



SYRINGE TECHNICAL REFERENCES

Syringe Technical Reference

The Syringe Technical Reference section includes detailed information on the operation, maintenance, and physical properties of most Hamilton syringes. The information is intended

as a general guideline. For specific details on a part number or application search for the part number on our website or contact a local Hamilton representative.

Syringe Care and Use	Daily Use Protocol, Plunger Care, Needle Care	P. 77, P. 79, P. 79
Syringe Specifications	Operating Parameters, Syringe Dimensions, Graduations	P. 80, P. 80, P. 81
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Syringe Care and Use

Operation of a syringe is relatively straight forward but there are some tips and tricks that will improve the performance and longevity of Hamilton syringes. This section is dedicated to best practices of operating and maintaining a syringe.

Daily Use Protocol

Step-by-step guide to syringe inspection, operation, cleaning, and storage.

P. 77

Plunger Care

The dos and don'ts of plunger maintenance.

P. 79

Needle Care

Tips on needle selection, inspection, and care.

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Daily Use Protocol

Step 1

Inspection

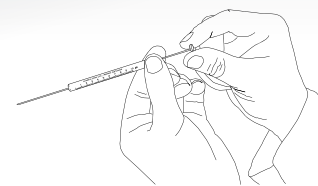
Before each use, thoroughly inspect the syringe for damage such as cracks and dried residue. Check the needle point for burrs from previous experiments. Do not use a needle with burrs. Burrs may tear GC septa leading to sample loss or poor peak shape.



Step 2

Grip

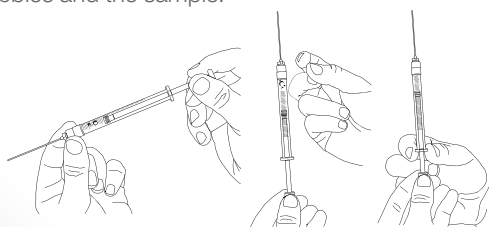
Avoid variations in liquid measure due to body heat by grasping the syringe flange and plunger as you draw and dispense fluids. Syringes should be used at a constant temperature. Accuracy and reproducibility specifications are determined at 25 °C.



Daily Use Protocol (Cont.)

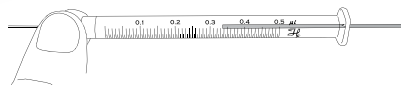
Step 3 Priming

Eliminate compressible trapped air by completely priming the syringe with sample. Immerse the needle point 2 mm to 3 mm into the sample solution. Then rapidly draw and dispense sample into the syringe until bubbles are no longer visible in the syringe barrel. Alternatively, remove air bubbles by turning the barrel upright and allowing the air bubbles to rise to the needle exit. Then dispense both the air bubbles and the sample.



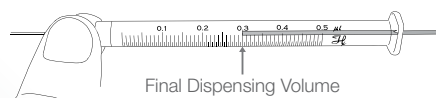
Step 4 Overfilling

Fill the syringe with a small amount of excess liquid.



Step 5 Required Volume

Slowly dispense the excess sample until only the required volume of sample remains in the syringe. Visually check to see that the syringe scale and sample meniscus are parallel. It is optional to clean the exterior surface of the needle with a lint-free tissue. Avoid wicking sample with the tissue by making sure it does not come in contact with the needle opening.



Step 6 Final Dispense

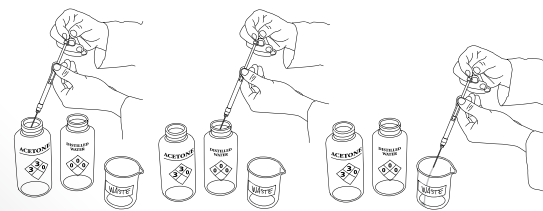
Dispense the final sample volume into an appropriate vessel.



Step 7 Cleaning

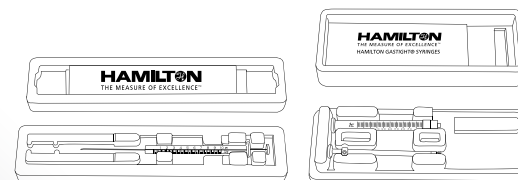
Rinse the syringe with a cleaning solvent known to solubilize the sample. Then rinse with deionized water, and finally rinse with high purity acetone. Allow time for the acetone to evaporate before storing the syringe. Do not soak or submerge the entire syringe in any cleaning agent.

The preferred cleaning agents are non-alkaline, non-phosphate, and non-detergent based. Hamilton offers a biodegradable, non-phosphate, organic Cleaning Solution Concentrate (P/N 18311).



Step 8 Storage

Store the syringe in its original packaging or the Syringe Rack (P/N 204880) to protect against breakage.



Step 9 Solvent Compatibility

The adhesive used to affix needles and hubs to Hamilton Microliter and Gastight syringes is the most chemically resistant available. However, with prolonged exposure, some solvents may attack and deteriorate this highly resistant adhesive. In particular, caution should be exercised with solvents containing halogenated hydrocarbons such as dichloromethane (methylene chloride). For applications using these solvents, Removable Needle (RN) syringes are recommended because no adhesive is present in the fluid path.





Plunger Care

Plungers are made of solid stock material and push the sample out of the syringe. Hamilton makes two types of plungers. The plungers on Microliter syringes are hand-fitted and are only liquid-tight. The plungers are not replaceable for Microliter syringes except for the 7000 series. The plungers on Gastight syringes have a PTFE tip and are replaceable. The PTFE tip creates a gas-tight fit against the interior of the glass barrel, making these syringes ideal for gases and liquids.

Dry Microliter Syringes

Always pull liquid into a syringe barrel to wet the interior surface. Avoid unnecessary moving or pumping of the plunger in a dry syringe. Excessive dry pumping increases plunger wear, shortens syringe life expectancy, and may lead to damage beyond repair.

Touching the Plunger

Avoid touching the plunger with your fingers. Abrasions, scratches, or oil due to handling the plunger with your fingers may interfere with proper plunger operation.

Accidental Plunger Removal

If the plunger is inadvertently removed from the syringe barrel, wipe it carefully with a lint-free tissue. Reinsert the plunger into the barrel and pump deionized water or acetone through the needle and syringe. In the case of Gastight plungers, dip the PTFE plunger tip into deionized water to re-wet it prior to reinserting the plunger into the barrel.

Binding Plungers

If the plunger feels like it is binding or rough, it may be soiled or bent. Do not apply force to move a plunger. Too much pressure can irretrievably bend the plunger or crack the syringe glass barrel. Try using an appropriate solvent and wiping with a lint-free cloth.

Needle Care

Use extreme caution in handling needles to avoid bending, contamination, or accidental personal injury. A variety of needle point styles and lengths are offered to meet the requirements of different applications. All Hamilton needles are electro-polished to assure smooth and burr-free products.

Sample Viscosity

Needles are designed to draw samples of normal viscosity. Samples with higher viscosity may need to be diluted. You may also consider using a needle with a larger inner diameter.

Dead Volume

Once your sample is dispensed, a small residual amount of sample remains in the needle. The amount of dead volume depends on the needle inner diameter and termination style. For example, with cemented or removal needles, the dead volume is generally less than 1 μL for small volume syringes and as much as 6.8 μL for large volume syringes.

Needle Bending

Avoid bending needles by selecting the largest needle outside diameter suitable for your application. Generally, bent needles cannot be straightened adequately for reliable operation.

Needle Burrs and Surface

Burrs, rough edges at the needle opening, and a rough needle surface can be removed by gently rubbing with a fine emery cloth or fine carborundum paper. Make sure to thoroughly rinse and dry the needle before using.

Clogged Needles

For a partially clogged needle, flush the syringe with an appropriate solvent to solubilize the clog. For a completely clogged needle, do not attempt to clean by forcing liquid or compressed air through the syringe. Excessive pressure could split the glass barrel. Alternatively, use the Hamilton Needle Cleaning Kit (P/N 76620A). Start by using the cleaning wires to dislodge any foreign material. Then flush with the Cleaning Solution Concentrate to further dissolve the clog. Once the clog is removed, rinse the syringe and needle thoroughly with deionized water. Wipe the exterior surfaces of the syringe barrel and needle dry with a lint-free tissue. Make sure that there is no residual cleaning agent in the syringe before using or storing the syringe.





Syringe Specifications

Operating Parameters

Operating temperature and pressure varies based on syringe size, plunger type, and syringe termination. In the table below are the general operating parameters for Hamilton syringes. Part number specific data sheets are available by searching the part number at www.hamiltoncompany.com.

Operating Parameters

Volume	Series	Pressure	Temperature
0.5 – 10 µL	7000	41 MPa	10 – 115 °C ¹
	600	14 MPa	10 – 115 °C ¹
	700	14 MPa	10 – 115 °C ¹
	800	14 MPa	10 – 115 °C ¹
	1700	7 MPa	10 – 115 °C ¹
	1800	7 MPa	10 – 115 °C ¹
25 – 100 µL	700	7 MPa	10 – 115 °C ¹
	800	7 MPa	10 – 115 °C ¹
	1700	7 MPa	10 – 115 °C ¹
250 µL – 10 mL	700	7 MPa	10 – 115 °C ¹
	800	7 MPa	10 – 115 °C ¹
	1700	3 MPa	10 – 115 °C ¹
	1800	3 MPa	10 – 115 °C ¹
25 – 100 mL	1000	0.7 MPa	10 – 80 °C
0.5 – 2 L	Super Syringe	0.2 MPa	0 – 80 °C

¹If the syringe termination is a cemented needle or luer tip cemented needle then the maximum temperature is 50 °C.

Syringe Dimensions

Most Hamilton syringes are standardized to a 60 mm plunger stroke length, and where possible, the same barrel outer diameter is used. For each syringe volume the inner diameter will change to accommodate the desired dispense volume.

Syringe Dimensions

Volume	Barrel OD	Barrel ID	Stroke Length
0.5 µL	7.8 mm	0.104 mm*	60 mm
1.0 µL	7.8 mm	0.145 mm*	60 mm
2.0 µL	7.8 mm	0.206 mm*	60 mm
2.5 µL	6.6 mm	0.34 mm	27 mm
5 µL 600 Series	6.6 mm	0.48 mm	27 mm
5 µL 700, 800 Series	6.6 mm	0.34 mm	54 mm
5 µL 7000 Series	7.8 mm	0.325 mm*	60 mm
10 µL 700, 800 Series	6.6 mm	0.49 mm	54 mm
10 µL 1700, 1800 Series	6.6 mm	0.46 mm	60 mm
25 µL	7.7 mm	0.73 mm	60 mm
50 µL	7.7 mm	1.03 mm	60 mm
100 µL	7.7 mm	1.40 mm	60 mm
250 µL	7.7 mm	2.30 mm	60 mm
500 µL	7.7 mm	3.26 mm	60 mm
1.0 mL	9.0 mm	4.61 mm	60 mm
2.5 mL – Thin Wall	9.7 mm	7.29 mm	60 mm
2.5 mL	10.3 mm	7.29 mm	60 mm
5 mL	13.5 mm	10.30 mm	60 mm
10 mL	17.7 mm	14.57 mm	60 mm
25 mL	27.1 mm	23.03 mm	60 mm
50 mL	36.9 mm	32.54 mm	60 mm
100 mL	36.9 mm	32.54 mm	120 mm
500 mL	75 mm	62 mm	166 mm



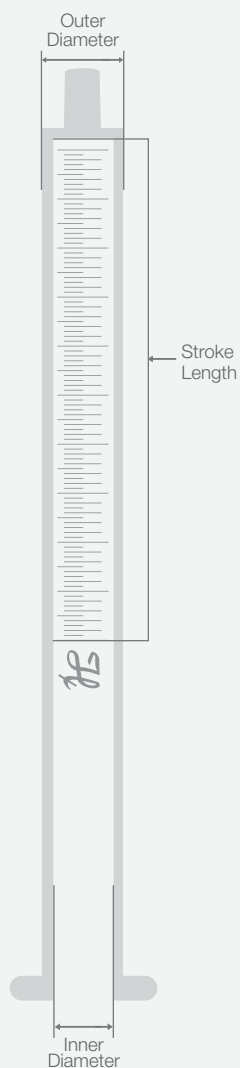
Syringe Dimensions (Cont.)

Syringe Dimensions (Cont.)

Volume	Barrel OD	Barrel ID	Stroke Length
1.0 L	100 mm	87 mm	167 mm
1.5 L	100 mm	87 mm	250 mm
2.0 L	100 mm	87 mm	334 mm

*For the 7000 series syringes the ID measurement is based on the OD of the plunger wire.

Syringes Figure 7. Syringe dimensions



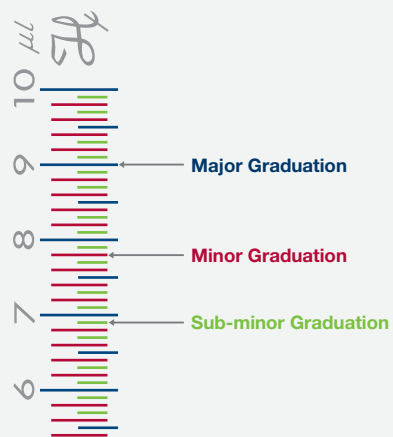
Graduations

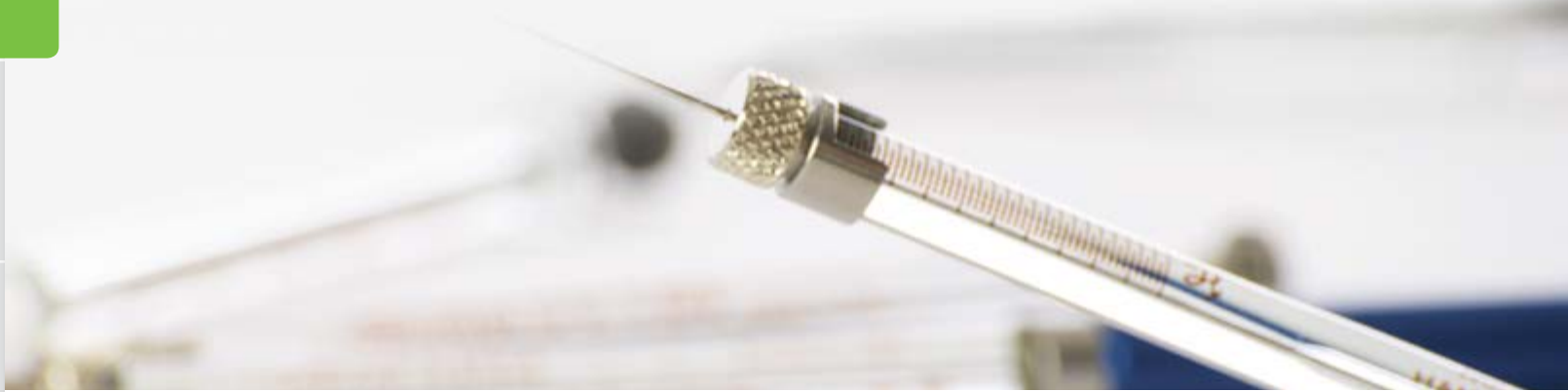
All manual Hamilton syringes have silkscreened graduations to assist in the precise positioning of the plunger. To simplify reading of the silkscreen there are three different types of graduation marks: major, minor, and sub-minor.

Graduations

Volume	Major	Minor	Sub-minor
0.5 µL	0.05 µL	0.01 µL	0.005 µL
1 µL	0.1 µL	0.02 µL	0.01 µL
2 µL	0.2 µL	0.04 µL	0.02 µL
2.5 µL	0.5 µL	0.1 µL	0.05 µL
5 µL 600 Series	1.0 µL	0.2 µL	0.1 µL
5 µL	0.5 µL	0.1 µL	0.05 µL
10 µL	1.0 µL	0.2 µL	0.1 µL
25 µL	2.5 µL	0.5 µL	0.25 µL
50 µL	5.0 µL	1.0 µL	0.5 µL
100 µL	10 µL	2.0 µL	1.0 µL
250 µL	25 µL	5.0 µL	2.5 µL
500 µL	50 µL	10 µL	5.0 µL
1 mL	100 µL	20 µL	10 µL
2.5 mL	250 µL	50 µL	25 µL
5.0 mL	500 µL	100 µL	50 µL
10 mL	1,000 µL	200 µL	100 µL
25 mL	2,500 µL	500 µL	250 µL
50 mL	5,000 µL	1,000 µL	500 µL
100 mL	5,000 µL	1,000 µL	500 µL
0.5 – 2.0 L	100 mL	20 mL	N/A

Syringes Figure 8. Graduation marks



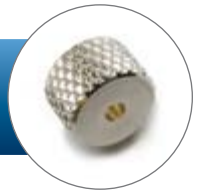


Syringe Replacement Parts

A limited selection of replacement parts and accessories are available for Hamilton syringes. For Gastight syringes most common plungers are available. For Microliter syringes the plunger is hand-fit to the barrel so a replacement plunger is not offered.

Removable Needle Nut

All Removable Needle (RN) syringes use part number 30902 for the replacement nut.



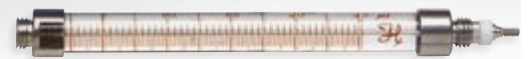
800 Series Syringe Replacement Parts

Holder Assembly



P/N	Volume
32135	5 – 250 µL

Barrel/Plunger Assembly

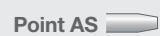


P/N	Volume	Termination	Gauge
32150	5 µL	Cemented Needle	26s ga
32134	5 µL	Removable Needle	No Needle
32151	10 µL	Cemented Needle	26s ga
32165	10 µL	Removable Needle	26s ga
32129	10 µL	Removable Needle	No Needle
32166	25 µL	Removable Needle	22s ga
32117	25 µL	Removable Needle	No Needle
32120	50 µL	Removable Needle	No Needle
32168	100 µL	Removable Needle	22s ga
32123	100 µL	Removable Needle	No Needle
32169	250 µL	Removable Needle	22s ga
32126	250 µL	Removable Needle	No Needle

Note: All included needles are 51 mm long with a point style 2.



Point Styles



1000 Series Syringe Replacement Parts

Spindle/Tip Assembly

P/N	Volume
52343-01	100 mL

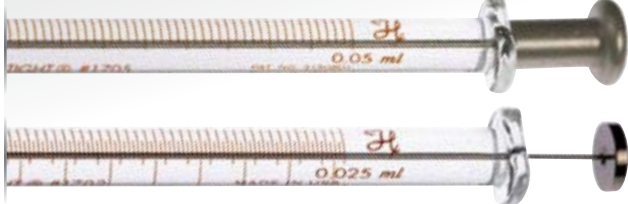
Plunger Assembly



P/N	Volume
1359-01	1 mL
1360-01	2.5 mL
13230	5 mL
13231	10 mL
13271	25 mL
13272	50 mL

1700 Series Syringe Replacement Parts

Plunger Assembly



P/N	Volume	Plunger Stop
13205	10 µL	No
1122-01	25 µL	No
13269	25 µL	Yes
1162-01	50 µL	No
1117-01	50 µL	Yes
1162-02	100 µL	No
1117-02	100 µL	Yes
1162-03	250 µL	No
1117-03	250 µL	Yes
1169-01	500 µL	No
1120-01	500 µL	Yes

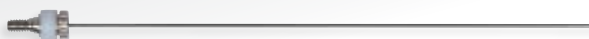
1800 Series Syringe Replacement Parts

Holder Assembly



P/N	Volume
32135	10 – 250 µL

Plunger Assembly



P/N	Volume
32193	10 µL
1160-01	25 µL
1161-01	50 µL
1161-02	100 µL
4871-01	250 µL

Glass Barrel



P/N	Volume	Termination	Gauge
32175	10 µL	Cemented Needle	26s ga
32187	10 µL	Removable Needle	No Needle
32188	25 µL	Removable Needle	No Needle
32189	50 µL	Removable Needle	No Needle
32190	100 µL	Removable Needle	No Needle
32191	250 µL	Removable Needle	No Needle

Note: All included needles are 51 mm long with a point style 2.



7000 Series Syringe Replacement Parts

Replacement Plunger and Needle Assemblies

P/N	Volume	Gauge	Length	Point
17887	0.5 µL	25 ga	70 mm	2
17187	0.5 µL	25 ga	100 mm	3
86258	0.5 µL	32 ga	70 mm	3
17888	1.0 µL (7001)	25 ga	70 mm	2
17188	1.0 µL (7001)	25 ga	70 mm	3
17890	1.0 µL (7101)	22 ga	70 mm	2
17190	1.0 µL (7101)	22 ga	70 mm	3
17891	2.0 µL (7002)	25 ga	70 mm	2
17191	2.0 µL (7002)	25 ga	70 mm	3
17192	2.0 µL (7102)	23 ga	70 mm	3
17893	5.0 µL	24 ga	70 mm	2
17193	5.0 µL	24 ga	70 mm	3

The 7000 series syringes have a plunger wire that runs inside the needle. The kit comes with a replacement plunger and needle so both can be changed at the same time. The plunger wire is extremely delicate and care must be taken not to cause damage during installation.

Super Syringe Replacement Parts

Plunger Replacement Parts

P/N	Volume	Description
18007	0.5 – 2.0 L	Piston Rod Knob
18005	0.5 – 1.0 L	Piston Rod
18053	0.5 L	Piston Disk
18054	1.0 – 2.0 L	Piston Disk
16160	0.5 L	Piston Disk O-ring
16161	1.0 – 2.0 L	Piston Disk O-ring



Point Styles





Sterilization and Disinfection

Cycling a syringe in an autoclave can result in damage caused by the metal and glass parts expanding at different rates. The table below shows the recommended chemicals

for disinfection and the syringe types that can withstand repeated autoclave cycles. As an alternative to the autoclave, all glass syringes can be sterilized using ethylene oxide.

Sterilization and Disinfection Table

Product	Autoclave Sterilization	Chemical Disinfection ¹
Cemented Needle Syringes	No	Yes, no bleach
Luer Tip Cemented Needle Syringes	No	Yes, no bleach
Fixed Needle Syringes	No	Yes, no bleach
Luer Tip Syringes	Yes	Yes
PTFE Luer Lock Syringes	Yes, except 25 mL and larger	Yes
Removable Needle Syringes	Yes	Yes, no bleach
Knurled Hub Syringes	Yes	Yes
SampleLock Syringes	No	Yes, no bleach
ChemSeal Syringes	Yes	Yes
Carbon Analyzer Syringes	No	Yes, no bleach
Constant Rate Syringes	No	Yes, no bleach
Neuros Syringes	Yes	Yes
Removable Needles (18 – 26s gauge)	Yes	Yes
Removable Needles (27 – 34 gauge)	Yes	Yes
Metal Hub Needles	Yes	Yes
Kel-F Hub Needles	Yes	Yes
PTFE Tubing	Yes	Yes
Kel-F Fittings	Yes	Yes

¹Recommended disinfecting chemicals are Microcide SQ® (P/N 3995-01), 10% bleach, acetone, or ethanol.

Syringes should be disassembled prior to autoclaving at 120 °C for 20 min.





Frequently Asked Questions

Below is a list of commonly asked questions. Find your question and then turn to the page to see the answer. If your question is not listed please contact your Hamilton representative.

Syringe Questions

- 1 → What is the accuracy of Hamilton syringes? P. 87
- 2 → Can Hamilton syringes be used on humans? P. 87
- 3 → Are the plungers for the Microliter syringes (600, 700, and 800 series) interchangeable? P. 87
- 4 → The plungers on the 700 series syringes move when very little force is applied. Can this be prevented? P. 87
- 5 → What are the most versatile syringes made by Hamilton? P. 87
- 6 → Why doesn't my RN adapter fit into my RN syringe? P. 87
- 7 → How do I adjust the needle exposure on my Neuros syringe? P. 87
- 8 → Do the 7000 Series Neuros syringes have replacement parts? P. 87
- 9 → How do you backfill syringes? P. 87

Needle Questions

- 10 → How do I find my needle for my syringe? P. 88
- 11 → Is the needle dead volume part of the total volume of the dispensed fluid? P. 88
- 12 → What does the "s" mean in a 22s or 26s gauge needle? P. 88
- 13 → Does Hamilton offer a needle sheath? P. 88
- 14 → Can disposable needles work with Hamilton syringes? P. 88



Syringe Questions

1 What is the accuracy of Hamilton syringes?

Hamilton syringes are manufactured to be accurate within $\pm 1\%$ of nominal volume, and with precision within 1%, measured at 80% of total scale volume. Our ISO 9001-2008 certified Quality System uses rigorous testing and quality checks to ensure the highest levels of accuracy and precision. To obtain a syringe-specific certificate the syringe must be purchased as a Calibrated Syringe (page 26).

2 Can Hamilton syringes be used on humans?

No, Hamilton syringes are labeled “Not for Human Use”. To discuss potential off label uses for Hamilton syringes please contact us.

3 Are the plungers for the Microliter syringes (600, 700, and 800 series) interchangeable?

No, each plunger is hand-fitted to the corresponding syringe barrel. Be very careful to keep each plunger with its original syringe barrel in order to maximize syringe performance.

4 The plungers on the 700 series syringes move when very little force is applied. Can this be prevented?

The plungers on Microliter syringes are designed to move freely to enable rapid injection into a GC. If more resistance is desired a Gastight syringe is recommended. The Gastight plunger uses a plastic seal between the plunger and syringe barrel, resulting in additional drag force to move the plunger.

5 What are the most versatile syringes made by Hamilton?

In our opinion, Gastight syringes with the Removable Needle termination are the most versatile. The plungers and the needles are replaceable if they get bent or wear out. Additionally, the dead volume of the Removable Needle termination is as small as a Cemented Needle syringe which is critical for small volume syringes.

6 Why doesn't my RN adapter fit onto my RN syringe?

The RN adapters are compatible with any SampleLock syringes or with Removable Needle syringes between 250 μL – 10 mL. If the proper size syringe is being used it is possible that the white ferrule from the previously installed needle is still stuck in the hub. This must be removed prior to installation of the RN adapter.

7 How do I adjust the needle exposure on my Neuros syringe?

To expose the needle loosen the RN nut on the end of the adapter, and then gently push the needle sleeve down. Be careful not to put your finger over the needle hole when moving the needle sleeve down. Sometimes the needle sleeve may be a little tight when using it for the first time.

8 Do the 7000 series Neuros syringes have replacement parts?

No, due to the design of the 7000 series needle plunger assembly the 7000 series Neuros syringes do not have any replacement parts.

9 How do you backfill syringes?

Backfilling a syringe can be useful when the syringe is connected to a needle or tubing with a large dead volume. Excessive dead volume makes the system difficult to prime and filling from the back may be the only option. Backfilling should not be used if the needle is clogged because reinsertion of the plunger can result in excessive backpressure and a cracked syringe barrel.

To backfill a Hamilton syringe, simply remove the plunger and load the solution from the back using a second syringe. Once the air bubbles are flushed out remove the second syringe and reinsert the plunger. For this purpose Hamilton offers a Priming Kit (P/N PRMKIT) which is recommended for syringes as small as 5 μL .

Note: This procedure is valid for 700 and 1700 series syringes only.





Needle Questions

10

How do I find a needle for my syringe?

Use the tutorial on page 9 to determine what needles are compatible with your syringe. Then turn to the Needles section to find a part number.

11

Is the needle dead volume part of the total volume of the dispensed fluid?

No, the liquid in the needle is not part of the dispense volume. The needle contains a constant dead volume throughout the aspirate and dispense steps.

When performing a GC injection one thing to consider is that the sample is aspirated at room temperature. When the sample is dispensed the needle starts to warm up to the temperature of the GC inlet. If the sample trapped in the needle is volatile it may begin to expand and result in the introduction of additional sample into the GC. To minimize this effect it is critical that the injection timing is the same for all injections.

12

What does the “s” mean in a 22s or 26s gauge needle?

For needles the gauge indicates the outer diameter of the needle tubing. The difference between a 26 gauge needle and a 26s gauge needle is the thickness of the tubing wall. The “s” needles have a thicker wall which results in a more rigid needle and a smaller dead volume. Smaller dead volume needles come standard on small volume syringes to make them practical to prime.

A table of available needle gauges and their dimensions can be found on page 119.

13

Does Hamilton offer a needle sheath?

No, Hamilton does not offer a needle sheath. Our syringes are not for human use, and our needles do not come with a medical point. If a sheath is required it is possible to buy a third party Luer Lock needle and attach it to a Hamilton Luer Tip or Luer Lock syringe.

14

Can disposable needles work with Hamilton syringes?

Yes, our Luer Tip (LT) and PTFE Luer Lock (TLL) syringes can accept most industry standard disposable luer lock needles.





Syringe Calibration

This syringe calibration 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

the calibration temperature. This method is not recommended for volumes below 2 μL . There is no upper volume limit.

Equipment and Materials

Step 1

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

Test Volume (μL)	Balance Sensitivity (mg)
1 – 10	0.001
10 – 100	0.01
100 – 1,000	0.1

Step 2

Use a balance table, or suitable equivalent to minimize vibration.

Step 3

Use a weighing vessel that has a total volume 12 to 40 times larger than the test volume, or 500 μL , 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 minimize evaporation.

Step 4

Handle the vessel with forceps or tweezers.

Step 5

Use deionized water that has equilibrated to room temperature.

Step 6

Use a calibrated thermometer to measure the temperature of the water.





Calibration Procedure

Step 1

Allow all test materials to equilibrate to room temperature (Note: For best results, this procedure should be performed at 22 °C – 26 °C.)

Step 2

Place a small amount of deionized water in the weighing vessel (between 2 and 30 test volumes).

Step 3

Fill a reservoir with deionized water and aspirate water into the syringe. Remove any bubbles by slowly aspirating and quickly dispensing the water several times.

Step 4

Place the weighing vessel on the balance pan and close the door of the balance chamber.

Step 5

Aspirate the sample to be measured. Hamilton uses 80% of the nominal volume for calibration.

Step 6

Tare the balance. Retrieve the weighing vessel from the balance chamber, dispense the volume of water, and return the vessel to the balance pan, closing the door to the weighing chamber. Record the mass of the deionized water.

Step 7

Weigh 10 samples 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.

Step 8

Measure and record the water temperature.



Calculating Accuracy and Precision

Step 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
18	0.998595
19	0.998405
20	0.998203
21	0.997992
22	0.997770
23	0.997538
24	0.997296
25	0.997044
26	0.996783
27	0.996512
28	0.996232
29	0.995944
30	0.995646

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

Step 2

Calculate the average dispensed volume from the individual dispensed volumes, V_i (where i is 1 to 10):

$$V_{avg} = \frac{(V_1 + V_2 + V_3 + \dots + V_{10})}{10}$$

Step 3

Calculate the syringe accuracy (where V_0 is equal to the expected dispense volume):

$$Accuracy (\%) = \left[\frac{(V_{avg} - V_0)}{V_0} \right] \times 100\%$$

Step 4

Calculate the standard deviation (STDEV) of the calculated volumes:

$$STDEV = \sqrt{\frac{\sum(V_i - V_{avg})^2}{10}}$$

Step 5

Determine the precision (coefficient of variation – CV):

$$CV (\%) = \frac{STDEV}{V_{avg}} \times 100\%$$



