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Determination of uncertainty for volume measurements of a piston-operated volumetric apparatus using a photometric method

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TECHNICAL REPORT

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Determination of uncertainty for volume measurements of a piston-operated volumetric apparatus using a photometric method

Détermination de l'incertitude de mesure pour les mesurages volumétriques des appareils volumétriques à piston au moyen de la méthode photométrique

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Foreword

ISO (the International Organization for Standardization) is a worldwide federation of national standards bodies (ISO member bodies). The work of preparing International Standards is normally carried out through ISO technical committees. Each member body interested in a subject for which a technical committee has been established has the right to be represented on that committee. International organizations, governmental and non-governmental, in liaison with ISO, also take part in the work. ISO collaborates closely with the International Electrotechnical Commission (IEC) on all matters of electrotechnical standardization.

The procedures used to develop this document and those intended for its further maintenance are described in the ISO/IEC Directives, Part 1. In particular, the different approval criteria needed for the different types of ISO documents should be noted. This document was drafted in accordance with the editorial rules of the ISO/IEC Directives, Part 2 (see www.iso.org/directives).

Attention is drawn to the possibility that some of the elements of this document may be the subject of patent rights. ISO shall not be held responsible for identifying any or all such patent rights. Details of any patent rights identified during the development of the document will be in the Introduction and/or on the ISO list of patent declarations received (see www.iso.org/patents).

Any trade name used in this document is information given for the convenience of users and does not constitute an endorsement.

For an explanation of the voluntary nature of standards, the meaning of ISO specific terms and expressions related to conformity assessment, as well as information about ISO's adherence to the World Trade Organization (WTO) principles in the Technical Barriers to Trade (TBT), see www.iso.org/iso/foreword.html.

This document was prepared by Technical Committee ISO/TC 48, *Laboratory equipment*.

This second edition cancels and replaces the first edition (ISO/TR 16153:2004), which has been technically revised.

The main changes are as follows:

— the term “standard deviation of the mean delivered volume” has been replaced in this document by “repeatability” according to ISO/IEC Guide 99 (VIM);

— a new uncertainty calculation example has been supplied;

— new uncertainty components have been added, namely, reproducibility, air cushion and resolution;

— new Annex A concerning the uncertainty in use of a single delivered volume has been added;

— new Annex B concerning volume correction due to pressure changes has been added.

Any feedback or questions on this document should be directed to the user’s national standards body. A complete listing of these bodies can be found at www.iso.org/members.html.

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Introduction

The example given in this document is informative and supports the requirements found in ISO 8655-8:2022, 9.4 and ISO 8655-7:2022, 4.2, to perform an estimation of measurement uncertainty when calibrating POVA according to the measurement procedures described in these documents and the principles of ISO/IEC Guide 98-3.

The revision of this document coincides with a major revision of the ISO 8655 series in 2022, reflecting the state-of-the-art measurement procedures and approaches for the estimation of measurement uncertainty.

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TECHNICAL REPORT **ISO/TR 16153:2023**

Determination of uncertainty for volume measurements of a piston-operated volumetric apparatus using a photometric method

1 Scope

This document gives detailed information regarding the evaluation of uncertainty for the photometric reference measurement procedure specified in ISO 8655-8 and the photometric procedure specified in ISO 8655-7:2022, Annex B according to ISO/IEC Guide 98-3.

This document also describes the determination of other uncertainty components related to the liquid delivery process of a piston-operated volumetric apparatus (POVA), e.g. repeatability and handling. Furthermore, it provides examples for the calculation and application of the uncertainty of the mean delivered volume and the uncertainty in use of a single delivered volume.

2 Normative references

The following documents are referred to in the text in such a way that some or all of their content constitutes requirements of this document. For dated references, only the edition cited applies. For undated references, the latest edition of the referenced document (including any amendments) applies.

ISO 8655-1, *Piston-operated volumetric apparatus — Part 1: Terminology, general requirements and user recommendations*

3 Terms and definitions

For the purposes of this document, the terms and definitions given in ISO 8655-1 apply.

ISO and IEC maintain terminology databases for use in standardization at the following addresses:

— ISO Online browsing platform: available at https://www.iso.org/obp

— IEC Electropedia: available at https://www.electropedia.org/

4 Modelling the measurement

The dual-dye ratiometric photometric measurement procedures described in ISO 8655-7 and ISO 8655-8 use a cuvette containing a copper(II) chloride solution of known volume, which is determined by a gravimetric method. The POVA under test is used to add an unknown volume of test solution with known Ponceau S concentration to the cuvette containing $CuCl_2$ solution. The contents of the cuvette are mixed without removing the cuvette from the light path of the spectrophotometer, and absorbances at 520 nm and 730 nm are measured before and after the addition of test solution.

Calibrator solutions of $CuCl_2$ and Ponceau S are prepared, and their absorbance values at 520 nm and 730 nm measured. Preparation of the Ponceau S test solutions of different concentrations involves the preparation of dilutions, which are expressed by the dilution ratio, R. Absorbances of the calibrator solutions, together with the dilution ratio, R, are used to calculate the calibration constant, K, for a given concentration of Ponceau S.

The unknown volume of Ponceau S solution delivered by the POVA under test is calculated from the volume and absorbances of the $CuCl_2$ solution prior to addition of test solution, the calibration constant K, and the absorbance of the mixture in the cuvette after addition of test solution.

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