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INTERNATIONAL DOCUMENT N° 10

GUIDELINES for the DETERMINATION of RECALIBRATION INTERVALS of MEASURING EQUIPMENT USED in TESTING LABORATORIES

Based on a report of
ILAC TASK FORCE E

adopted by the International Committee of Legal Metrology in 1984
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INTERNATIONAL DOCUMENTS
of the INTERNATIONAL ORGANIZATION of LEGAL METROLOGY

The document « Work Policy of OIML », adopted in principle by the 4th International Conference of Legal Metrology in 1972, mentions the possibility for the Organization to publish International Documents meant to facilitate the harmonization of national regulations concerning metrology and likely to contribute to the development of metrology services.

These documents do not have the rigid character of International Recommendations, that is to say, in particular, that the provisions of article VIII of the Convention, by which Member States « shall be morally obliged to implement these decisions as far as possible », do not apply.

GUIDELINES for the DETERMINATION of RECALIBRATION INTERVALS of MEASURING EQUIPMENT USED in TESTING LABORATORIES

1. Introduction

An important aspect of the efficient operation of a calibration system within a testing laboratory is the determination of the maximum period between successive calibrations of reference standards and measuring equipment. A large number of factors influence the frequency of recalibration and should be taken into account by the testing laboratory and by the accrediting authority. The most important factors are :

— type of equipment,
— manufacturer's recommendation,
— trend data obtained from previous calibration records,
— recorded history of maintenance and servicing,
— extent and severity of use,
— tendency to wear and drift,
— frequency of cross-checking against other reference standards,
— frequency and quality of in-house check calibrations,
— environmental conditions (temperature, humidity, vibration, etc.),
— accuracy of measurement sought.

The cost of calibration cannot normally be ignored in determining the recalibration intervals and this may therefore be a limiting factor. It is obvious from all these stated factors that a list of recalibration intervals which can be universally applied cannot easily be constructed. It is more useful to present guidelines on how recalibration intervals may be established, and then reviewed once calibration on a routine basis is under way.

There are two basic and opposing criteria which are required to be balanced when deciding on the recalibration intervals of each measuring instrument. These are :

— the risk of a measuring instrument going out of tolerance when in use should be as small as possible,
— the annual calibration costs should be kept to a minimum.

Therefore, methods are presented in this International Document for the initial selection of recalibration intervals and the readjustment of these intervals on the basis of experience. Initial recalibration intervals for a wide range of equipment have been gathered from industry in reply to a questionnaire circulated to accrediting authorities in certain countries. These are presented in a separate document. The

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BIML note

Task force E of the International Laboratory Accreditation Conference (ILAC) prepared a report on initial recalibration intervals of measuring equipment used in testing laboratories. ILAC 83 transmitted this report to OIML for consideration and publication.

The report was subdivided into two parts, published separately :
— this International Document,
— the document « Examples of initial recalibration intervals ».

values given can serve as a guideline for determining initial recalibration intervals, but this should be done with care, taking into account the influence factors stated above, which may cause the values to vary widely.

2. Initial choice of recalibration intervals

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

Factors to be taken into account are :

— the instrument manufacturer's recommendation,

— expected extent and severity of use,

— the influence of the environment,

— the accuracy of measurement sought.

3. Methods of reviewing recalibration intervals

Once calibration on a routine basis has been established, adjustment of the recalibration intervals should be possible in order to optimise 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 ; instruments may be less reliable than expected ; the usage may not be as anticipated ; it may be sufficient to carry out a limited calibration of certain instruments instead of a full calibration ; the drift determined by the recalibration of the instruments may show that longer recalibration intervals may be possible without increasing risks, and so on.

If the shortage of money or shortage of staff means that extended recalibration intervals are necessary, it should not be forgotten that the costs of using inaccurate instruments are not insignificant. If an estimate of these costs be made, it may well be found more economic to spend more money on calibration and thereby reduce the recalibration intervals.

A range of methods is available for reviewing the recalibration intervals. They differ according to whether :

— instruments are treated individually or as groups (e.g. by manufacturer or by type),

— instruments go out of calibration by drift over time or by usage,

— data are available and importance is attached to the history of calibration of the instruments.

No one method is ideally suited for the full range of instruments encoutered. Furthermore, it should be noted that the method chosen will be affected by whether the laboratory intends to introduce planned maintenance. There may be other factors which will affect the laboratory's choice of method. The method chosen will, in turn, affect the form of records to be kept.

The so-called engineering intuition which fixed the initial recalibration intervals, and a system which maintains fixed intervals without review, are not considered as being sufficiently reliable and are therefore not recommended.

Method 1 : automatic adjustment or « staircase » (calendar-time)

Each time an instrument 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 used, possible trouble with a group of instruments indicating the desirability of a technical modification, or preventive maintenance, will be known.

A disadvantage of systems treating instruments individually may be that it is difficult to keep the calibration work-load smooth and balanced, and that it requires detailed advanced planning.

Method 2 : control chart (calendar-time)

Significant calibration points are chosen 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 recalibration interval, or in case of very stable instruments, the drift over several intervals. From these figures the optimum interval may be calculated.

This method is difficult to apply, in fact, very difficult in the case of complicated instruments and can virtually only be used with automatic data processing. Before calculations can commence, considerable knowledge of the law of variability of the instrument, or similar instruments, is required. Again, it is difficult to achieve a balanced work-load. However, considerable variation of the recalibration intervals from the prescribed is permissible without invalidating the calculations ; reliability can be calculated and in theory at least it gives the efficient recalibration interval. Furthermore, the calculation of the scatter will indicate if the manufacturer's specification limits are reasonable and the analysis of drift found may help in indicating the cause of drift.

Method 3 : « in-use » time

This is a variation on the foregoing methods. The basic method remains unchanged but the recalibration interval is expressed in hours of use, rather than calendar months. The instrument is fitted with an elapsed time indicator, and is returned for calibration when the indicator reaches a specified value. Examples of instruments are thermocouples, used at extreme temperatures, dead weight testers for gas pressure ; length gauges (i.e. instruments that may be subject to mechanical wear). The important theoretical advantage of this method is that the number of calibrations performed and therefore the costs of calibration varies directly with the length of time that the instrument is used.

Furthermore, there is an automatic check on instrument utilisation. However, the practical disadvantages are many and include :

— it cannot be used with passive instruments (e.g. attenuators) or standards (resistance, capacitance, etc.),

— it should not be used when an instrument 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 back-up,

— 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 again will increase costs,

— it is even more difficult to achieve a smooth flow of work than with the methods mentioned above, since the (calibration) laboratory has no knowledge of the date when the recalibration interval will terminate.

Method 4 : in service checking, or « black-box » testing

This is a variation on methods 1 and 2, and is particularly suitable for complex instruments or test consoles. Critical parameters are checked frequently (once a 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 instrument is found out of tolerance by the « black box » it is returned for a full calibration.

The great advantage of this method is that it provides maximum availability for the instrument user. It is very suitable for instruments geographically separated from the calibration laboratory, since a complete calibration is only done when it is known to be required. The difficulty is in deciding on the critical parameters and designing the « black box ».

Although theoretically the method gives a very high reliability, this is slightly ambiguous, since the instrument may be failing on some parameter not measured by the « black box ». In addition, the characteristics of the « black box » itself may not remain constant.

Examples of instruments suitable for this method are density meters (resonance type) ; Pt-resistance thermometers (in combination with calendar-time methods) ; dosimeters (source included) ; sound level meters (source included).

Method 5 : statistical approach

When large numbers of identical instruments i.e. groups of instruments are to be calibrated, the recalibration intervals can be reviewed with the help of statistical methods. Detailed examples can be found in the work of L.F. Pau and references.

4. Examples of recalibration intervals

Although there is a wide scatter in recalibration intervals of measuring instruments used in calibration and testing laboratories depending on accuracy level and working conditions, it is useful to create an international forum for the exchange of information on initial recalibration intervals.

Therefore, it has been decided to elaborate a separate document, entitled « Examples of initial recalibration intervals » as a basis for know-how exchange. All interested countries are invited to make contributions. Care will be taken to ensure that the document remains up-dated.

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N O T E

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'GUIDELINES for the DETERMINATION of RECALIBRATION INTERVALS of MEASURING EQUIPMENT USED in TESTING LABORATORIES'

The report presented to ILAC by its working group E was transmitted to the International Organization of Legal Metrology for consideration and possible publication, in conformity with the Resolution ILAC 5/83 adopted by ILAC 83.

This report is subdivided into two parts :

- a document 'Examples of initial recalibration intervals' widely distributed in June 1984; additional information was requested, from the recipient States, with the intention of updating this document by the end of 1985,
- a draft International Document (*) submitted to the OIML Member States for study, comment and vote, and to certain International Institutions concerned, for study and comment.

At the closing date of voting (31 August 1984), the results (20 yes, 1 no, 0 abstention) allowed the draft to be considered as adopted; some comments were received : some, of mostly editorial nature or not concerning the technical content of the text, were taken into consideration; others, more general, will be taken into consideration at a later date, during a revision of DI No 10. In this way, it was possible to avoid certain difficulties rightly mentioned by Dr. Lawrence D. Eicher, Assistant Secretary General of ISO, in his letter ISO-ILAC 84, dated 1984-07-23.

Whilst distributing this DI No 10, OIML requests the readers to make any comments which would help to improve or complete the text. The creation of an OIML working group or of a joint ILAC-OIML working group, to be responsible for the continuation of the work, is at present being examined.

(*) see explanations on OIML International Documents on page 2 of DI No 10.