coil-based geophones and seismometers should be calibrated with the specified load impedance for the intended use which must be stated on the calibration certificate.

Self-contained vibrometers

Self-contained vibrometers and non-contact vibration measuring systems such as laser vibrometers and vibration meters, should be calibrated, whenever possible, as a unit with all associated acquisition hardware and operating software. For systems with non-portable components, calibration of system elements separately may be required. Often calibrations will state a ratio of the applied acceleration (or velocity) compared to the measured/displayed acceleration (or velocity).

Ultrasonic power meters

Facilities performing the calibration of ultrasonic power meters should follow IEC 61161 (AS/NZS 4714). Calibration of ultrasonic power meters must include a check with the included "standard mass". Between regular calibration intervals, ultrasonic power meters must be checked with this mass before and after measurements of the ultrasonic power of a working transducer.

References

This section lists publications referenced in this document. The year of publication is not included as it is expected that only current versions of the references shall be used.

Standards and other references

AS 1000 *The International System of Units (SI) and its application*

AS 1259.1	*Sound level meters: non-integrating*
AS 1259.2	*Sound level meters: integrating - averaging*
AS/NZS 2399	*Acoustics – Specifications for personal sound exposure meters*
ISO 16063–11	*Methods for the calibration of vibration and shock transducers – Part 11: Primary calibration by laser interferometry*
ISO 16063–21	*Methods for the calibration of vibration and shock transducers – Part 21: Vibration calibration by comparison to a reference transducer*
AS/IEC 60645.1	*Electroacoustics – Audiological equipment*
	Part 1: Pure-tone audiometers
IEC 60318-6	*Electroacoustics – Simulators of the human head and ear – Part 6: Mechanical coupler for the measurement of bone vibrators*.
IEC 60651	*Sound level meters* (superseded)
IEC 60804	*Integrating-averaging sound level meters* (superseded)
AS/IEC 60942–2004 (IEC 60942)	
	Electroacoustics – Sound calibrators
IEC 61094	*Measurement microphones*
IEC 61161	*Ultrasonics – Power measurement – Radiation force balances and performance requirements*
IEC 61672	*Electroacoustics - Sound Level Meters*
	Part 1: Specifications (Also published as an AS standard)
	Part 2: Pattern evaluation tests (Also published as an AS standard)
	Part 3: Periodic tests (Not yet released as Australian Standard at time of print)
ISO 3741	*Acoustics -- Determination of sound power levels of noise sources using sound pressure -- Precision methods for reverberation rooms*

ISO 3745	*Acoustics -- Determination of sound power levels of noise sources using sound pressure -- Precision methods for anechoic and hemi-anechoic rooms*
OIML R88	*Integrating-averaging sound level meters*

Amendment Table

The table below provides a summary of changes made to the document with this issue.

AMENDMENT TABLE	
Section or Clause	**Amendment**
New document	This document represents a direct adoption of the former Calibration Application Document Appendix A. The document has been reviewed and updated to reflect the new accreditation criteria documentation structure.