Analysis of key technologies and typical problems in computer assisted proficiency testing and Measurement

Hong Zhang*, Yibo Zhao
Shanghai Institute of Measurement and Testing Technology, Shanghai, China

*Corresponding author: zhangh@simt.com.cn

Abstract. Proficiency testing and on-site assessments are the two most commonly used ability evaluation techniques. This article explains the necessity of participating in proficiency testing activities, discusses the key technologies for the implementation of proficiency testing, and summarizes the typical problems found in the implementation of the actual proficiency testing. The reasons for the common unsatisfactory results of proficiency testing are also analyzed. The suggestions and solutions are put forward.

Keywords: proficiency testing, reasons for dissatisfaction, problem analysis, solutions

1. Preface
Proficiency testing is an activity that uses inter-laboratory comparisons to evaluate the abilities of participants in accordance with pre-established criteria. It can be seen as an activity to determine the calibration and testing capabilities of laboratories or inspection agencies. [1]

As a conformity assessment activity, proficiency testing can not only evaluate the laboratory’s technical capabilities, but also to identify possible problems and risks in its management and technical capabilities. It can be used for laboratory quality control. [2, 3]

2. The key knowledge of proficiency testing

2.1. The necessity of participating in proficiency testing activities

2.1.1. Requirements of China National Accreditation Service for Conformity Assessment (CNAS). CNAS requires that conformity assessment bodies that apply for accreditation and have been accredited must prove their technical capabilities by participating in relevant proficiency testing activities [4].

CNAS can only accept or accredit laboratories that are satisfied in the proficiency certification activities or whose unsatisfactory results can prove that they have carried out effective corrective measures. For any laboratories that have not participated in the proficiency certification in accordance with the prescribed frequency and field, CNAS will take warning, suspension and cancellation of qualification measures [5].

2.1.2. The needs of the laboratory itself. The roles of proficiency testing for laboratories are as follows:
It can be ensured that the laboratory maintains its technical level. It is conducive to the laboratory's self-assessment and maintains the stability of laboratory technology and the accuracy and reliability of
results. It can be used as an external quality control method, which together with internal quality control constitutes laboratory quality control [6].

It is possible to identify problems such as systematic errors in the laboratory and formulate relevant measures. These measures may involve personnel, methods, instrument calibration and other issues, which include personnel supervision and monitoring, personnel knowledge and experience, evaluation of training effects, intermediate checks and method confirmation, etc. [7].

The trust in the laboratory's ability to continuously produce reliable data can be strengthened. The satisfactory result of proficiency testing is a kind of proof of the laboratory's technical ability. If the laboratory has participated in the proficiency testing for many times and obtained satisfactory results, the on-site test in the proficiency testing project can be exempted from the laboratory accreditation or the on-site assessment of the qualification [8].

It can enhance the self-confidence of the laboratory and improve the core competitiveness of the laboratory. Laboratories that achieve satisfactory results can be recommended to undertake government commissions and authorizations, or designated inspection tasks. For laboratories, it is an opportunity.

2.2. Verification of qualifications and technical capabilities

The qualification and technical capabilities of the organization unit and the leading laboratory should be focused on verification before it can be included in the proficiency testing plan.

The proficiency testing plan (including measurement audit) carried out by each proficiency testing provider (PTP) accredited by CNAS within the approved scope

Inter-laboratory comparisons such as measurement comparisons organized by government authorities at all levels or certification agencies or professional/industry committees

The leading laboratory keeps the national measurement standard or sub-standard of the project;

Other ways to participate in proficiency testing, such as accreditation bodies that have signed a mutual recognition agreement with CNAS, Asia-Pacific Laboratory Accreditation Cooperation (APLAC) and European Accreditation Cooperation (EA), etc.

If there is no proficiency testing that can be obtained, it is recommended that the laboratory preferentially choose the proficiency testing activities implemented by PT accredited by CNAS, or choose two authoritative laboratories accredited by CNAS for inter-laboratory comparison.

3. Key technologies of proficiency testing

3.1. Preliminary preparations for proficiency testing

3.1.1. Selection of personnel. Those who participate in proficiency testing activities will directly affect the accuracy of the results. If the purpose of proficiency testing is to evaluate whether there are systematic errors in the laboratory and the accuracy of the data results, it is necessary to select some personnel with high technical level, rich experience, and high ability to analyze and solve problems, and try to avoid the occurrence of errors in the testing process.

If the proficiency testing is used to verify the training effect of a certain standard method or to supervise and monitor the personnel capabilities, it is possible to arrange related personnel to participate in proficiency testing activities and seek an opportunity to improve the overall competence of the personnel.

3.1.2. Choice of method. Every proficiency testing has a method. If the method is unified in the comparison plan, then all participants should strictly follow the prescribed method. If there is no prescribed method, it is necessary to choose the frequently used or the currently effective or other suitable methods to achieve the purpose of method comparison or confirmation.

Familiar with the method, you should be very clear about the principle of the selected method, the use of the instrument, the operating steps, and the role of each step. The precautions in the experiment and the calculation of the results should be also clear.
3.1.3. Verification and calibration of measuring instruments. In order to minimize the system error, all measuring instruments in the experiment should be verified or calibrated by the metrological verification department or the qualified calibration organization in accordance with the requirements of regulations and system documents. They can be used after meeting the technical performance indicator of the method standard.

It does not mean that the instruments are accurate within the validity calibration period, and there are often deviations or abnormal responses, which should be checked before use. For the balance, we can choose a standard weight with an intermediate range as the verification standard to ensure that the technical indicators meet the requirements before using it. It can be ensured the best testing period.

In addition, regarding the applicability of the instrument, whether the equipment used is suitable for the requirements of the proficiency testing program, we should also organize relevant technical personnel to check beforehand.

3.1.4. Simulation exercise. After carefully studying the inspection and detection methods, the inspectors must be organized to simulate the verification process, and they can prepare samples by themselves, conduct internal drills, and solve the problems in the simulation process in advance.

3.2. Implementation of proficiency testing activities

3.2.1. Check the integrity of the samples first after receiving the samples to be verified. Carefully check the packaging status of the sample. If there is any abnormality such as damage, we should contact the proficiency testing provider in time. At the same time, the sample should be stored strictly in accordance with the requirements of the work instruction to avoid affecting the test results by the improper storage.

3.2.2. Organize studying the specific requirements of the operating manual. The operating manual is formulated for the each proficiency testing plan, which clarifies the method standards used, sample information, sample processing methods, original records, and result reports. It has strong operability and pertinence. We must study and understand the specific requirements of the operating manual carefully.

3.2.3. Complete the process of proficiency testing samples. We should complete the test process of proficiency testing samples in accordance with the requirements of the operating manual and the key points determined in the preliminary preparation process.

The technicians should verify the comparison test data to ensure its accuracy and reliability. Verification methods include as follows: test data of different personnel, test data of different instruments and equipment, test data of different methods, test data on different dates and test data of related parameters.

3.2.4. Issue the result report of proficiency testing in accordance with the requirements. After completing the test process of the proficiency testing samples, we must issue a result report of proficiency testing according to the requirements. If it is feasible, we must have experienced personnel to review the result report. Under normal circumstances, the plan will give the requirements of the result report. If there is no requirement, we can issue a verifiable result report in accordance with the laboratory requirements. Since the proficiency testing requires the completion of a small number of samples in a relatively short time, the laboratory is not allowed to perform multiple repeated measurements, so it can be used as a manifestation of the laboratory's true ability.

4. Typical problems of proficiency testing

After completing the proficiency testing activities, the organization that can verify the activities will conduct statistical evaluations on the data results of the participants according to the predetermined
statistical methods and judgment standards, and give their own proficiency testing results. Generally, the proficiency testing results are divided into satisfactory, unqualified, suspicious or problematic results. If there is a problem with the verification result, or the result is not satisfied, it should investigate the potential error or the source of the unsatisfactory result, identify the existing problem and initiate corrective and preventive measures. We should conduct a comprehensive investigation of factors such as personnel, equipment, methods, and the environment. The typical problems accumulated in actual proficiency testing and their solutions are listed below.

4.1. Personnel factors
The professional quality of the personnel will affect the accuracy of the test results, and any negligence of the test personnel in the operation process can lead to the deviation of the final result. In the actual proficiency testing, it is found that some laboratories have less business related to proficiency testing projects, the testing personnel lack actual experience, and they do not have enough mastery of the operational proficiency and key points of calculation. The authorized signatory has no relevant work experience, and is unable to ensure the accuracy of the test data. The operators lack targeted training, assessment and supervision, and have insufficient understanding of standards and technical specifications. The operations are inconsistent with the operating manual.

Proficiency testing activities generally select two or more qualified personnel with extensive testing experience to participate in, which can identify, handle and correct abnormal conditions that occur during the testing process, and make appropriate judgments on the accuracy of the testing results. Newly qualified personnel are encouraged to participate because the proficiency testing activities are a good time for training and exercise.

4.2. Equipment factors
Equipment factors are most likely to affect the test results and cause unsatisfactory results of proficiency testing. In the actual work, some laboratories don’t provide equipment in accordance with the standards and technical specifications, leading to instrument instability during on-site testing with lack of effective maintenance. Some laboratories don’t implement the equipment traceability and periodic verification as required, and don’t implement equipment confirmation after verification and calibration. Some laboratories’ confirmation records do not clearly define the corresponding requirements of parameters used and are lack of conformity judgment. Other laboratories handle the equipment abnormality by itself and continue to use it without confirming the qualification, etc.

The management of equipment should be strengthened, and the facilities should be complete and normally operating. When participating in proficiency testing activities, the instruments and equipment should be adjusted to keep the indicators in a stable state, ensuring the reproducibility of the testing data, improving the precision of the results, and reducing the deviation between the data, therefore achieving more accurate and reliable results.

4.3. Methodological factors
The operating manual of the proficiency testing plan is compiled according to the characteristics of the project. If the inspector does not strictly follow the requirements of the operating factors, the operation link is different from that of other laboratories, which may lead to deviation of the results. In addition, the laboratories use detection systems with different principles, instruments and operating procedures, which may lead to deviations of proficiency testing results and affect the accuracy of test results.

4.4. Other factors
Other factors include the original record information is incomplete or difficult to trace. The original record does not use the template specified in the comparison plan. The measurement result is not standardized, and the last position is inconsistent with that of the measurement uncertainty. The measurement uncertainty claimed by the laboratory does not fully analyze the influence quantity, which leads to unreasonable evaluation results. The measurement units, number rounding, retention of effective digits,
and incorrect calculation formulas may all affect the results. Only by fully mastering the key points of technology can we successfully complete proficiency testing activities.

5. Conclusions
Proficiency testing, as an internationally-used method for laboratory technical capability evaluation and external quality control, has attracted more and more attention from domestic and foreign industries and academia. The use of proficiency testing as a technical means can effectively and continuously improve the laboratory's management level, calibration or testing capabilities and risk management, and enhance the laboratory's market competitiveness.

References
[1] The China National Accreditation Service for Conformity Assessment. CNAS-CL03 Accreditation Criteria for Proficiency Testing Providers [S]. 2010.
[2] Li Linyuan. Application of proficiency testing evaluation and its results in laboratory quality system [J]. Cemented Carbide, 2018, 35(05): 366-372.
[3] Mao Yan. Analysis of the significance of laboratories participating in proficiency testing activities [J]. Journal of Food Safety and Quality Testing, 2014, 5(09): 2958-2961.
[4] Xie Qingnan. Application of proficiency testing in accredited laboratories [J]. Modern Measurement and Laboratory Management, 2016, 24(04): 36, 40-41.
[5] Hu Jinhao. Analysis of the similarities and differences of proficiency testing requirements for laboratory accreditation at home and abroad—taking international organizations IECEE CBTL and domestic organizations CNAS and CMA as examples [J]. China Standardization, 2019(S2): 153-157.
[6] Liu Jie. Talking about the necessity of my country's calibration laboratories participating in proficiency testing activities [J]. China Inspection and Testing, 2019, 27(01): 56-57.
[7] Lin Limin. Study on the practice of proficiency testing and laboratory quality management [J]. Journal of Food Safety and Quality Testing, 2013, 4(04): 1288-1291.
[8] Xia Nana. Talking about the experience of proficiency testing [J]. Technology Wind, 2020 (04): 205