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Rubber — Guide to the calibration of test equipment

Caoutchouc — Lignes directrices pour l'étalonnage du matériel d'essai

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Contents

Page

Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

International Standards are drafted in accordance with the rules given in the ISO/IEC Directives, Part 2.

The main task of technical committees is to prepare International Standards. Draft International Standards adopted by the technical committees are circulated to the member bodies for voting. Publication as an International Standard requires approval by at least 75 % of the member bodies casting a vote.

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights.

ISO 18899 was prepared by Technical Committee ISO/TC 45, *Rubber and rubber products*, Subcommittee SC 2, *Testing and analyses*.

Rubber — Guide to the calibration of test equipment

1 Scope

This International Standard outlines the principles of calibration of rubber test equipment and gives guidance on the general requirements for ensuring measurement traceability, establishing the basis for deciding calibration intervals and estimating measurement uncertainty.

Methods of calibration for a range of parameters applicable to rubber test equipment are briefly described with reference to relevant standards where appropriate.

2 Normative references

The following referenced documents are indispensable for the application of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 9000, *Quality management systems — Fundamentals and vocabulary*

ISO 10012, *Measurement management systems — Requirements for measurement processes and measuring equipment*

ISO/IEC 17025, *General requirements for the competence of testing and calibration laboratories*

3 Terms and definitions

For the purposes of this document, the metrological terms and definitions given in ISO 9000 and ISO 10012, together with the following definitions, apply.

NOTE The terminology used in this International Standard is also in line with the terms and definitions given in ISO Guide 30.

3.1
calibration
process of establishing the relationship between the values of a quantity indicated by a measurement instrument and the corresponding values indicated by a reference instrument

3.2
verification
activity whereby measurement or test equipment is subjected to a specified examination or calibration and found to perform within stipulated tolerance limits

3.3
metrological confirmation
set of operations required to ensure that an item of measurement equipment is in a state of compliance with the requirements for its intended use

3.4
calibration system
part of a quality system which includes the calibration and metrological confirmation of test equipment and any reference standards held

4 Principles of calibration

Generally metrological confirmation involves calibration and also any necessary adjustment, repair, recalibration, sealing or labelling. Confirmation may also involve the verification of a value, for example a length, of some feature of a test apparatus. In common terminology, the whole process of confirmation is considered as the service performed by a calibration laboratory, and frequently the action of “calibrating” test equipment is more correctly providing metrological confirmation that it meets specified requirements.

Calibration is based on the principle of there being established values of measurement, represented by reference standards (sometimes called transfer standards), against which other measurements can be compared. The calibration value is transferred in turn from an internationally recognized standard to a nationally recognized standard (often called a primary standard) to a series of secondary or transfer standards and then to the measurement or test equipment. Measurement traceability is being able to relate a measurement through an unbroken chain of comparisons to a primary standard.

Each stage of the transfer of calibration by comparison down the chain results in an increasing uncertainty in the measurement and hence a lowering of the accuracy which can be guaranteed. Hence it is essential to establish that the measurement standard used has a sufficiently small uncertainty for the purpose.

5 Calibration systems

Requirements for measurement processes and measurement equipment are given in ISO 10012, and the general criteria for the operation of test laboratories are given in ISO/IEC 17025.

Where test laboratories carry out their own calibrations, they shall operate a management system conforming to ISO 10012. Where an outside calibration laboratory is used, it shall, wherever possible, be accredited by the relevant national accreditation body.

NOTE Information on accreditation of test and calibration laboratories can be obtained from national accreditation bodies.

6 Traceability

The calibration results for measurement instruments shall be traceable, wherever possible, to national standards.

7 Calibration intervals

Test equipment and measurement standards shall be calibrated at appropriate intervals established on the basis of the stability, purpose and frequency of use of the equipment/standards. The intervals between calibrations shall be such as to assure the reliability of the measurements made.

Because of differences in instrument performance, frequency of use, etc., it is not possible to give specific intervals in all cases. However, for the purposes of this International Standard, three classes of calibration interval are recognized for test equipment:

a) initial verification only;

b) “standard” interval;

c) in use.

Regardless of the class of interval, equipment shall also be re-verified after any probable change in the accuracy of the equipment such as would be caused by disturbance, relocation or repairs due to damage or wear.

In-use calibration is calibration at the time of use of the test equipment, usually before making test measurements.

The “standard” interval should preferably be chosen following the guidance given in ISO 10012. Some generally accepted intervals are given in Annex A of this International Standard.

8 Records

Records shall be kept for all measurement equipment and all calibrations carried out, as specified in ISO 10012.

NOTE 1 A calibration certificate for one parameter of an apparatus, even if from an accredited laboratory, does not constitute confirmation of the whole test equipment.

NOTE 2 Guidance on certificates for reference materials is given in ISO Guide 31.

9 Estimate of uncertainty

However skilfully the calibration is performed, the result will always be subject to an associated uncertainty. An estimate of this uncertainty is required for each calibration in order that compliance with the specified requirements can be confirmed. The estimate of the uncertainty shall be made using accepted methods of analysis, combining the random and systematic errors, and shall include errors that are attributable to the measurement standard and those attributable to personnel, procedures and the environment.

NOTE Guidance on the estimation of uncertainty is given in the *Guide to the expression of uncertainty in measurement*.

A useful guide for test laboratories is that the uncertainty of measurement for transfer standards should be at least five times smaller than that required of the test equipment being calibrated.

10 Conditioning

Measurement standards and measurement equipment shall be calibrated and used in an environment controlled to the extent necessary to ensure valid measurements. Due consideration shall be given to temperature, rate of change of temperature, humidity, lighting, vibration, cleanliness (including dust control) and other factors affecting measurement. Where pertinent, these factors shall be monitored and recorded and, when necessary, compensating corrections shall be applied to the measurement data.

Generally, the ambient temperature for polymer testing is required to be (23 ± 2) °C, and calibrations would normally be carried out at that temperature. However, the usual practice in calibration is to calibrate at an ambient temperature of (20 ± 2) °C. Calibration of polymer-testing equipment at this temperature will be satisfactory for testing in the normal range. The apparatus to be calibrated and the measurement standard shall be conditioned at the calibration temperature for sufficient time for temperature equilibrium to be reached.

11 Procedures

Calibration is carried out following a defined procedure. Each parameter of an apparatus has its own procedure, but these procedures may be combined into a single procedure for the whole apparatus. This International Standard gives the methodology used for each parameter, arranged in sections according to the type of measurement involved (e.g. force, electrical). The information given is intended as guidance for test laboratories. Individual laboratories will have to formulate specific working procedures for the particular calibration equipment and transfer standards to be used, the method to be followed and the records to be kept.

The number of replicate measurements to be made for each calibration will depend on the particular circumstances, and has to be specified in the detailed procedures. Typically, between one and five replicates will be required. An estimate of the component of uncertainty due to the measurement process will require at least three, and preferably five, repeats, but, where this uncertainty has been estimated from a separate trial, a single measurement may be considered adequate.

Attention is drawn to the difference between calibrating a measurement instrument and verifying a quantity (e.g. the difference between a dial gauge and the specified length of a component of the test equipment). In general, the procedures given apply to measurement instruments or devices which form part of the apparatus, e.g. a voltmeter or pressure gauge. However, where appropriate, the procedure may also discuss the measurement of a quantity. A quantity is normally verified using a measurement instrument.

12 Expression of results

If necessary, corrections shall be applied to the readings obtained. When two instruments (the instrument being calibrated and a reference instrument) are being compared, the differences between the two sets of readings shall be tabulated with respect to the reading of the reference instrument. If required, the differences shall be plotted to produce a calibration curve. Where a quantity has been measured, the readings shall be recorded. The estimate of uncertainty shall be calculated.

NOTE There is sometimes confusion between the error in the indicated value and the correction to be made. For example, if the error is − 3 units then the correction is + 3 units.

13 Calibration records

The information recorded shall include:

a) a reference to this International Standard, i.e. ISO 18899;

b) a description and unique identification of the equipment calibrated;

c) the parameters measured;

d) the measurement procedures used;

e) a unique identification of the calibration standards used and reference to their traceability to an internationally recognized standard, e.g. a calibration certificate;

f) the date on which each measurement was completed;

g) the calibration results obtained after and, where relevant, before any adjustment or repair;

h) the assigned calibration interval;

i) the designated limits of permissible error;

j) the relevant environmental conditions and a statement of any corrections made necessary by these conditions;

k) the estimated uncertainty of the measurement results;

l) details of any servicing, adjustment, repairs or modifications carried out;

m) identification of the person(s) performing the measurement;

n) identification of the person(s) responsible for ensuring the correctness of the recorded information.

14 Electrical measurements

14.1 Current

The measurement of current is largely confined to electrical and chemical tests. A variety of types of ammeter may be encountered and the range of current level and accuracy required is quite wide. In particular, some methods require the measurement of very small currents, and specialized procedures and calibration standards are needed to achieve the necessary low level of uncertainty.

The ammeter is compared to a standard instrument or to a standard current source.

Relevant standards: IEC 60051-1 and IEC 60051-9.

14.2 Voltage

The measurement of voltage is largely confined to electrical and chemical tests. A variety of types of voltmeter may be encountered and the range of voltage level and accuracy required is quite wide. In particular, some methods require the measurement of very small voltages, and specialized procedures and calibration standards are needed to achieve the necessary low level of uncertainty.

The voltmeter is compared to a standard instrument or to a standard voltage source.

Relevant standards: IEC 60051-1 and IEC 60051-9.

14.3 Frequency and bandwidth

The usual situation involving frequency is where a frequency generator requires verification, but there may also be a need to calibrate a frequency meter. The principle is the same in both cases.

Comparison is made with a standard frequency meter.

Relevant standards: IEC 60051-1 and IEC 60051-9.

14.4 Resistance

The measurement of resistance is largely confined to electrical tests. The usual situation is that a resistor or resistor network requires verification which is carried out using a calibrated resistance meter. As an alternative to using a resistance meter, the resistance may be measured by means of standard resistors in a bridge circuit.

The instrument is used to measure standard resistors.

Relevant standards: IEC 60051-1 and IEC 60051-9.