Information and methodological support for intermediate checks of equipment and assessment of metrological characteristics

Shodlik Masharipov[1*], *Oybek* Mustafayev[1], and *Sunnat* Oymirov[2]

[1]Tashkent State Technical University named after Islam Karimov, Tashkent, Uzbekistan
[2]Test sertification enterprise, Tashkent, Uzbekistan

Abstract. The purpose of this article is to study the intermediate checks of equipment and to make sure that there are no faults and non-conformities that can lead to damage to equipment or harm to the user's health after power supply, contamination and damage to the objects of control. Measurements used in practice are distinguished by a variety of characteristics: by the nature of the dependence of the measured value on time, by the method of obtaining a numerical value, by the conditions that determine the accuracy of the measurement result, by the measuring instruments used and methods of processing measurement results and, accordingly labor intensity, and the error of the measurement result. Types and methods of measurements are the objects of consideration of theoretical and applied metrology and are selected in accordance with the specific measurement task.

1 Introduction

The test laboratory shall carry out (intermediate) checks at appropriate intervals between two successive calibrations to ensure that the equipment is serviceable and suitable for use, and to detect faults in a timely manner. These activities shall be carried out by qualified personnel using reference standards (calibration standards), reference standards, and other equipment used for verification and will keep records, in particular, of the expected measurement uncertainty.

The test laboratory carries out intermediate checks of the equipment in accordance with this instruction and the responsible person for metrology will keep records of the results obtained.

Laboratory equipment means measuring instruments, test equipment, auxiliary equipment and indicator instruments.

2 Materials and methods

Influencing factors on measurement accuracy related to measurement premises.

* Corresponding author: shodlik29081986@mail.ru

To maintain confidence in serviceability, the equipment periodically confirms:

- readiness for operation;
- correct functioning;
- compliance of its characteristics with the requirements stipulated by the measurement and testing process;
- compliance with the established acceptance criteria.

At the stage of putting the equipment into operation, initial confirmation of compliance is carried out in the form of primary verification/calibration, certification.

Periodic confirmation of compliance:

- check of readiness for operation;
- check of metrological characteristics;
- setting;
- verification/calibration.

Periodic verification of compliance:

- check of readiness for operation;
- check of accuracy characteristics;
- setting;
- certification.

Periodic verification of compliance and indicators includes:

- check of readiness for operation;
- check of accuracy characteristics.

Check of readiness for operation

Figure 1 shows the external appearance of a certified standard buffer pattern.

Fig. 1. External type of certified standard buffer screen.

All laboratory equipment shall be tested to determine readiness for operation prior to commencement of work. The purpose of the inspection: to make sure that there are no faults and non-conformities that can lead to damage to the equipment or harm to the user's health after power supply, contamination and damage to the monitored objects.

Readiness check includes:

 https://doi.org/10.1051/itmconf/20245902017

- visual inspection for absence of mechanical damages, power cable malfunctions, contamination of the working surface;
- monitoring of environmental conditions;
- control of individual equipment elements provided for by the operating manual.

If faults or deviations are identified, follow the recommendations of the equipment operating instructions and occupational safety instructions. If it is impossible to quickly bring the equipment into operation or environmental conditions to the permissible limits, the equipment is not allowed for operation.

3 Results

Figures 2,3,4 show the results of intermediate pH meter tests using certified buffer solutions.

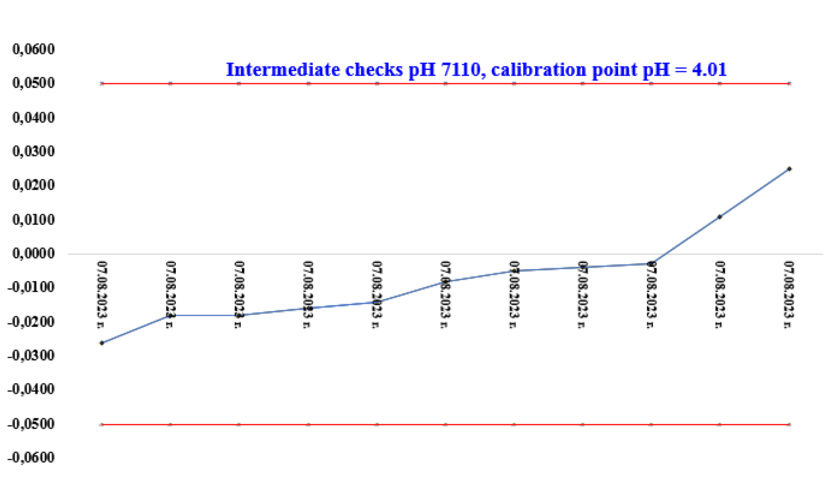

Fig. 2. Results of intermediate pH meter tests using certified buffer solutions for calibration point 4.01.

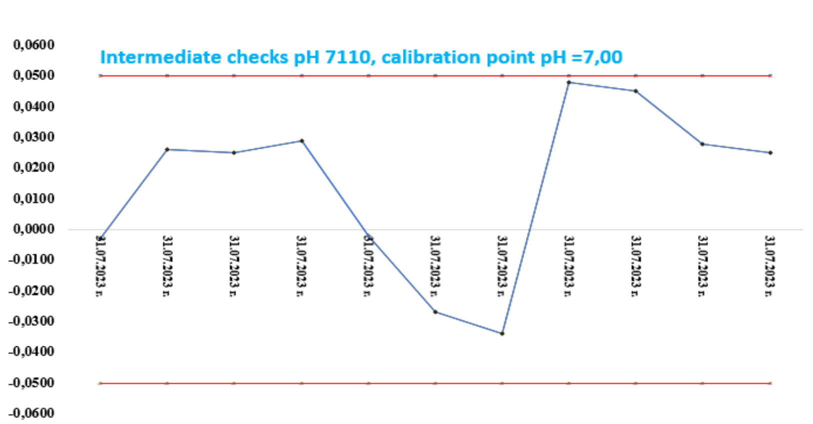

Fig. 3. Results of intermediate pH meter tests using certified buffer solutions for calibration point 7.

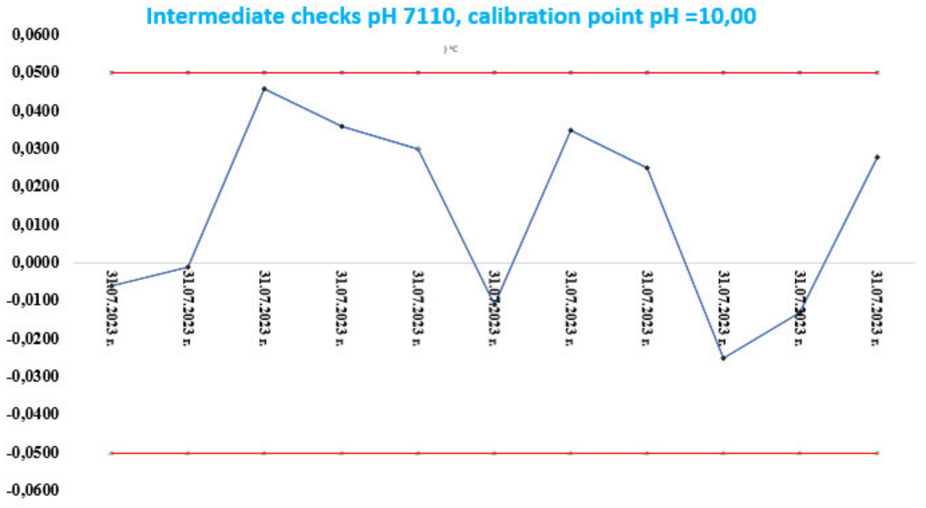

Fig. 4. Results of intermediate pH meter tests using certified buffer solutions for calibration point 10.

Verification of MI metrological characteristics

Measuring instruments shall be checked for metrological characteristics with a certain frequency. The frequency of MI check does not exceed the calibration/calibration period and is a guarantee of equipment compliance with metrological requirements before the next verification/calibration.

The scope and frequency of MI inspection can be regulated by the test procedure/operating manual. Otherwise, the original operating manuals and manufacturer's recommendations should be used to determine them. If these documents do not contain the necessary information on the scope of the check, refer to the verification/calibration methods of this and similar MI type.

3.1 Check of auxiliary equipment

They can be boxes of abacterial air, electrophoresis chambers with a current source, magnetic stirrers, microscopes, devices for obtaining especially clean water, sampling devices, electric stoves and much more. Indicators can also be included here.

Despite the fact that the auxiliary equipment is not subject to strictly standardized accuracy requirements, many devices need to be periodically checked. For example, the boxes of abacterial air, among other things, provide air purity in the working chamber according to the concentration of suspended particles - this indicator deteriorates as the filters built into the box are contaminated and can be monitored by a portable meter of aerosol particles. Water treatment devices such as Millipore systems or conventional distillers produce purified water, the quality of which is normalized, depends on the condition of the device, its replaceable elements and can be checked by monitoring the ESP, pH, etc.

Appendix 1 shows examples of methods for intermediate checks of different measuring instruments. Similar methods are also suitable if they provide the necessary accuracy. If there are several means of verification, it is recommended to use the means specified in the MI verification/calibration methods. In the absence of the necessary tools and tests, the verification of the metrological characteristics of the MI will be carried out during verification/calibration in accordance with the established procedure.

Table 1. Methods of intermediate checks of the measuring instrument.

№	Name of equipment	Interim Inspection Method	Means for interim checks	Records
1	Electronic scales	Check the scales by weighing the control weights, the actual weight of which is indicated in the accompanying documentation, verification certificate or calibration certificate. It is recommended that the check be carried out over the entire weighing range using weights with a mass close to the smallest, largest weighing limit and the middle of the range.	External and built-in weights (metrological control certificate)	Digitally Maintained/Work Logs
2	Analyzers (spectrophotometers)	Check the functional status of the optical filters and the device as a whole using a test kit for the plate or standard solutions that reproduce the certified absorbance value.	Test Plate/Reference Solutions	Digitally Maintained/Work Logs
3	TOC-L type total carbon analyzers	Evaluation of analyzer suitability and calibration stability based on relative response efficiency during analysis of standard solutions with known concentration.	Purified water, standard plants Example: sucrose plant, 1,4-parabenzoquinone plant	Digitally Maintained/Work Logs
4	Liquid analyzers conductometers	Analysis of standard solutions with known values of specific conductivity. The value of electrical conductivity, taking into account the temperature correction, should be read from the accompanying documentation/label for each standard solution. Standard solutions may be prepared from standard titers or	Standard screens Primer: HANNA instruments HI7033	Digitally Maintained/Work Logs

		chemical samples according to the procedures specified in the specifications for the particular analyzer type or other regulatory documents.		

When determining the permissible deviation during MI verification, it is necessary to focus on the standards given in the MI type description (it is an appendix to the MI type approval certificate). If the data sheet/operating manual shows a lower error/uncertainty of measurements and the possibility to perform measurements with the specified accuracy, it is recommended to use this lower value.

3.2 Check of accuracy characteristics

The test equipment shall pass the accuracy test at a certain frequency. The frequency of the TS check does not exceed the inter-certification/inter-calibration period and is a guarantee of the equipment compliance with the accuracy requirements before the next certification.

As a rule, the procedure for VT inspection is regulated by the operating manual. Otherwise, you must define the scope and frequency of the check yourself. For laboratories operating in accordance with the requirements of O'z DSt ISO/IEC 17025:2019, this can be done as part of a risk analysis.

If there are several means of verification, it is recommended to use the means specified in the methods of certification of TS/calibration method. In the absence of the necessary means and tests, verification of the accuracy characteristics of the IO will be carried out during the certification in accordance with the established procedure.

When determining the permissible deviation during the TS check, it is necessary to focus on the standards given in the test method. If the data sheet/operating manual gives greater accuracy of reproducing the conditions and possibility to check the data sheet with the specified accuracy, it is recommended to use this value.

Consider the case when the method does not specify specific requirements for the reproduced parameter (for example, the rotation speed of the centrifuge), in the operational documentation this parameter is not normalized, and the auditor requires to check the accuracy of reproduction of the test conditions. In this case, it makes sense to regulate it for yourself: conduct a risk assessment, test a series of samples at different parameter values and determine the range allowed for a successful test. Depending on the procedures adopted in the laboratory, the test results can be documented as equipment qualification or as technical expertise.

When determining the permissible deviation during the check in the absence of a normalizing standard, it is necessary to regulate this parameter yourself, for example, using a risk analysis.

3.3 Setting up laboratory equipment

If a negative result is obtained during the inspection, it is necessary to perform the actions specified in the operating manual to bring the equipment into compliance (for example, configuration or maintenance) and repeat the inspection. In case of repeated negative result, the work with the equipment must be stopped and repair should be organized.

In case of automatic adjustment (autocalibration) system, the latter is carried out in autonomous mode during equipment operation.

4 Conclusion

Measurement error is the most important measurement characteristic and is a quantitative assessment of the degree of approximation of the measurement result to the true value of the quantity. The measurement error is always a random variable, which can be represented as the sum of two components called systematic error and random error.

The presence of a random error cannot be detected by the result of a single observation, and a systematic error cannot be determined by mathematical processing of the results of multiple observations. Systematic error can be determined and, accordingly, eliminated only experimentally. The instrumental error is not due to the ideal properties of the measuring instruments used. Methodological error is a consequence of the imperfection of the measurement method.

Subjective error is associated with the individual characteristics of the observer. Exemplary measuring instruments are intended only to transfer the size of units from standards to working measuring instruments. Working measuring instruments are used for any measurements not related to the transfer of unit sizes. Each measuring instrument must be used only for its intended purpose. The use of working measuring instruments for verification and calibration work is not allowed. In the same way, the use of standard instruments for measurements not related to verification is prohibited.

Reference

1. ISO/IEC 17043:2023 Conformity assessment General requirements for the competence of proficiency testing providers
2. E.K. Nedorezkov, *Methods of processing the results of measuring physical quantities: Lecture summary* (Gorno-Altaysk, GAGU, 2011)
3. D.N. Khamkhanova, *Applied Metrology:* Textbook (Ulan-Ude, Publishing House of VSSTU, 2006)
4. I.N. Khasanov, *Methods of metrological examination of regulatory documentation* (Tashkent, Tashkent State Technical University named after A. R. Beruni, 2007)
5. B.A. Knyazev, V.S. Cherkassky, *Beginning of processing experimental data* (Novosib.un-T. Novosibirsk, 1996)
6. V.Yu. Voloshchenko, V.G. Sapogin, *Methodological development Assessment of errors in physical measurements* (Taganrog, Publishing house of TRTU, 2004)
7. V.S. Sizikov, *Stable methods of processing measurement results* Tutorial (SPb.: "SpecialLit," 1999)
8. V.V. Svetozarov, *Elementary processing of measurement results* (M., Ed.MEPhI, 1983)
9. M.A. Faddeev, *Elementary processing of the results of the experiment* (Nizhny Novgorod, Publishing House of Nizhny Novgorod State University, 2002)
10. G.A. Vesnitseva et al., *Processing measurement results*. Guidelines (St. Petersburg, 2003)
11. W. Carmack, H. Chichester, D. Porter, D. Wootan, J. Nucl. Mater. **473**, 167-177 (2016)
12. D.M. Wachs, L. Capriotti, D. Porter, J. Nucl. Mater **557**, 153304 (2021)
13. Denise Neudecker, Allan D. Carlson, Stephen Croft, Matthew Devlin, Keegan J. Kelly, Amy E. Lovell, Paola Marini, Julien Taieb, EPJ Nuclear Sci. Technol. **9**, 30 (2023).
14. M.S. Kassim, S.A. Sarow, IOP Conference Series: Materials Science and Engineering **870(1)**, 012032 (2020). https://doi.org/10.1088/1757-899X/870/1/012032

15. C. Yildirim, A.M. Şenyol, D. Kamber, American Journal of Hypertension **14(5)**, 438 (2001). https://doi.org/10.1016/ s0895-7061(00)01260-7
16. Sh.M. Masharipov, K.R. Ruzmatov, S.A. Rahmatullayev et al., Journal of Physics: Conference Series **2094(5)**, 052011 (2021)
17. S.M. Masharipov, R.K. Azimov, Measurement Techniques **60(6)**, 643-646 (2017). https://www.springerprofessional.de/en/multifunctional-information-and-measuring-complex-for-controllin/15100128
18. P.M. Matyakubova, SH.M. Masharipov, K.R. Ruzmatov, M.K. Sultanov, Journal of Physics: Conference Series **1889**, 032037 (2021)
19. Sh.M. Masharipov, K.R. Ruzmatov, S.A. Rahmatullayev, M.M. Mahmudjonov, A.G. Isaqov, Journal of Physics: Conference Seriesthis link is disabled **2094(5)**, 052011 (2021)
20. Sh.M. Masharipov, K.R. Ruzmatov, B.X. Ametova, N.A. Djumaniyazova, Z.S. Kenjayeva, AIP Conference Proceedings **2647**, 070006 (2022)
21. SH.M. Masharipov, Journal of Physics: Conference Series, Volume **2373**, 052001 (2022). https://www.doi.org/10.1088/1742-6596/2373/5/052001
22. S.M. Masharipov, S.A. Rakhmatullaev, E3S Web of Conferences **390**, 01006 (2023)
23. V.P. Savchuk, Processing of measurement results. Physical laboratory. Ch1: Study manual for university students (Odessa, ONPU, 2002)
24. V.P. Yakovlev, *Regulatory and organizational foundations of metrological support* Tutorial (Spb. GTU RP, 2011)
25. A.E. Friedman, *Fundamentals of metrology* (S.Pb., NPO Professional, 2008)
26. A.I. Pahodun, *Experimental research methods. Measurement errors and uncertainties* Tutorial (St. Petersburg, St. Petersburg State University ITMO, 2006)