# GMP 3

## Good Measurement Practice
## for
## Method of Reading A Meniscus Using Water or Other Wetting Liquid

Two common methods are used for setting a meniscus. The method used in calibration should be consistent with the intended use of the volumetric standard. For interlaboratory comparisons, the method to be used should be defined during the planning stages of the comparison.

In all apparatus where the volume is defined by a concave meniscus, the reading or setting is made on the lowest point of the meniscus. In order that the lowest point may be observed, it is necessary to place a shade of some dark material immediately below the meniscus, which renders the profile of the meniscus dark and clearly visible against a light background. A convenient device for this purpose is a collar-shaped section of thick black rubber tubing, cut open at one side and of such size as to clasp the tube firmly.

Two common types of meniscus readers are available. These include black/white meniscus card readers or magnifying glasses with cross-hairs. The width of the graduation will affect the readability of the meniscus and should be estimated to the nearest 1/10 of a division. Black/ white meniscus card readers are simple to create as shown in the figure below. More elaborate card readers may be purchased that allow placement around the neck of a flask.

This type of meniscus reader is generally preferred for Option A method of reading the meniscus. Another type of meniscus reader consists of a clear lens (plastic or glass) with etched lines on the front and back that are aligned to prevent parallax errors in reading. This type of reader is preferred for Option B.

The meniscus of most liquids used in volumetric standards is concave with the lowest point in the center used to determine the reading. The meniscus formed by a non-wetting liquid, such as mercury (Hg), is convex with the highest point in the center. The highest point of such a meniscus is used to make the reading. The reading of a mercury barometer is a classical example of this kind. In making the reading, the observer's eye should be normal to and in the same horizontal plane as the meniscus. The illumination is adjusted to get a sharp definition of the meniscus. Elimination of parallax error is very important and can be judged by slight fluctuations of eye level that do not affect the reading.

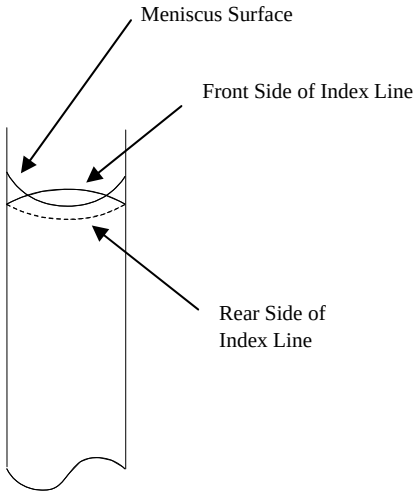
The curvature of a meniscus is related to the surface tension of the liquid and inversely related to the diameter of the tubing in which it is formed. When reading any meniscus, it is important to

ascertain that it is in an equilibrium position. Tapping of sight glasses and/or small motions of containers may be used to induce slight displacements of the meniscus. Return to the same reading is evidence of a stable meniscus.

**Option A –**

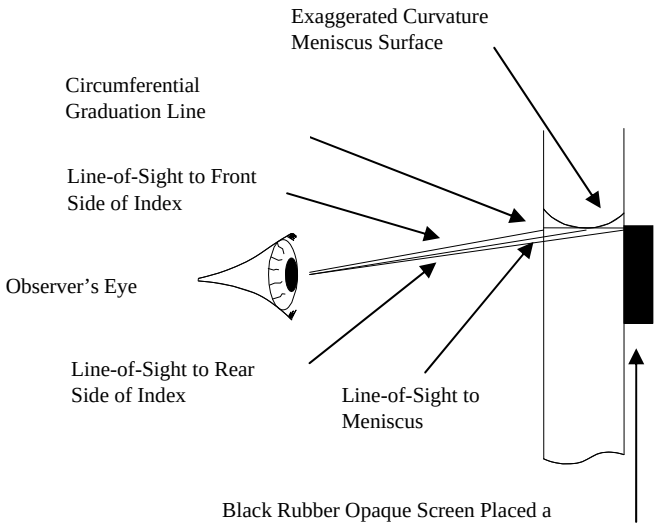
Option A is suitable when graduation lines extend more than 75 percent of the circumference of the sight gage area, for example with graduated neck type flasks or single mark flasks.

The position of the lowest point of the meniscus with reference to the graduation line is such that it is in the plane of the middle of the graduation line. This position of the meniscus is obtained by making the setting in the center of the ellipse formed by the graduation line on the front and the back of the tube as observed by having the eye slightly below the plane of the graduation line. This is illustrated below. The setting is accurate if, as the eye is raised and the ellipse narrows, the lowest point of the meniscus remains midway between the front and rear portions of the graduation line. By this method it is possible to observe the approach of the meniscus from either above or below the line to its proper setting.




Observer's View From Slightly Below the Horizontal Level of the Graduation Line.

**FRONT VIEW**



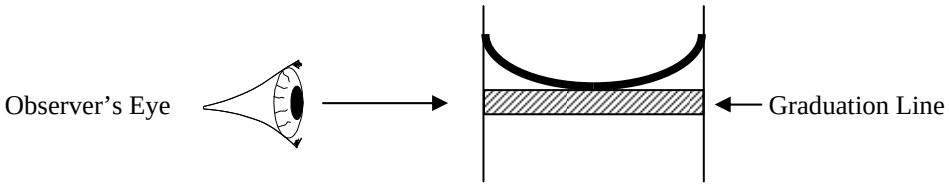

Black Rubber Opaque Screen Placed a Fraction of a Millimeter Below the Graduation Line (or a Card Reader with the Black Side on the Bottom.)

**SIDE VIEW**

**Option B**

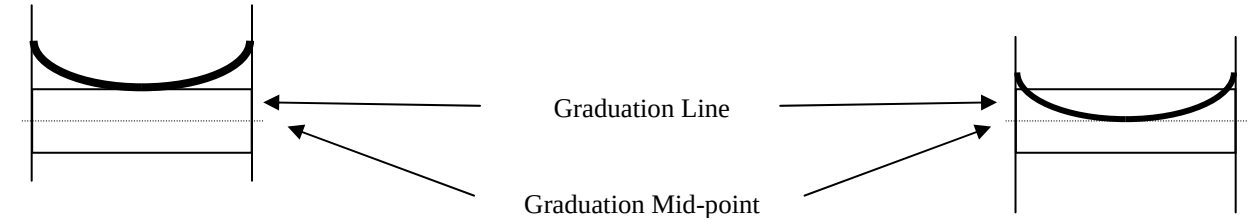
Option B, is typically used with opaque liquids or when the graduation mark does not extend around the circumference of the volumetric standard.

The position of the lowest point of the meniscus with reference to the graduation line is horizontally tangent to the plane of the upper edge of the graduation line. The position of the meniscus is obtained by having the eye in the same plane of the upper edge of the graduation line as shown below. Offsets from reading in the same plane will produce parallax errors.




**Comparison of Option A and Option B Methods**

For most practical applications the difference between these two methods is insignificant compared to the tolerances of the volumetric standards. However, a component for measurement uncertainty should be included as appropriate. When performing calibrations, using the glassware as precision standards with clear liquids, or when comparing results among laboratories the difference in meniscus setting is directly related to the visible thickness of the meniscus and the volume of liquid contained in the neck between the top of a graduation line and the middle of the graduation line as shown in the following diagram as 1) which results with Option B when clear liquids are used and 2) which results with Option A and is only possible when clear liquids are used.




When opaque liquids are used, an additional error or correction factor can be estimated based on the volume contained between the upper and lower edges of the meniscus. The curve of the meniscus and impact of this error is dependent on the diameter of the meniscus and surface tension of the liquid being used.

Where possible, the method of reading the meniscus during calibrations should be performed in the same way in which the meniscus will be read during normal use.

Estimate potential errors in reading the meniscus, or errors in single-mark flasks by using the equation for the volume of a cylinder:

$Vol = \pi r^2 h$ where $r$ is the radius of the internal diameter and $h$ is the height of the line or volume in question. Units will be determined based on the dimensional units that are used. For example radius in $cm^2$ and height in cm, will provide results in $cm^3$ or mL. The meniscus itself often has an observed "thickness" that is larger than the graduation lines so should be considered as well.

Example:

The internal diameter of a flask is 1.5 cm (15.00 mm).
The height of the line is 0.50 mm.

$Vol = \pi (\frac{15}{2})^2 0.5 =$ 88.36 $mm^3$ (0.088 mL). These values are rounded for illustrative purposes only; significance must be evaluated based on measuring instruments and flask resolution.

Experimental data obtained by reading a meniscus among multiple laboratory staff members may also be used to incorporate an estimate of uncertainty in meniscus reading.