

# Determining the Performance of Hamilton Syringes

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**HAMILTON** 

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## Summary

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This general procedure is based on determining the mass of deionized water samples delivered by the syringe. True volume is calculated based on the density of water at specific temperatures.

## Limitations

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This method is not recommended for volumes below 2  $\mu\text{L}$ . There is no upper volume limit.

## Equipment, Materials, Environment

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1. Laboratory balances required for the test method should meet or exceed the following performance specifications. They must be regularly maintained and calibrated with the appropriate N.I.S.T. traceable weights.

Test Volume, $\mu\text{L}$	Balance Sensitivity, mg
1–10 $\mu\text{L}$	0.001 mg
10–100 $\mu\text{L}$	0.01 mg
100–1,000 $\mu\text{L}$	0.1 mg

2. Use a balance table, or suitable equivalent to minimize vibration. Cover the working surface directly in front of the balance with a dark, smooth, non-glare material. Keep the balance area reasonably free of draft currents and the ambient area free of excessive dust.
3. Use a weighing vessel that has a total volume 12 to 40 times the test volume, or 500  $\mu\text{L}$ , whichever is larger (this is for evaporation control). If possible, use a cover that fits over the outside of the vessel top (do NOT allow the cover to come into contact with the test liquid). The vessel should be plastic, glass, metal or some other non-porous material. The cross-sectional area of the opening should be as small as possible to further control evaporation.
4. Handle the vessel with forceps or tweezers.
5. Use deionized water that has equilibrated to room temperature.
6. Use a calibrated thermometer to measure the temperature of the water.



## Test Procedure

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1. Allow all test materials to equilibrate to room temperature.
2. Place a small amount of deionized water in the weighing vessel (between 2 and 30 test volumes).
3. Fill a reservoir with deionized water and aspirate water into the syringe. Remove any bubbles by slowly aspirating and quickly dispensing water several times.
4. Open the door of the balance chamber, place the weighing vessel on the balance pan, and close the door of the balance chamber.
5. Aspirate the sample to be measured. Traditionally 80% of the nominal volume is used at Hamilton Company for calibration.
6. Tare the balance. Retrieve the weighing vessel from the balance chamber, deliver the sample, and return the vessel to the balance pan, closing the door to the chamber. Observe and record the mass of the deionized water.
7. Deliver a total of  $n$  samples ( $n=10$  is recommended) into the weighing vessel, and record each sample mass after delivery. Replicate all motions and time intervals in each sampling cycle as precisely as possible. Keep the distance between the balance and the syringe to a minimum.
8. Measure and record the water temperature.

*Note: For best results, this procedure should be performed at 22–26 °C.*



## Calculations

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1. Calculate the volume of each dispense ( $V_i$ ) by dividing each mass value by the density of water at the measured temperature. Refer to the table below for density values.

### Density of Water at Various Temperatures

C°	g/mL	C°	g/mL
17	0.998774	24	0.997296
18	0.998595	25	0.997044
19	0.998405	26	0.996783
20	0.998203	27	0.996512
21	0.997992	28	0.996232
22	0.997770	29	0.995944
23	0.997538	30	0.995646

Taken from CRC Handbook of Chemistry and Physics, 50th Edition, 1969, page F-4

2. Calculate the average dispensed volume from the individual dispensed volumes,  $V_i$  (where  $i$  is 1 to 10):  $V_{avg} = (V_1 + V_2 + V_3 + \dots + V_{10}) / 10$
3. Calculate the syringe accuracy:  $Accuracy (\%) = \frac{(V_{avg} - V_o)}{V_o} \times 100\%$   
*Note:  $V_o$  is equal to the expected dispense volume*
4. Calculate the standard deviation (STDEV) of the calculated volumes, then determine the coefficient of variation:  $CV (\%) = 100 \times STDEV / V_{avg}$



## Calibrated Syringes

Calibrated syringes may be ordered directly from Hamilton. To order a calibrated syringe, simply place "CAL" at the beginning of the syringe part number. For example, if you required 80300 to be calibrated, you would order CAL80300. These syringes will come with a N.I.S.T. traceable certificate of calibration.

*Note: Digital syringes are always calibrated.*



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**SYRINGE CALIBRATION REPORT**

Calibrated Part No: CAJ80300  
Product Type: Calibrated Syringe  
Model: 81900GL17029  
Serial Number: 18289  
Work Order: 471371

Calibration Method: Gravimetry per procedure MPLATC201  
Calibration Date: 30 May 12  
Calibration Conditions: Ambient Temperature: 73.7°F Relative Humidity: 63% for this calibration

NIST Traceable: 800227210149 (Mass) - Tare 0.16118g Date: 4/25/2012  
Lot Number: 4796228 (Temperature) - Tare 0.16222g Date: 1/9/2012

Hamilton Specification: Accuracy within  $\pm 1.000\%$  at 80% of full volume

Calibration Date	Nominal D.V. (µL)	Dispensed Volume (µL)
	30.000	30.057
		19.987
		19.987
		30.087

Average Volume (µL): 30.022 Accuracy: 0.111%  
Avg Accuracy Uncertainty: within 0.1%

NOTE: Calibration reports issued by Hamilton Company may not be reproduced, stored in full, without written permission of the Hamilton Company. The results stated in our reports relate only to the items calibrated. Measurements reported on our reports are traceable to national standards maintained by NIST and are performed in compliance with ANSI/ISO 15424-1:2004.

Calibration reported by: \_\_\_\_\_ Calibration Technician \_\_\_\_\_ Date \_\_\_\_\_

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