Presentation and comparison between two guidelines for the determination of calibration intervals of measuring instruments: FD X 07-014 (11/2006) and ILAC-G24 / OIML D 10 (2007) (E)

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Introduction

The traceability of the measure results is in theory the main concern of metrologist. Calibration and evaluation of the measurement uncertainty allow to demonstrate this traceability. Yet, calibration is valid at the moment of the operation only. Given that the measurement uncertainty depends partially of the calibration results: it is realist only if the device does not evolve. Thus question of calibration intervals is an essential question of traceability too often overlooked. There are mainly two reference documents dealing with this subject: RP1 published by OIML (International Organization of Legal Metrology) and part FD X 07-014 published in 2006 by AFNOR

*Note: To be complete, there is also a standard published by BNAE (Bureau de Normalisation de l'Aéronautique et de l'Espace – Aeronautics and Space Office of Standardization – RM AERO 800-25: **Guide pour l'optimisation des intervalles de confirmation métrologique d'un instrument de mesure)** which is not really applicable in industry, from the workgroup organizer's point of view (Gilbert Brigodiot).*

Presentation of the two guidelines:

- FD X 07-014: French guideline offering some method of calibration interval and allowing to justify intervals of metrological confirmation for the measuring instrument used in the company. Delta Mu took part in the editorial staff of this guideline. It was published by AFNOR in 2006
- ILAC-G24 /OIML D 10: International guideline for the determination of calibration intervals of measuring instruments. This guideline was collectively realized between ILAC (International Laboratory Accreditation Cooperation) an OIML (International Organization of Legal Metrology)

Optimization methods proposed by the two standards:

- FD X 07-014: It offers three concrete methods of optimization. The third method is in appendix :

  - **Method of the drift**: The first method offered by FD X 07-014 is a method based on the equipment drift. The first stage of this method consists in modelling the drift observed for every equipment by the method of least squares. All the instruments of a same family are grouped, in a second stage, to determine the maximal drift of the family (statistically). Then, the periodicity of every instrument can be calculated according to its last value of calibration and the slope of maximal wear of its family.

- o **Method of the periodicity ratio** : The second method consist in determining the calibration interval of a measuring instrument according to the part it represents in the measurement uncertainty of the process in which it operates. The more the equipment's contribution in the measurement instrument is low, the less the periodicity can be important. On the contrary, the more the equipment's contribution is important, the weaker the periodicity will be

- o **Method OPPERET**: This third method introduced by the company EADS is presented in appendix FD X 07-014. This method was offered in a guide published by the CFM (Collège Français de Métrologie) in September 2005. It allows to determine the calibration intervals of measuring instruments considering various criteria. It is not confine to follow the drift of an instrument, but it also incorporates the concept of risk arising to factors which can degrade or improve the quality of the measurement. It does also not forget the constraints of coat or organization and the capacity to detect or not an abnormality. Factors to considered are to be individually analysed according to every industrial context.

- o **Monitoring of equipment**: The guideline FD X 07-014 also prompts us to realize in addition to traditional calibration some periodical monitoring of equipment whatever the optimization method chosen (which may be limited to a visual inspection). It presents us an example of monitoring which can be initiated with a control chart.

- • ILAC-G24 / OIML D 10 : It offers five methods to optimize the calibration frequencies:

  - o **Method 1 – Automatic adjustment or "staircase" (calendar-time)**: It is a simple method to operate. It consists in determining an interval (in the example presented: 80 % of the maximum permissible error). During the calibration, if the instrument is found in this interval, the periodicity is extended, if the instrument is found outside this interval, the periodicity is reduced.
    Note Delta Mu: This method is rather arbitrary. The rules of increase or decrease the calibration interval are not documented. The rule of the 80% is not justified and the measurement uncertainty is not considered

  - o **Method 2 – Control chart (calendar-time):** In this method, significant calibration points are chosen. We follow on a control chart the evolution of this significant calibration points over time. Through this monitoring, we can determine an individual derives from each instrument that allows us to calculate the optimum frequency.
    Note Delta Mu: This method is only applicable for deriving devices. Unfortunately, it is often not obvious to make the difference between a real drift and successive isolate disorder. For this type of control chart, we would recommend a chart EWMA (exemple : http://www.statsoft.fr/concepts-statistiques/glossaire/c/ewma.html)

  - o **Method 3 – "In-use" time:** This method is usable for not deriving instruments when they are not used. It consists in following the real in-use time of a device. The calibration interval is expressed in "hours of use", rather than calendar months but it's only deducted when the instrument is used. It can be used with one of the foregoing methods to determine the optimum calibration interval in "hours of use".
    Note Delta Mu: This method is rather difficult to implement because it requires to record each use. Furthermore, the guideline doesn't really give us the rules defining the calibration interval in "hours of use". The foregoing methods don't actually give any.

- o **Method 4 – In service checking, or "black-box" testing:** In the guideline, this method is recommended for complex instruments or test consoles. It consists to made-up a specifically "black-box" to check the critical parameters of our instrument. The check can be made directly on the device without performing external calibration. A complete calibration in the calibration laboratory is only made when required.

  Note Delta Mu: This method is more a monitoring strategy than a method to determinate calibration interval. However, this method has an official nature and it intends to calibrate instrument only in case of doubt during monitoring. It's an interesting argument for optimal management calibration interval.

- o **Method 5 – Other statistical approaches**: The guideline refers to statistical tools and softwares (without specifying them) which can allow us to optimize the calibration interval. It points us to an example of such a software described by A. LEPEK. To review the calibration interval of a large numbers of identical instruments, it also recommends us some example which can be find in the work of L. F. PAU

  Note Delta Mu: Delta Mu has always facilitated the use of statistics in metrology. However, the guide is very vague on how to proceed.

Comparison between the two guidelines:

- **Comparison between Method of the drift (FD X 07-014)** / **Method 2 – Control chart (ILAC-G24 / OIML D 10)**

  Because the two methods follow the equipment drift, they may seem similar. The method by control chart (ILAC-G24 / OIML D 10) studies the individual drift from an instrument and uses this individual drift to determine the next calibration. Therefore, it considers that the instrument is going to derive identically in the future. It does not consider possible changes in the use of the instrument or a different drift in the end of life of the instrument. Method of the drift (FD X 07-014) studies the behaviour of all the instruments of the same family. It allows to determinate a maximum drift including more intensive use instruments or end life instrument. Furthermore the FD X 07-014 method clearly explains the method principle and introduces the tools to determinate the next calibration. Such information is not available in the Method 2 of OIML D 10.

  So for instruments having a known drift, it seems more interesting to use the method presented in FD X 07-014.

- **Comparison between Method of the periodicity ratio (FD X 07-014) / Method 1 – Automatic adjustment or "staircase" (ILAC-G24 / OIML D10)**

  These two methods are rather different but it seems interesting to compare them. Method presented in ILAC G-24 / OIML D 10 seems to be the simplest of all methods to provide. Indeed during the calibration, the periodicity needs to be extended when the instrument is found in an interval (as a percentage of the maximum permissible error) and reduced when found outside this interval. To use this method, the maximum permissible error and the interval have to be correctly chosen.

  Method presented in FD X 07-014 shows the part of a measuring instrument on the process in which it operates. It allows to verify if the instrument error significantly occurs or not in the measurement process.

The drawback of the FD X 07-014 method is that the process must be perfectly know. It requires the evaluation of measurement uncertainty of the process and the exploitation of the calibration result of the device involved in. This fact is in reality a quasi-requirement of standards, even if it is still rare that industrials estimate their uncertainties.

Furthermore, the method which allows to determinate calibration interval according to the periodicity ratio is described in guideline FD X 07-014. OIML D 10 doesn't give details about the amount of extended or reduced calibration interval. It seems also important to note that to reduce the periodicity of an instrument which has been found outside 80% of the maximum permissible error it is necessary to make sure that device drift is proved. The laboratory's capability is also important in this method. The limit chosen must be greater than the measurement uncertainty of the laboratory to avoid the risk of decreasing the periodicity because of the measurement noise.

So the method of the periodicity ratio (FD X 07-014) which determines a calibration interval according to the part of instrument on the process uncertainty seems more interesting to use.

- **Monitoring of equipment (FD X 07 – 014) / Method 4 – In service checking, or "black-box" testing (ILAC-G24 / OIML D10)**

    These two methods are quite similar. On both methods, we try to extend calibration interval by adding monitoring. This monitoring allows to follow the instrument evolution continuously. So a problem on the instrument can be detected more quickly and then can be sent for calibration and / or repair.

    We can ask two questions on this monitoring:

    1. In ILAC-G24 / OIML D 10, the method is recommended for complex instruments or test consoles: Why not recommend this method for all instruments? If it works for complex instruments, there is no reason why it would not for the other ones!

    2. The second question concerns the two methods. It is recommended to use these monitoring in addition to the traditional periodic calibrations. Why not conduct regular monitoring and make calibration only when it is needed? Traditional calibration would be reserved only for cases where we have a doubt about the instrument. **In future standards, it would be interesting to favour this monitoring compare to periodic calibration.** That would reduce calibration costs and machine downtimes (during calibration) while improving the quality of the follow-up of instruments.

- **Method 3 – "In-use" time (ILAC-G24 / OIML D10)**

    The idea is to define the periodicity based on the actual use of the device. The periodicity is only deduced when the instrument is used. This method is to be combined with another optimization method. This "in-use" time method is already used by many manufacturers in France. **It might be interesting to refer it on future draft standard of FD X07-014. However it doesn't mean that it should be a new method.**

- **Method OPPERET (FD X 07-014) / Method 5 – Other statistical approaches (ILAC-G24 / OIML D10)**

    Lastly ILAC G 24 / OIML D 10 signals that there are other statistical methods that could be used to determine the calibration interval. Unfortunately, it does not describe these methods. FD X 07-014 presents statistical methods widely documented. If the quantitative data are not available, it's possible to implement the method OPPERET described in appendix. Calibration interval can be determinate with this method according to different quantitative and qualitative factors. **This method is really interesting because it can be used for all the instruments** without knowing the technical details of the processes in which the instrument are involved.

Conclusion

    FD X 07 -014 provides detailed methods that can be used according to the equipment. It's interesting to see that all the devices of a company can be optimized through at least one of three offered methods.

The ILAC-G24 / OIML D10 methods are less detailed and let the user with many questions to be resolve before applying the method. FD X 07-014 seems to be more practical and useful. Some interesting comments on ILAC-G24 / OIML D10 could be included in a future draft of the FD X 07-014.