

DEVELOPMENT OF SOFTWARE FOR THE CALIBRATION OF MEASURING INSTRUMENTS

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Abstract: This document aims at the presentation of a set of computational applications developed by a metrological laboratory in order to support the data acquisition and the data processing for different types of calibration tests, which are performed in accordance with procedures based on well-known documents, like as international standards.

Keywords: Calibration, Data Processing, Quality Management, Computational applications

1 INTRODUCTION

As a basic condition for the fulfilment of its mission, a metrological laboratory must be equipped with reference standards and have a set of calibration procedures. The former are traceable to the primary standards of the quantities related with the tests carried out; the calibration procedures must be developed by the laboratory and based on international standards, when possible.

A large number of calibrations performed according the procedures are time consuming, mainly due to the large number of required measuring data or the time intervals needed for the stabilisation of the metrological conditions in the different testing steps. So, it is very convenient to use reference standards with interfaces for the data acquisition by a computer.

Sometimes, a general purpose software is supplied by the manufacturers of the reference standards. However, the metrological laboratory must undertake the development of specific computational applications for the most important calibration tests, in order to accomplish the main requirements of the calibration procedures, as far as data acquisition and processing are concerned; additionally, the laboratory is responsible for the format of its own calibration certificates, and other documents, which are also generated by means of the developed applications, thus leading to the improvement of the internal organisation.

The purpose of this paper is to present some computational applications developed for the calibration tests carried out by the Central Laboratory for Metrological Support [1] of the Laboratório Nacional de Engenharia Civil, Lisbon, Portugal, aiming at, in general, the automatic data acquisition and data processing, the evaluation of measurement uncertainties, the computation of the calibration results and the edition of the certificates.

2 CONTENTS

This laboratory is equipped for the calibration and testing of some types of measuring instruments in the domains of length, temperature, pressure and mass, so the computational applications described in the paper were developed considering the characteristics of the available reference equipment in these areas.

As far as the length measurement is concerned, the paper describes an computational application developed for the calibration of dial gauges according with the standard NF E 11-050 [2]. This application is basically charged with the data acquisition, the evaluation of some statistical parameters and the computation of the errors defined in the calibration procedure.

Previously, following a request of the programme, the user inserts the relevant characteristics of the instrument under calibration, namely, identification data and parameters to define the testing steps. Then, the application evaluates the step interval based on the type of instrument (analogue or digital), on the resolution and on the number of laps (in the analogue case). After these initial settings, the length test consists of a sequence of three sets of operations presented in figure 1.

In the first of these, related with scale analysis, each length step is displayed in a sequential order and the operator is charged with their implementation in the testing machine, being stored both the

complementary information introduced by the user (described in figure 2) to create the final report (certificate) which can be printed almost immediately after the end of the testing operations.

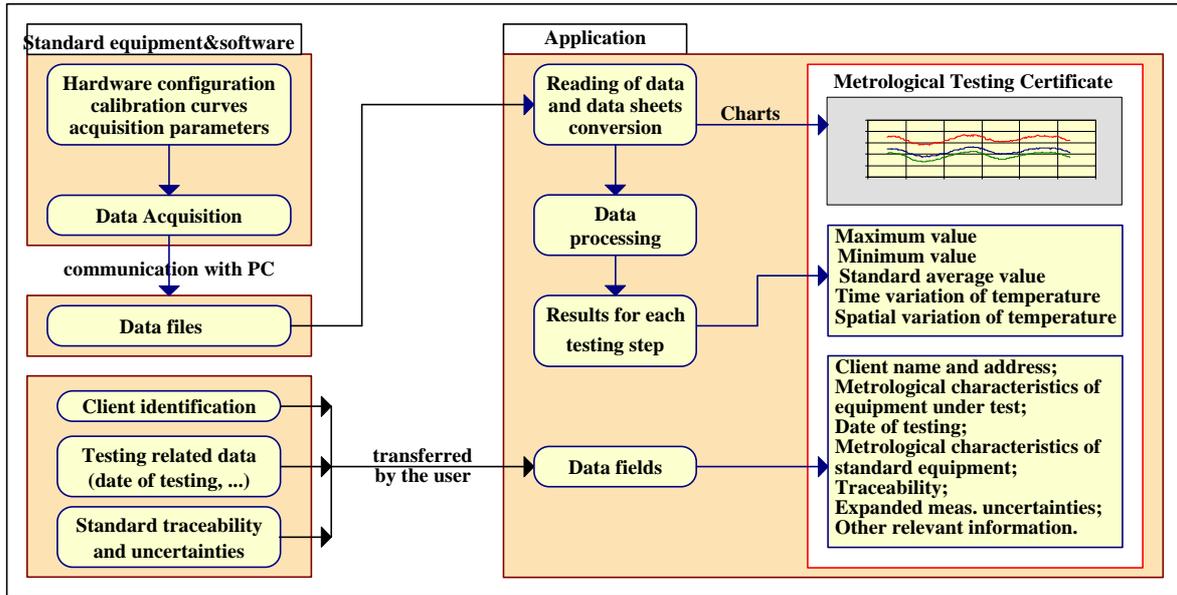


Figure 2. Integrated temperature testing process

Aiming at the calibration of manometers and pressure transducers according to the standard EN 837-1 [4], two applications are also presented in the paper. One of them is designed for use with a digital pressure calibrator and compares the displayed reference values with the measuring instrument indicated values; the other one is developed for use with a dead-weight tester and is suitable for the generation of a series of reference pressure values by means of a set of standard weights.

These applications contain data libraries which include, in the first case, the correction function of the reference equipment readings, obtained from the calibration certificate results, and the values for the different uncertainty components and, in the second case, the conventional true-value for each dead-weight and corresponding value for individual correction, uncertainty, ageing drift and other relevant uncertainty components.

In both cases, the computational applications process the calibration data typed by the user, store it in an array, perform the computation of statistical parameters (mean values, standard deviations, deviations from conventional true values), the correction of the pressure reference values (complete in the case of dead-weights), the evaluation of calibration deviations and the computation of the degrees of freedom and expanded measurement uncertainties; furthermore, the software allows the printing of a calibration certificate related with each test.

Nevertheless, the application developed for use with the dead-weight tester takes in account, specially, that each new testing step is achieved only by means of a new standard mass joined to the previous ones, so the reference labels of the different masses with their metrological parameters have to be recognised by the software.

Finally, an application developed for the calibration of weighing instruments based on the standard EN 45501 [5] is described (figure 3). In accordance with the calibration procedure, the standard weights used for the implementation of two successive test steps can be completely different, each step being generally made with the combination of a certain number of weights.

This computational application is similar to the aforesaid one developed for the dead-weight pressure tester, in what refers to the data libraries, which contain also the identification of each standard weight and the individual conventional true value, uncertainty and ageing drift. However, due to the possible use of different sets of standard weights in two consecutive steps, considering both the types of weighing instruments subjected to calibration and the requirements of the procedure, the user needs to identify the individual reference number of each one in an array, allowing the application to combine values in order to compute the global conventional true value and other results for each testing step.

The evaluation of degrees of freedom and expanded measurement uncertainty is also performed by the application, using self evaluated results (repeatability) and other uncertainty components (stored in library array), for each testing step.

Joining all this results and complementary data introduced directly by the user (client information, reference standard information and testing related data), a calibration certificate is generated as final result of the application, which can be printed.

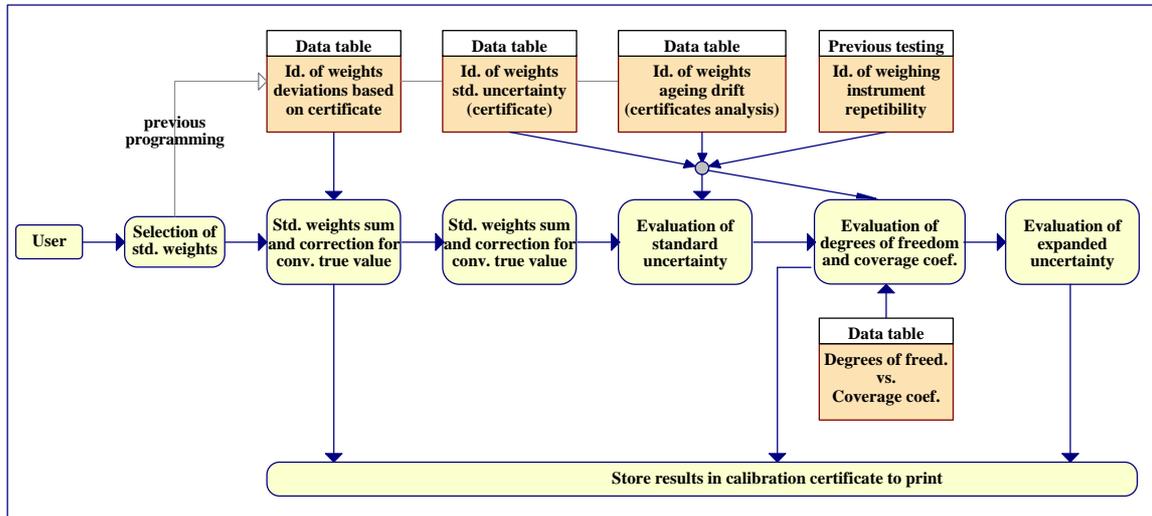


Figure 3. Computational application tool for weighing instruments calibration

3 CONCLUSION

Considering both the heavy work related with certain tests and the large number of measuring instruments being calibrated at the aforesaid metrological laboratory, the implementation of the applications described in this paper led to improvement of the productivity in the calibration service and decrease of the failing rates dues to the operator errors.

Other natural advantages arise from the use of computational applications in the process of calibration, namely, the improvements resulting from the possibility of introducing graphical presentation and from the reduction of time spend in paperwork and in the time necessary to issue a calibration certificate.

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