**[lab name]**

**Calibration and Verification of Volumetric Devices**

 **[#]**

**In Compliance with V1M2 5.5.13.1.(e)**

**VERSION #1.0 Effective date: January 1, 2024**

**APPROVED BY**

**Signature**

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**New SOP**

**Revision History**

|  |  |
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| Version number and effective date | Revisions made |
| V 1.0 January 1, 2024 | Conforms to TNI 2016 standards. |
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# Volumetric Devices

All volumetric devices include all pipettes, burettes, mechanical dispensers including mechanical burettes, and non-Class A graduated cylinders are to be checked for volume accuracy if they meet the following criteria and are not exempted by V1M2 5.5.13.1.(e).(i).

* They are used to measure sample volumes as part of the analysis or sample preparation procedures including dilutions or concentrations of samples.
* They are used to measure standard volumes in preparation of intermediate, working, or calibration series standards,
* The creation of any calibration verification or positive control solution.
* In all titrimetric measurements.
* Preparation of or additions to samples or standards of surrogates, internal standards, tracers, or matrix spikes.
* Microbiological measuring devices include serological pipettes, membrane filter funnels (if the volume mark is used to measure samples), sample containers with a volume mark or those that dispense media volumes.

## Exempt Devices

In addition to those exemptions listed in V1M2 5.5.13.1.(e).(i), the following devices are exempt.

* Quanti-trays provided by Idexx Corp. or any similar device. It meets the requirement found in 1.7.3.7.b).(iii).(c) but checking via volumetric or gravimetric means is not practical.
* Class B graduated cylinders used to measure sample volumes exceeding 200 mL, or in the measurement of sample volumes for Biochemical Oxygen Demand.
* Graduated cylinders or mechanical volumetric devices used to add reagents as part of a test are not included if the reference method states the added volume in whole milliliters or uses terms such as approximately or provides a range of volumes (1 to 2 mL).

# Volumetric Assessment Frequency

Volumetric devices are to be assessed on receipt or before first use. Mechanical devices including those used for dispensing bacterial media and automatic titrators are reassessed quarterly. Quarterly is defined as no more than 100 days and no less than 60 days between calibrations.

# Procedure

All volumetric devices are assessed using gravimetric procedures. In general, a volume of reagent grade water is added to the device or is taken up by the device, then dispensed into a tare vessel capable of holding at least 5 individual measurements.

The balance does not have to be an analytical balance if it measures to 0.01 grams.

To avoid any potential measurement errors especially when working with small volumes in large devices, analyze more than one dispensation and use the average.

Record the net weight increase for a single dispensation or the total net weight if multiple dispensations are done. Equations are provided below.

## Volumetric devices except mechanical devices

* For volumetric devices that are bottles or other containers with a single volume mark, tare the device first, then add the water to the mark.
* Graduated cylinders or any device listed as To Contain (TC) is to be treated the same as the above but may need multiple volume checks as noted below.
* Graduated pipettes, tare a container, fill the pipette with water, then dispense into the container. This may be done more than once.

Graduated cylinders or graduated pipettes that are used at volumes over 10mL. Select volumes such that the entire range of the device is covered. You may need several volumes if the device covers a range greater than 50mL. Add reagent grade water at each volume, then dispense into a tared container.

## Mechanical Devices

* If the device is used at a single volume or the volume range is less than or equal to 10 mL, then select the preset volume or the largest volume. Take up water and dispense it into a tared container.
* If the device is used over a range greater than 10mL, then select volumes representing the smallest volume and additional volumes so that the entire range is covered by at least 5 individual volumes.

## Records

For each IDed volumetric device record the measured volume or volumes, the tare weight if the tare function not used, and the final weight. After computing the gravimetrically determined volumes, record the percent difference.

The status of the calibration is to be clearly marked on mechanical devices and include the dates of the last and expected next calibration. All other devices are to be IDed by lot number or other unique identification.

# Computations

Compute the measured volume(s) by first subtracting the tare weight of the container from the total weight of the container after the addition of water. Ease in the process is gained by setting the tare weight of the container to zero by using the balance tare function.

If the net weight is from a single dispensation, then use equation 2. Otherwise, compute the average weight of the total dispensations by the following equation.

Equation 1 Assessing volumetric dispensing equipment.

$$Average weight in grams=\frac{wt in grams\_{Final}-wt in grams\_{tare}}{\# dispensations}$$

From the single weight or the average weight, the volume can be computed from the following.

Equation 2 Gravimetrically determined volume.

$$Gravimetrically determined volume in mL=\frac{Weight in grams}{Density of water at room temperature in ^{grams}/\_{mL}}$$

Water densities at several temperatures are provided in Table 1 in the Appendix. It is not necessary to measure the actual water temperature. Either select the temperature in the table nearest the room temperature or compute by interpolation using the following.

Equation 3 Interpolating density.

$$Density=Density\_{lower temp}+\left(Density\_{lower temp}-Density\_{higher temp}\right)×\frac{\left(room temp-lower temp\right)}{10}$$

The error in measured volume is determined as follows.

Equation 4 Measurement error determination.

$$\% error=100×\frac{gravimetrically determined volume-measured volume}{gravimetrically determined volume}$$

# Criterion

For all volumetric devices except those used for microbiological testing or digital titrators, the allowed error is + 0.25%. Digital titrators the allowed error is + 0.12%. All microbiological volumetric devices are allowed an error of + 2.5% per V1M5 1.7.3.7.(b).(iii).(d). If the volumetric device meets these requirements, then it can be used without correction factors.

Except for microbiological volumetric devices, any device where the measured difference does not meet the above criterion but is not more than twice that criterion may be used with the application of a correction factor.

Equation 5 Correction factor.

$$Correction factor=gravimetrically determined volume-measured volume$$

Any device that does not meet the criterion and is not eligible for a correction factor will be treated as follows.

* A single device that cannot be repaired will be discarded.
* A failure for a lot of devices will have the lot discarded.
* Mechanical devices that can be repaired will be sent for service.

# References

* *Management and Technical Requirements for Laboratories Performing Environmental Analyses*, The NELAC Institute (TNI), Rev 2.1, September 1, 2016

# Definitions and Acronyms

Words specific to this document or used outside of their dictionary definition are defined here. Acronyms can be defined in the text above on their first appearance.

## Definitions

## Acronyms

# Appendix

Table 1 Water density in grams/mL at various temperatures

|  |  |
| --- | --- |
| 60°/15.6° | 0.99907 |
| 70°/21° | 0.99802 |
| 80°/26.7° | 0.99669 |
| 90°/32.2° | 0.99510 |

Table 2 Allowed volume errors for ASTM Class A and B volumetric flasks

