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Determination of calibration intervals and re-calibration of measuring instruments - A guide for Laboratories and Inspection Bodies

Mauritius Accreditation Service

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Foreword

The MAURITIUS ACCREDITATION SERVICE (MAURITAS) is a governmental body established in 1998 to provide a national, unified service for the accreditation of Conformity Assessment Bodies (CABs) such as calibration/testing laboratories, certification bodies and inspection bodies. Organizations that comply with the MAURITAS requirements are granted accreditation by MAURITAS.

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- R series — Publications containing general policy and requirements related to MAURITAS accreditation.
- G series — Publications providing guidance on MAURITAS requirements.
- A series — Publications related to assessment procedure
- P series — MAURITAS quality system procedures
- F series — MAURITAS Forms
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Determination of calibration intervals and re-calibration of measuring instruments - A guide for Laboratories and Inspection Bodies

1. Purpose

1.1 This document provides a guidance on the determination of the calibration intervals as well as for the re-calibration of measuring instruments.

2 Scope and Responsibilities

2.1 This document serves as a guidance for accredited and applicant laboratories and inspection bodies for determining the calibration intervals and re-calibration of measuring instruments.

3. References

The following documents contain provisions which, through reference to this text, constitute provisions of the MAURITAS accreditation system. For dated references, subsequent amendments to, or revisions of, any of these publications do not apply. For undated MAURITAS references, the latest edition of the document referred to, applies. MAURITAS maintains a register of the current valid MAURITAS accreditation documents.

3.1 MAURITAS R series

3.2 ISO/IEC 17000 **:** Conformity Assessment – Vocabulary and General Principles

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

3.4 ISO 15189 **:** Medical laboratories- Particular requirements for quality and competence

3.5 ILAC-G24 **:** ILAC Guidelines for the determination of calibration intervals of measuring instruments

3.6 SANAS TG 05-05 **:** Guidelines concerning calibration intervals and re-calibration.

3.7 MAURITAS G4 **:** Measurement and calibration systems

4 Definitions

4.1 Calibration Interval

The period over which there is an estimated high probability that the performance of the instrument will remain within the desired specification.

4.2 Laboratory

A body that performs one or more of the following activities:
-Testing
-Calibration
-Sampling associated with subsequent testing or calibration

5 Calibration intervals

5.1 Gauges and instruments should be recalibrated before drift or wear cause them to be unfit for purpose.

5.2 The rate of drift or wear in a given application is estimated by projection from past calibration history.

[This is why calibration certificates should contain actual calibration measurement results (before and after any necessary adjustment), not just “pass” or “fail”. Only the laboratory can provide the data needed to determine the calibration interval].

5.3 In the case of standard lamps, consideration must be given to cumulative burning time.

5.4 Calibration intervals should be chosen to give the desired confidence in measurements for an acceptable cost of calibration. The desired confidence depends on the risk and consequences of an inaccurate measurement. These factors are determined by the user and are therefore subject to discussion between the laboratory and the user.

6 Re-calibration

6.1 Calibration is necessary in order to establish confidence in the performance of a gauge or instrument. A calibration history supported by certificates contributes to this confidence. It is therefore good practice to compare new calibration results with old ones. In certain circumstances it may be possible to reduce the amount of “new” calibration work on the basis of consistency with previous results.

7 Criteria for Determining Calibration Intervals

7.1 An important aspect of the efficient operation of a calibration system is the determination of the maximum period between successive calibrations of measurement standards and measuring equipment. A large number of factors influence the frequency of calibration. The most important of these factors are:

- type of equipment;
- manufacturer’s recommendations;
- trend data obtained from previous calibration recommendations;
- recorded history of maintenance and servicing;
- extent and severity of use;
- tendency to wear and drift;
- frequency of cross-checking against other measuring equipment, particularly measuring standards;
- frequency and formality of in-house check calibrations;
- environmental conditions (temperature, humidity, vibration, etc);
- accuracy of measurement sought;
- the penalty of an incorrect measured value being accepted as correct because the measuring equipment has become faulty.

7.2 It is obvious from all these stated factors that a list of calibration intervals which can be universally applied cannot be constructed. It is more useful to present guidelines on how calibration intervals may be established and then reviewed once calibration on a routine basis is underway.

7.3 There are two basic and opposing criteria which are required to be balanced when deciding on the calibration intervals for each item of measuring equipment. These are:

- the risk of measuring equipment failing to conform to specification when in use should be as small as possible;
- keeping the calibration costs to a minimum. The cost of calibration cannot normally be ignored in determining calibration intervals and this may therefore be a limiting factor.

7.4 Therefore, methods have been presented in this document for the initial selection of calibration intervals and for the readjustment of these intervals on the basis of experience.

8 Initial Choice of Calibration Intervals

8.1 The basis of the initial decision in determining the calibration interval is invariably the so-called engineering intuition. Someone with experience of measurements in general, or of the measuring equipment to be calibrated in particular, and preferably with knowledge of the intervals used by other laboratories, makes an estimate for each item of equipment or group of items as to the length of time it is likely to remain within tolerance after calibration.

Factors to be taken into account are:

- the equipment manufacturer's recommendation;
- the extent and severity of use;
- the influence of the environment;
- the accuracy of measurement sought.

9 Methods of Reviewing Calibration Intervals

9.1 A system which maintains calibration intervals without review, determined only by so-called engineering intuition, is not considered to be sufficiently reliable.

9.2 Once calibration on a routine basis has been established, adjustment of the calibration intervals should be possible in order to optimize the balance of risks and costs as stated in the introduction. It will probably be found that the intervals initially selected are not giving the desired optimum results due to:

- items or equipment may be less reliable than expected;
- their usage may not be as expected;
- it may be sufficient to carry out a limited calibration of certain items instead of a full calibration;
- the drift determined by the regular calibration of the equipment may show that longer calibration intervals are possible without increasing the risks, and so on.

9.3 If shortage of funds or shortage of staff means that extended calibration intervals are necessary, it should not be forgotten that the costs of using inaccurate measuring equipment may be significant. If an estimate of these costs is made, it may well be found to be more economic to spend more money on calibration and to reduce the calibration intervals.

9.4 A range of methods is available for reviewing the calibration intervals. These differ according to whether:

- items of equipment are treated individually or as groups (for example, by maker or by type);
- items fail to comply with their specifications due to drift with the lapse of time, or by usage;
- data are available and importance is attached to the history of calibration of the equipment.

9.5 No one method is ideally suited for the full range of equipment encountered.

9.6 Method 1: Automatic or 'Staircase' Adjustment

9.6.1 Each time an item or equipment is calibrated on a routine basis, the subsequent interval is extended if it is found to be within tolerance, or reduced if it is found to be outside tolerance. This 'staircase' response may produce a rapid adjustment of intervals and is easily carried out without clerical effort. When records are maintained and analysed, possible trouble with a group of items, indicating the desirability of a technical modification or preventive maintenance, may become apparent.

9.6.2 A disadvantage of systems that treat items individually may be that it is difficult to keep the calibration workload smooth and balanced and that it requires detailed advanced planning.

9.7 Method 2: Control Charts

9.7.1 The same calibration points are chosen from every calibration and the results are plotted against time. From these plots, both scatter and drift are calculated, the drift being either the mean drift over one calibration interval or, in the case of very stable equipment, the drift over several intervals. From these figures the effective drift maybe calculated.

9.7.2 The method is difficult to apply, in fact very difficult in the case of complicated equipment, and can virtually only be used with automatic data processing. Before calculations can commence, considerable knowledge of the law of variability of the equipment or of similar equipment is required. Again, it is difficult to achieve a balanced workload. However, considerable variation of the calibration intervals from those prescribed is permissible without invalidating the calculations. Reliability can be calculated and, in theory at least, it gives the more efficient calibration interval.

9.7.3 Furthermore, the calculation of the scatter will indicate if the manufacturer's specification limits are reasonable, and the analysis of the drift which is found may help in indicating the cause of the main drift.

9.8 Method 3: Calendar Time

9.8.1 Items of measuring equipment are initially arranged into groups on the basis of their similarity of construction and of their expected similar reliability and stability. A calibration interval is assigned to the group, initially on the basis of engineering intuition.

9.8.2 In each group, the quantity of items which return at their assigned calibration interval and are found to have excessive errors or to be otherwise nonconforming is determined and is expressed as a proportion of the total quantity of items in that group which are calibrated during a given period. In determining the 'nonconforming' items, those which are obviously damaged or which are returned by the user as suspect or faulty, are not included as they are not likely to cause measurement errors.

9.8.3 If the proportion of 'nonconforming' items of equipment is excessively high, the calibration interval should be reduced. If it appears that a particular sub-group of items (such as a particular make or type) does not behave like the other members of the group, this sub-group should be removed to a different group with a different calibration interval.

9.8.4 The period during which the performance is assessed should be as short as possible, compatible with obtaining a statistically meaningful quantity of calibrated items for a given group.

9.8.5 If the proportion of nonconforming items of equipment in a given group proves to be very low, it may be economically justifiable to increase the validation interval.

9.8.6 Other statistical methods may be used.

9.9 Method 4: 'In-Use' Time

9.9.1 This is a variation on the foregoing methods. The basic method remains unchanged but the calibration interval is expressed in terms of hours of use rather than in calendar months of elapsed time. An item of equipment may be fitted with an elapsed time indicator, and is returned for calibration when this indicator reaches a specified value.

9.9.2 The important theoretical advantage of this method is that the number of calibrations performed, and therefore the cost of calibration, varies directly with the length of time for which the equipment is used. Furthermore, there is an automatic check on equipment utilization.

9.9.3 However, the practical disadvantages are many, and include:

- it cannot be used with passive measuring instruments (for example, attenuators) or with passive measurement standards (resistors, capacitors, etc.);
- it should not be used when equipment is known to drift or deteriorate when on the shelf, or when handled, or when subjected to a number of short on-off cycles;
- it should in any case have a calendar-time backup;

- the initial cost of the provision and installation of suitable timers is high and, since users may interfere with them, supervision may be required which will again increase costs;
- it is even more difficult to achieve a smooth flow of work than with the other methods mentioned, since the calibration laboratory has no knowledge of the date when the calibration interval will terminate.

9.10 Method 5: In-Service or 'Black-Box' Testing

9.10.1 This method is complementary to a full calibration. It can provide useful interim information on characteristics of measuring equipment between full calibrations and can give guidance on the appropriateness of the calibration programme.

9.10.2 This method is a variation on methods 1 and 2 and is particularly suitable for complex instruments and test consoles. Critical parameters are checked frequently (once per day or even more often) by portable calibration gear or, preferably, by a 'black-box' made up specifically to check the selected parameters. If the equipment is found to be nonconforming by using the 'black-box', it is returned for a full calibration. The major advantage of this method is that it provides maximum availability for the equipment user. It is very suitable for equipment which is geographically separated from the calibration laboratory, since a complete calibration is only done when it is known to be necessary or at extended calibration intervals. The main difficulty is in deciding on the critical parameters and in designing the 'black-box'.

9.10.3 Although the method theoretically gives a very high reliability, this is slightly ambiguous, since the equipment may be failing on some parameter which is not measured by the 'black-box'. In addition, the characteristics of the 'black-box' itself may not be constant and it also needs to be regularly calibrated.

10 MAURITAS Requirements Concerning the Determination of Calibration Intervals

10.1 The Officer in Charge of a MAURITAS accredited/applicant laboratory or inspection body should discuss all calibration requirements with his/her customer, also taking into consideration the manufacturer's recommendations. The conditions under which gauges or instruments will be used should be included in the discussion. Calibration intervals must be adjusted after mutual consent between the metrologist and the customer. The calibration interval or re-calibration date may only appear on a Certificate of Calibration if requested in writing by the customer.

10.2 If a gauge or instrument is abused, damaged, or subjected to conditions which cause wear or drift, it is the responsibility of the user of the gauge or instrument to request recalibration at appropriate intervals.

10.3 Whenever any equipment is being commissioned, the equipment should be calibrated before being put in use.

11. Related Forms

Appendix A: Amendment Table

SN	Section	Amendment

