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Requirements for the competence of testing environmental laboratories

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Abstract. Laboratory accreditation is the best mechanism to provide assurance to customers on the quality and competence of the laboratory. The main steps of accreditation followed by a testing environmental laboratory are presented in this paper. An example could be Ecometallurgical Laboratory from University Politehnica of Bucharest (UPB-CCEEM). This laboratory is accredited for analyses of different parameters for surface and wastewaters, soils and also the composition of some alloys such as iron, aluminum and copper. Thus, the two practical elements which inter-relate and whose complexity and importance depend on the extent of the scope, namely the quality management system and the technical competence are presented in this paper, being developed on three levels: internal check achieved by the analyst, internal check achieved by the Quality Laboratory Chief and external check – inter-laboratories comparison schemes.
Key Words: laboratory, accreditation, environment, uncertainty.

Introduction. If testing and calibration laboratories comply with the requirements of the International Standard ISO 17025/2005, they will operate a quality management system for their testing and calibration activities that also meets the principles of ISO 9001. Ecometallurgical Laboratory from University Politehnica of Bucharest – Research Center for Ecometallurgical Expertise (UPB-CCEEM) is an accredited laboratory and complies with the SR EN ISO/CEI 17025/2005 requirements from November 24th 2003. The accreditation domain refers mainly to environment tests but also consists of metallic materials tests.

The laboratory analyses the following materials: surface and waste waters, eluates from wastes known as leachates, soils and metallic materials such as alloys. The following techniques are used for identify different types of pollutants (organic and inorganic):

- atomic absorption spectrometry (by flame and furnace);
- molecular absorption spectrometry;
- optical emission spectrometry.

The advantages of the accreditation process. The laboratory was created in order to confirm the management and technical requirements from SR EN ISO/CEI 17025/2005. In this way, for each element of the quality system the laboratory had elaborated the specific quality documents, for instance: Quality Manual, procedures, work instruction, flow-charts, attaching plug, etc.

By help with the most important document of the quality system, Quality Manual, the laboratory has established the following:

- the quality politics statement and quality objectives;
- responsibilities of the technical manager and the quality manager;
- references considering the technical procedures and instructions.

Also, the general, specific and operational procedures are very important. To the base of the quality system are the quality reports as evidences of the fact that the system implementation is held below check. Although it is a voluntary act, the quality control (QC) from our laboratory represents an essential part of the quality management

focused on the achievement of the quality requirements just as can be noticed from the Figure 1.

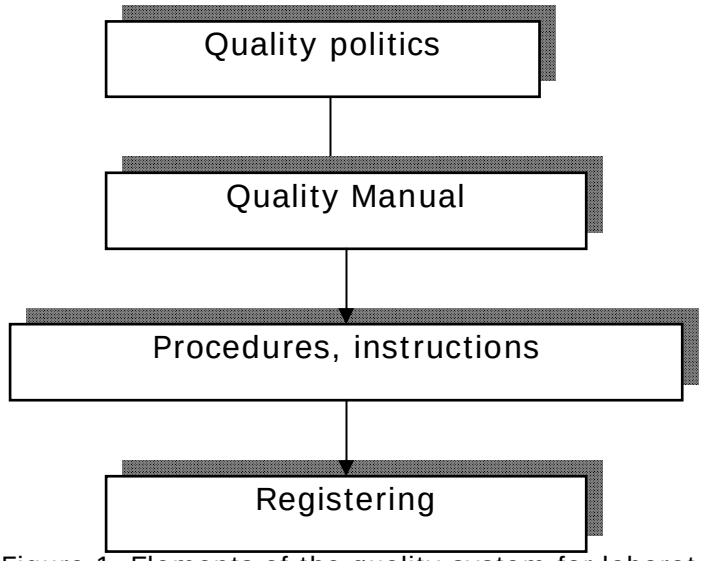

Figure 1. Elements of the quality system for laboratory.

The activity of the quality control develops on three levels:

- internal check achieved by the analyst;
- internal check achieved by the quality responsible/laboratory chief;
- external check – inter-laboratories comparison schemes.

The nonconformities which can appear are identified during the internal or external audits by the auditors, but can be also noticed by the personal which transmits the nonconformity to the top management or from the customer reclamations. During the technical operations those nonconformities can be:

- the calibration of the instruments;
- the validation dates;
- the verification of the analyses report.

Even if the application of this standard is volunteer, the advantages of the accreditation process are:

- the accomplishment of the tests in legal conditions identical with one of the laboratories from EU;
- the development and cooperation between laboratories and another profile organization, through shifts of information and experience, as well as through the harmonization of the standard or procedural methods;
- the assurance of a high level management, which will increase the number of analyses, minimizing the errors and the reduction of the customers complaints, will assure the credibility of analytic results in front of the authorities and customers;
- leads on to the mutual acceptance of the data referring to the chemical compounds effects on the environment and health, by avoiding in that way the iteration of the results in different countries and of course, saving time and funds.

Also, it is important to mention that the measures implementation concerning the quality assurance leads on to:

- an optimum management of the laboratory;
- the improvement of the activities efficiency;
- the minimization of the errors;
- the personal stimulation and motivation;
- the increase of the laboratory reputation.

By help of accreditation process, laboratory gained the following competences:

a) has managerial and technical personnel who, irrespective of other responsibilities, the authority and resources needed to carry out the duties, including the implementation, maintenance and improvement of the management system, and to identify the occurrence of departures from the management system or from the

procedures for performing tests, and to initiate actions to prevent or minimize such departures;

b) has arrangements to ensure that its management and personnel are free from any undue internal and external commercial, financial and other pressures and influences that may adversely affect the quality of their work;

c) has policies and procedures to ensure the protection of its customers' confidential information and proprietary rights, including procedures for protecting the electronic storage and transmission of results;

d) has policies and procedures to avoid involvement in any activities that would diminish confidence in its competence, impartiality, judgement or operational integrity;

e) defines the organization and management structure of the laboratory, its place in any parent organization, and the relationships between quality management, technical operations and support services;

f) specifies the responsibility, authority and interrelationships of all personnel who manage, perform or verify work affecting the quality of the tests and/or calibrations;

g) provides adequate supervision of testing and calibration staff, including trainees, by persons familiar with methods and procedures, purpose of each test and/or calibration, and with the assessment of the test or calibration results;

h) has technical management which has overall responsibility for the technical operations and the provision of the resources needed to ensure the required quality of laboratory operations;

i) ensures that its personnel are aware of the relevance and importance of their activities and how they contribute to the achievement of the objectives of the management system.

Performances of laboratory. Because the most analyses are environment analyses, it is important that the laboratory to confirm its results. The methods use for determining the performance of these analyses is made by help of one of the following ways:

- the calibration using the reference materials;
- comparing the obtained results with the ones from others methods;
- inter-laboratories comparisons;
- systematically estimation of those factors affecting the result;
- uncertainty estimation of results.

The knowledge of the uncertainty of measurement of testing results is fundamentally important for laboratories, their clients and all institutions using these results for comparative purposes. Competent laboratories know the performance of their testing methods and the uncertainty associated with the results. Uncertainty of measurement is a very important measure of the quality of a result or a testing method. Other such measures are reproducibility, repeatability, robustness and selectivity.

Consideration should be given to the different factors which may contribute to the overall uncertainty of a measurement (not all are relevant in all cases), such as:

- definition of the measuring;
- sampling, transportation, storage and handling of samples;
- preparation of samples;
- environmental and measurement conditions;
- the personnel carrying out the tests;
- variations in the test procedure;
- the measuring instruments;
- calibration standards or reference materials;
- software and/or, in general, methods associated with the measurement;
- uncertainty arising from correction of the measurement results for systematic effects.

One of the most important analyses from our laboratory is the establishing of the metal contents from liquid solutions, such as waters.

Basis on Guide to the expression of uncertainty in measurement (known as the GUM) and the International vocabulary of basic and general terms in metrology (known as the VIM), the laboratory has estimated the uncertainty for different methods. To prove

if an analytical method is producing fit for purpose results on routine basis, there is need for an analytical goal accepted and compared for uncertainty of measurement.

The uncertainty of measurement values are usually reviewed when the following conditions occur:

- changes in method;
- changes of authorized personnel;
- system calibration changes;
- a change in any parameter effecting the uncertainty.

The most used method in our laboratory is atomic absorption spectrometry (AAS) for heavy metals detection. Figure 2 indicates which the steps for metal detection by AAS are.

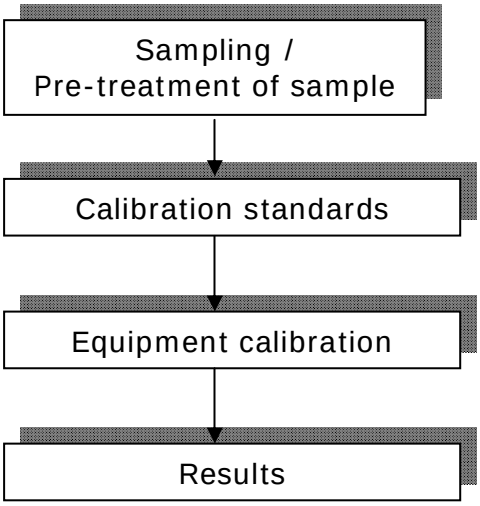

Figure 2. Flow chart of the uncertainty estimate.

The laboratory knows, in this way, each and every step of the test and how it will be affected by those steps. Also, a good way to determine the factors leading to uncertainty in the laboratory is to use fish bone analysis – the cause and the effect chart, presented in the Figure 3. The chart refers to metal detection by atomic absorption spectrometry (AAS), from aqueous medium. For example, this chart is used for iron, cadmium, lead, zinc, nickel and chromium solution.

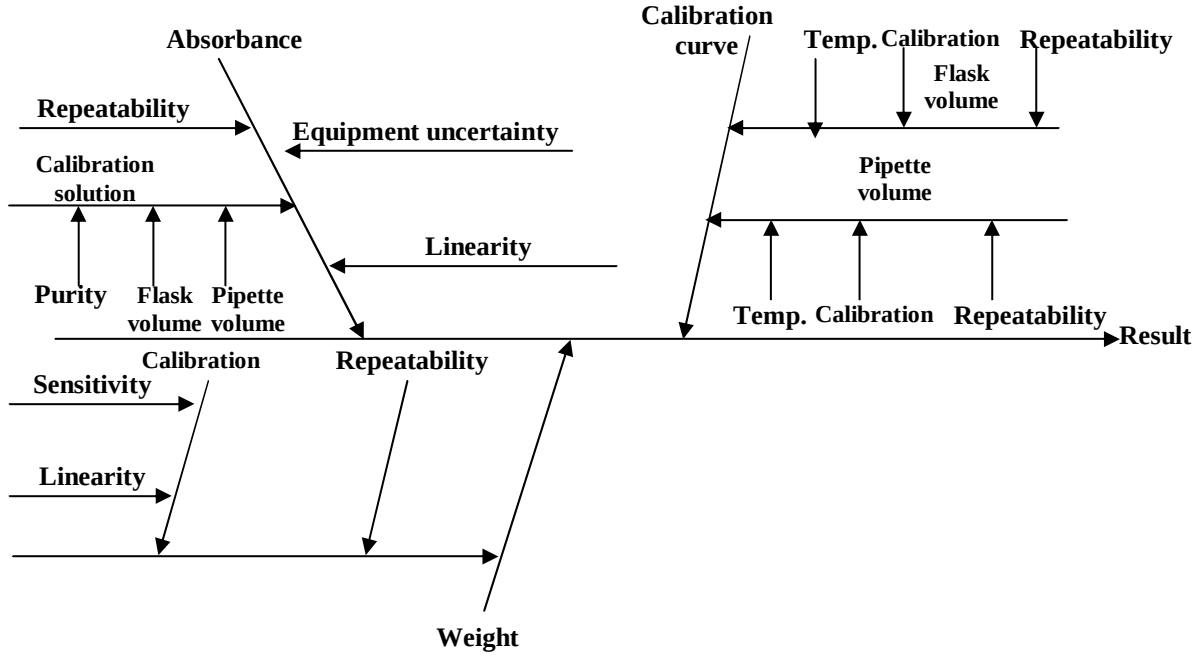

Figure 3. Fishbone diagram (cause-and-effect diagram).

Major sources of calibration error include differences in analysis methods used by different laboratory instruments, lot-to-lot variations in calibration materials and lack of traceability between secondary references materials and primary standards.

Some of the commercial suppliers provide the uncertainty estimates of assigned values.

In our laboratory, we decide to apply GUM suggestions to tests for Cu, Ni, Fe, Cd, Zn, Pb measurements by Atomic Absorption Spectrometry (AAS).

For the other elements (such as organic compounds, for example PCB-s, or sulphides, cyanides, phosphates or for alloys, etc.) we use the uncertainty measurements values from internal Quality Control (QC) date over a period of time.

We have also used the data from external quality control results for some of the elements.

Conclusions. The accreditation of a testing laboratory according to SR EN ISO 17025/2005 means the implementation of a quality system which brings significantly improvements regarding the organization, the management and development way of the activities in the environmental laboratories

To determine the true value of a measured quantity is an important issue to identify and evaluate the most of the relevant elements contributing to the uncertainty of measurement. Also, to report the results with the uncertainty of measurement is for the benefit of the customers, but practically there is need for ongoing education and training to create awareness for laboratories.

The quality politics certifies directions which must be followed for the maintenance of a high level quality in the laboratory activity and is established at the highest level of the laboratory authority.

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