

# NanoAerosol Generator

## Model 3250: User Manual



NanoAerosol Generator Model 3250: User Manual  
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The following is a history of the NanoAerosol Generator Model 3250 User Manual (part number 2679001):

Version	Date	Change
Version 1.0	December 2016	
Version 1.1	June 2017	Updated photographs, installation and operation instructions and company name. Added troubleshooting instructions.
Version 1.2	July 2017	Updated photos, some instructions, packing list.
Version 1.3	March 2018	Updated Adjusting the Nebulizer Gas Pressure and Troubleshooting Instructions.

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## About This Manual

### Intended Audience

The NanoAerosol Generator Model 3250 User Manual is intended to be used by qualified personnel (such as technicians and engineers) in a laboratory setting.

### Scope of User Manual

This user manual contains detailed instructions for the installation and set up of the NanoAerosol Generator Model 3250. The manual also contains an explanation of how the aerosol generator works.

### Definitions

- UPW: Ultrapure Water
- EU: European Union
- RAE: Residue After Evaporation
- EEPROM: Electrically Erased Programmable Read Only Memory
- psi: pounds per square inch
- kPa: Kilo Pascals
- PFA: Perfluoralkoxy (high purity, chemical resistant plastic)
- PTFE: Polytetrafluoroethylene (high purity, chemical resistant plastic)
- PEEK: Polyether Ether Ketone (high purity, chemical resistant plastic)
- VAC/VDC: Volts Alternating Current/Volts Direct Current
- AC: Alternating Current
- mA: Milliampere
- PLC: Programmable Logic Controller
- NVR: Non-Volatile Residue
- DNVR: Dissolved Non-Volatile Residue
- PNVR: Precipitated Non-volatile Residue

# Safety and Handling Procedures

Read this section to learn safe handling procedures for the NanoAerosol Generator.

There are limited user-serviceable parts inside the NanoAerosol Generator: all repair and maintenance must be performed by a qualified service technician.

When working with the NanoAerosol Generator:

- Do not remove any parts from the instrument unless this manual tells you to do so.
- Do not remove the instrument housing or covers while power is supplied to the instrument.

## Safety Signals

The following warning symbols and labels are used in the documentation and on the NanoAerosol Generator. Follow the procedures described in this manual to use the instrument safely.



### Warning

Warnings are used for the following purposes:

- To indicate that unsafe use of the instrument could result in serious injury to you or cause irrevocable damage to the instrument.
- To indicate that if you do not follow the procedures described in this manual, you may damage the instrument.
- To draw attention to important information about the operation and maintenance of the NanoAerosol Generator.



### High Voltage Sticker

A High Voltage warning sticker attached to the NanoAerosol Generator warns you that un-insulated voltage within the instrument may be sufficient to give you an electric shock. Do not make contact with any part inside the instrument.



### Grounding Connection Sticker

A Grounding Connection sticker attached to the NanoAerosol Generator indicates that the nebulizer is connected to earth ground and cabinet ground.

### Warnings



Please familiarize yourself with the following warnings before operating the NanoAerosol Generator:

- The aerosol particles created by the Model 3250 NanoAerosol Generator may pose a health risk if inhaled. If not connected to other instrumentation, vent the aerosol output to a fume hood or through a particle filter.
- The NanoAerosol Generator must be used following manufacturer's specifications otherwise safety cannot be guaranteed.
- All service work must be performed by qualified service technicians - only qualified service technicians should remove the cover.
- When the aerosol generator is running, there are hot surfaces inside the device. Do not remove the cover at any time unless you are a qualified service technician.
- To prevent electric shocks, ensure that all electrical outlets are grounded.
- Follow the instructions for all inlet and outlet connections. Incorrect connections will cause the aerosol generator to malfunction.
- The air or nitrogen supplied to the aerosol generator must be clean, dried, oil-free and regulated at 50-60 psi.
- Use only aqueous samples.
- Do not remove or tamper with the protective mesh sleeve or pressure relief valve on the pressurized vessel — injury could be caused.
- When the pressurized vessel is connected to the NanoAerosol Generator, turn off the sample pressure before removing the lid of the pressurized vessel.
- During normal operation, do not tilt the aerosol generator at angles  $>30^\circ$ .
- You must drain the aerosol generator before you move or ship it. Do not ship an undried/undrained device back to Kanomax FMT, Inc.: doing so might damage the device and invalidate the warranty.
- Do not subject an undrained device to freezing temperatures: doing so might damage the device and invalidate the warranty.
- Do not inject sample without first confirming that the nebulizer gas pressure is set to 35 psi.



### How the NanoAerosol Generator Works

The NanoAerosol Generator uses an ultrafine droplet nebulization technique to pneumatically aerosolize aqueous suspensions of nanoparticles. The decreased droplet size allows the NanoAerosol Generator to deliver small size ( $< 30$  nm) aerosol particles without restrictions on sample suspensions, such as those required by the electrospray nebulization method; it also reduces the interference from dissolved non-volatile residue (DNVR) contaminant present in many nanoparticle suspensions. When using traditional pneumatic nebulization techniques, DNVR can cause problems in differentiating nanoparticles from the overall size distribution.

The liquid sample is introduced into the NanoAerosol Generator either from a regulated pressurized vessel, a syringe pump, or via a peristaltic pump. The sample is then nebulized into ultrafine droplets at a rate of 600 - 700 sccm. An impaction pin positioned within 1.0 mm of the nebulizer nozzle removes the largest liquid droplets; the remaining wet aerosol containing droplets has a nominal mode diameter of  $\sim 550$  nm. The wet aerosol is then conditioned at an elevated temperature to evaporate liquid, leaving only the nanoparticles and unwanted precipitated non-volatile residue. The aerosol is combined either actively or passively with clean, dry air before exiting the Aerosol Output on the front panel. When the Dilution Air Active mode is selected, the NanoAerosol Generator delivers 1.7 L/min of aerosol. When the Dilution Air Passive mode is selected, the Aerosol Output outlet is at near-atmospheric pressure with an internal vent and up to 1.5 L/min of dry aerosol flow can be drawn from the instrument; if more than 1.5 L/min is drawn, ambient aerosol is pulled into the sample stream. In the passive mode the connected equipment must draw aerosol from the NanoAerosol Generator at a minimum of 1 slpm to ensure the nebulized aerosol is mixed with sufficient dry air to reduce vapor condensation.

Using a traditional pneumatic nebulizer aerosol generator for nanoparticle generation from aqueous suspensions often results in a high lower limit of differentiable particle size because of the interference from dissolved non-volatile residue present in most liquid samples. Reflected in the generated aerosol particle size distribution, this dissolved non-volatile residue interference has an order of severity that is directly related to the distribution of the nebulized droplets. After droplet evaporation, any dissolved non-volatile residue present in a droplet creates a particle of precipitated residue regardless of whether the droplet contains wanted nanoparticles or not. When there is a nanoparticle in a droplet, precipitated non-volatile residue forms a coating over the particle. The relative thickness of the coating becomes significant when attempting to aerosolize nanoparticles  $< 30$  nm or

particles where the surface properties are of concern (such as those aimed at toxicology studies). The NanoAerosol Generator mitigates precipitated non-volatile coating by minimizing the size of the nebulized droplets using a unique KanomaxFMT-designed ultrafine droplet nebulization technique. The decreased droplet sizes thereby reduce the influence of precipitated non-volatile residue on the final aerosol properties. In addition to the aerosolization of nanoparticle suspensions the NanoAerosol Generator is able to generate particles with controlled composition of unknown precipitative non-volatile residue. Traditional nebulizers are typically limited by residue in the solvent.

Figure 1 shows a nanoparticle generation comparison between a traditional nebulizer and the NanoAerosol Generator. Figure 2 is a schematic diagram illustrating the main components of the NanoAerosol Generator.

**Figure 1: NanoAerosol Generator and Traditional Nebulizer comparison in nanoparticle generation.**

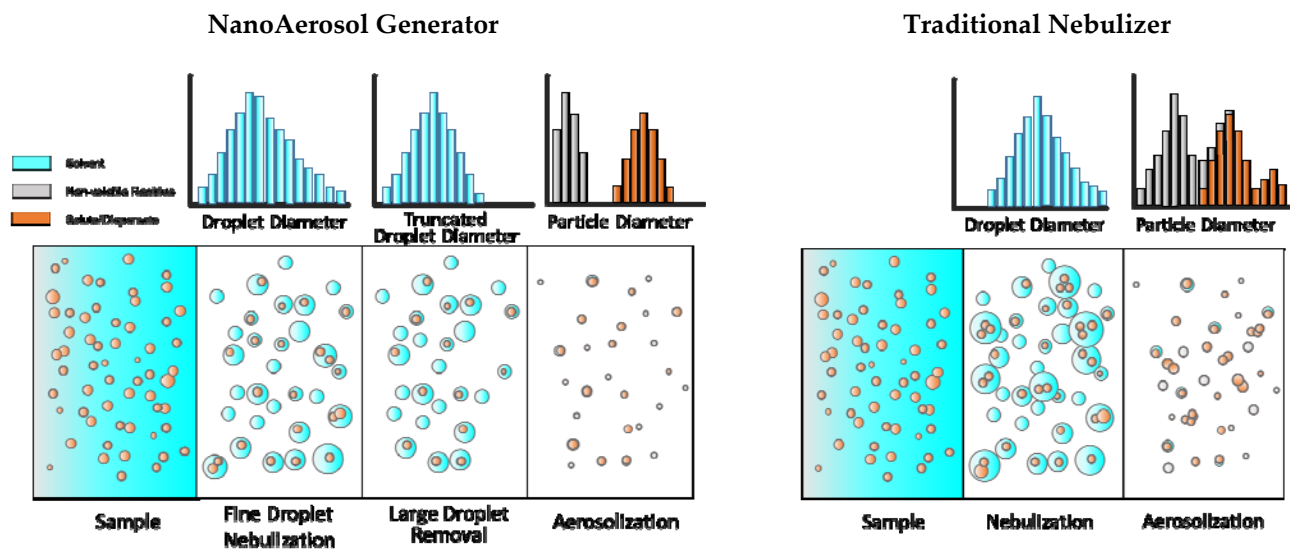
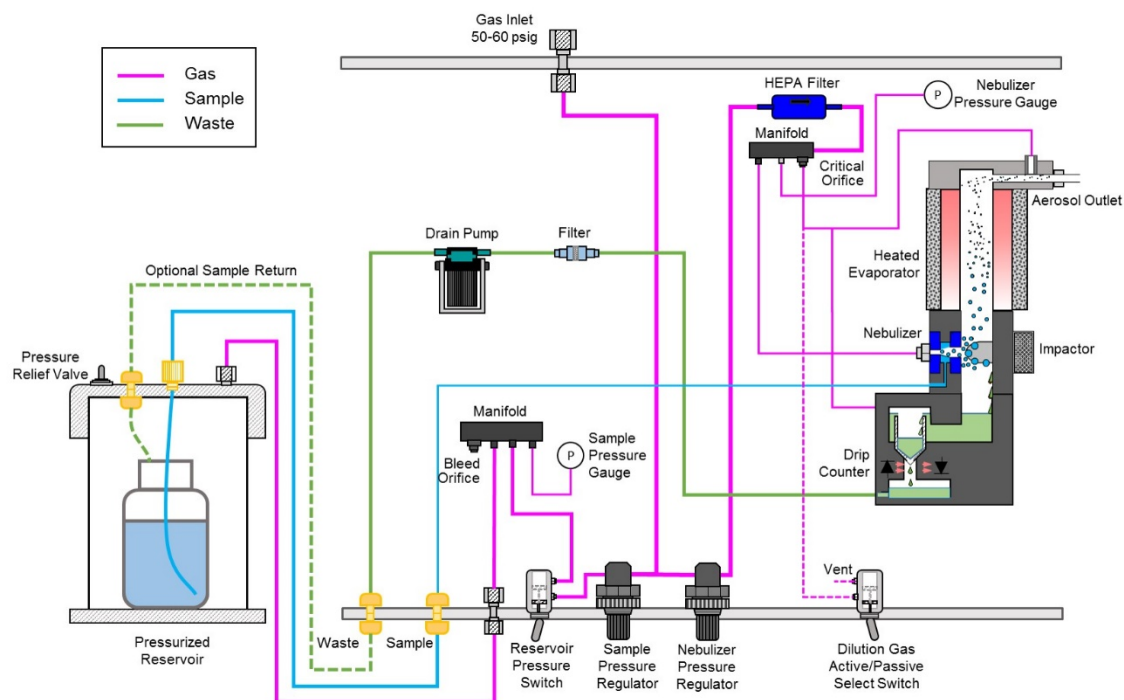


Figure 2: Schematic Diagram of the NanoAerosol Generator Model 3250.



The NanoAerosol Generator offers the following advantages over existing aerosol generation technology:

- Easy-to-use ultrafine nebulization technique producing droplets  $< 1\mu\text{m}$  in diameter.
- Ability to generate  $< 30\text{ nm}$  aerosol particles of known precipitated non-volatile residue (PNVR) composition.
- Does not require a conductive solution (unlike electrospray aerosolization).
- Does not require an ion source to discharge droplets to remove Rayleigh fissions.
- Limits the influence of precipitated non-volatile residue on nebulized particles.
- Ability to inject a small sample directly into the nebulizer.
- Integrated heated evaporator.
- Drip counter to continuously monitor nebulizer sample flow rate.
- Temperature and pressure logging of on-line sample flow.
- Feedback control of evaporator and nebulizer housing temperatures to aid in stability.

### Applications

- Aerosol generation of PNVR particles with mode diameter < 30 nm.
- Aerosolization of highly monodisperse < 50 nm particle standards (such as particle size standards fabricated with polystyrene latex (PSL), silica, gold, etc.).
- Analyzing drugs and other medical nanoparticles in water.

The NanoAerosol Generator is protected by US patents 8,272,253 and 8,573,034, and is available from Kanomax FMT, Inc. Licensing is available for customers who wish to incorporate this technology into other applications.

### Acknowledgement

The ultrafine nebulization method used in this device is based on technology licensed from CT Associates, Inc. (CTA). We offer our sincere thanks to Don Grant, Gary Van Schooneveld, and Mark Litchy for their invention, their clever insights to this unique technology, and the gracious feedback they have provided during the development of this product. Patent numbers 8,272,253 and 8,573,034 have been issued to CTA and licensed by Kanomax FMT, Inc. Patent number 7,852,465 has been issued to Kanomax FMT, Inc.

# How to Install the NanoAerosol Generator Model 3250

The NanoAerosol Generator can be operated with a pressurized vessel or a peristaltic pump/ Note: The pump is not included and is sold separately.

## Installation Overview

Following is an overview of the steps required to install a NanoAerosol Generator. Please read the detailed instructions (beginning below) for each step before you set up the instrument.

- Unpacking the NanoAerosol Generator.
- Connecting the waste outlet.
- Connecting the air supply.
- Connecting the power.
- Connecting the pressurized vessel.
- Connecting the aerosol outlet.

## Unpacking the NanoAerosol Generator

To unpack the NanoAerosol Generator, follow these instructions:

1. Carefully remove the NanoAerosol Generator from its shipping container. Save the original packing materials for use when shipping the Generator back to Kanomax FMT, Inc. for service, or for moving the Generator to a different location.



**Warning.** If the NanoAerosol Generator is returned to Kanomax FMT, Inc. in anything other than the original shipping container, you will be charged for any damage that occurs during shipping. If you do not have the original shipping container, contact Kanomax FMT Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

2. Place the Generator on a level surface.
3. Make sure there is an unrestricted air flow around the device. Kanomax FMT, Inc. recommends at least a 2-inch air gap on both sides and the top of the instrument.
4. Allow the Generator to reach ambient temperature, if necessary.
5. Make sure all the items listed in Table 1, were included in the NanoAerosol Generator shipment. If any of the items are missing, or damaged, please call Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

**Table 1: Packing List**

Part Number	Description	Quantity
NAG 3250	NanoAerosol Generator	1
PV-3260	Pressurized Vessel	1
1973250	User Manual, Printed	1
2605004	USB Flash Drive containing the NanoAerosol Generator User Manual	1
1330001	Power Supply Cable (USA only)	1
3020018	1/16 inch OD .030 ID PFA Tubing	1
3020008	1/8 inch OD 1/16" ID PFA Tubing	1
1610077	Flangeless Male Nut 1/16 inch black	2
1610078	Flangeless Ferrule 1/16 inch	2
1610056	Flangeless Male Nut 1/8 inch	2
1610057	Flangeless Ferrule 1/8 inch	2
1610085	Tube Adapter (for peristaltic pump)	1
1611049	Quick Disconnect 1/8 in barbed tube	1
3020002	¼ inch OD 1/8 inch ID Tygon Tubing (3 ft length)	1
3020010	1/8 inch OD 1/16 inch ID Polyethylene tubing	1

### Equipment You Need

To install the NanoAerosol Generator, you need the following items:

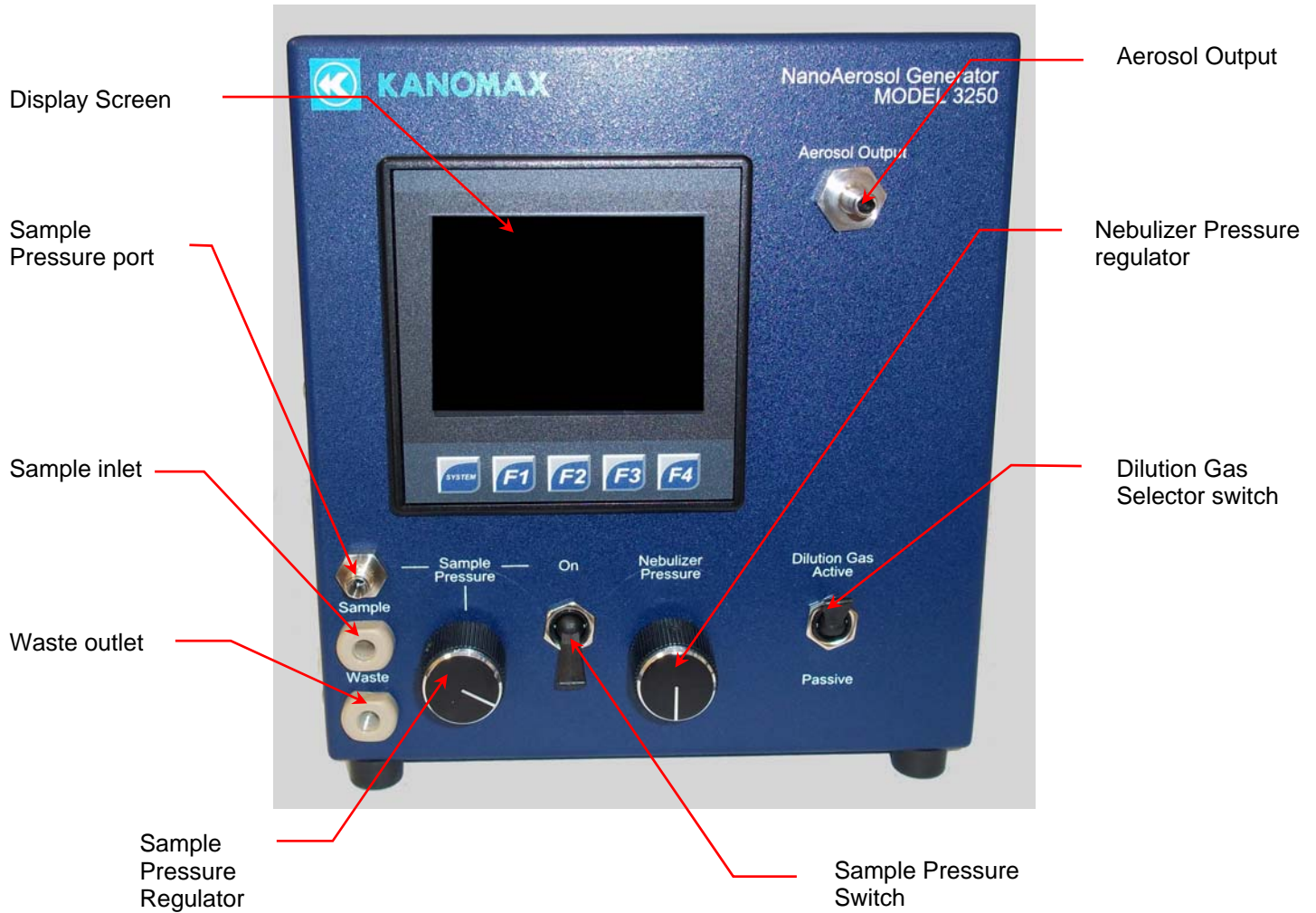
- Wrenches in 5/8, 9/16, ½, and 7/16 size, or two adjustable wrenches.
- A length of 1/8 inch OD tubing sufficient to reach from the instrument to your waste drain (4 ft maximum length).
- Conductive ¼ inch OD tubing for transporting the generated aerosol.
- A supply of clean, dry, compressed air at 2 slpm.
- Sample bottle.
- Access to a suitable waste container.
- 120-240 VAC power at 50/60 Hz.

**Note:** No ¼ inch OD tubing is supplied with the NanoAerosol Generator.

### Installing the NanoAerosol Generator

Figures 3 and 4 show the front and back panels of the NanoAerosol Generator.

**Figure 3: Front Panel of the NanoAerosol Generator.**





## NanoAerosol Generator Model 3250: Installation

Figure 4: Back Panel of the NanoAerosol Generator.



### Connecting the Compressed Air or Nitrogen Supply

The air or nitrogen supplied to the NanoAerosol Generator must be clean, dried, oil-free and regulated at 345-414 kPa (50-60 psi) at 2 slpm.

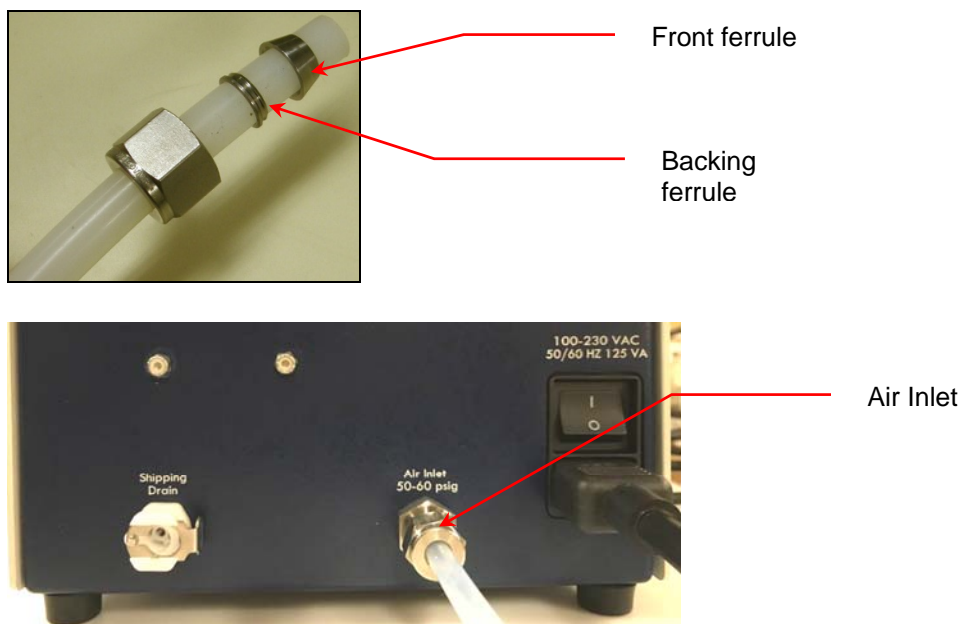
Follow these instructions to connect the compressed air supply:

1. Remove the protective cap from the **Air Inlet** on the back panel.



2. Using a length of ¼ inch OD polyethylene tubing with a Swagelok fitting on one end, insert the tubing into the **Air Inlet** fitting on the back panel.



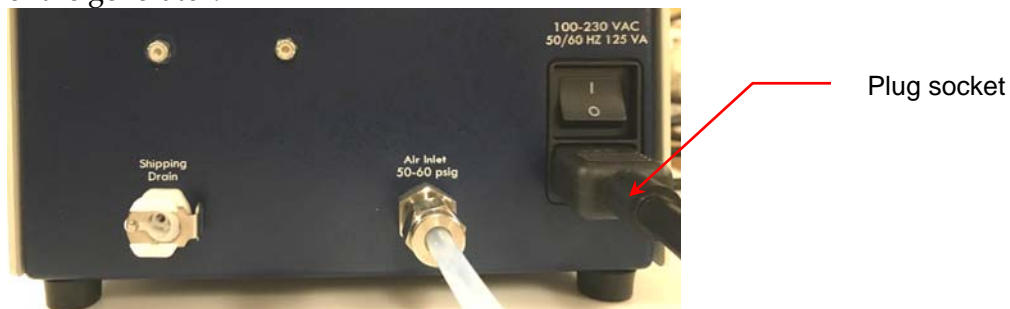


3. Using an adjustable wrench, tighten the Swagelok nut one turn past hand tight to swage the ferrules onto the tubing. Note: Use a second wrench to avoid turning the fitting on the back panel. Once the ferrules have been swaged, the fitting only requires slight tightening upon reassembly.
4. Connect the other end of the tube to your air supply.
5. Turn on the air at the source. The incoming pressure must be regulated at 345-414 kPa (50-60 psi).

### Connecting the Power

To connect the power supply, follow these instructions:

1. Plug the supplied power cable into the AC plug socket on the back panel of the generator.



2. Plug the cord into an earth-grounded AC power source (100 to 240 VAC, 50 to 60 Hz, 0.6 A).

**Warning:** Ensure that the ground is secure. Connection to an improperly grounded electrical source is a severe shock hazard.

1.

### Connecting the Waste Drain

Excess sample from the NanoAerosol Generator is removed from the instrument through the **Waste** outlet on the front panel using a solenoid pump. The waste can be sent to a suitable waste container or it can be recycled by connecting the waste tubing to the pressurized vessel.

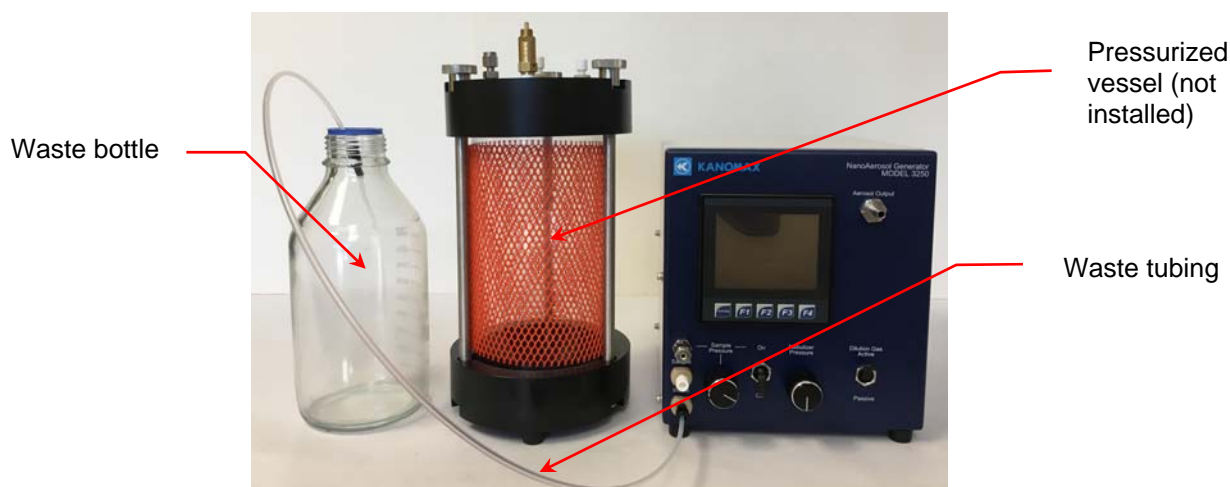
Follow these instructions to connect the waste drain:

1. Remove the plug from the **Waste** outlet on the front panel.
2. Connect a supplied nut and ferrule to one end of the two-foot length of 1/8 inch OD PFA tubing.
3. Push the nut into the **Waste** outlet fitting.

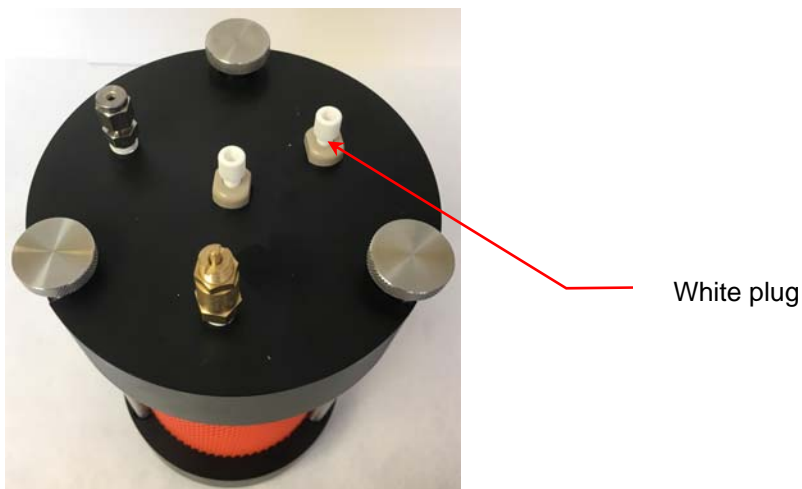
**Warning:** Do not over-tighten the fitting or you will damage the tube and/or fitting.



4. Insert the other end of the tube into a waste container.



5. Make sure the white plug is in place on top of the pressurized vessel.



2.

Follow these instructions to recycle the waste:

1. Remove the plug from the **Waste** outlet on the front panel.
2. Remove the white plug from the top of the pressurized vessel. Save the plug for reuse. (See photo above for location of white plug.)
3. Connect a supplied nut and ferrule to one end of the supplied 1/8 inch OD PFA tubing. Push the nut into the **Waste** outlet.

**Warning:** Do not over-tighten the fitting or you will damage the tube and/or fitting.

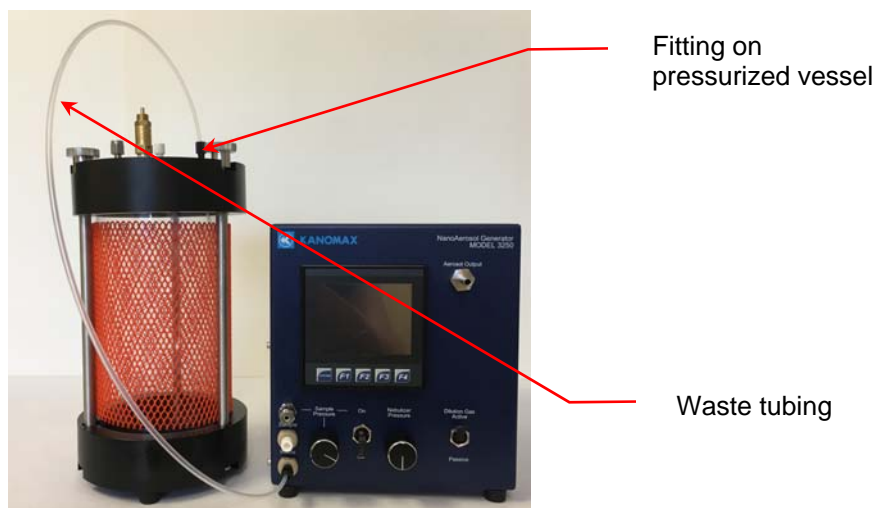


Waste outlet



4. Place the supplied nut and ferrule on the other end of the tubing and insert into the pressurized vessel top.

**Note:** When you place your preferred sample bottle inside the pressurized vessel, make sure that the waste tubing is inserted into the bottle and not the pressure chamber.



3.

### Connecting the Aerosol Output

Generated aerosol particles can be transported to downstream detection or collection instrumentation through the Aerosol Output outlet using either a Passive or Active Dilution Gas mode.



**Warning:** When **Dilution Gas Passive** is selected, the Aerosol Output outlet is at near-atmospheric pressure with an internal vent. The connected equipment must draw aerosol from the instrument. If the measurement device draws more than 1.5 L/min, ambient aerosol will be drawn into the sample stream. The device must draw more than 1 L/min to prevent condensation from forming in the aerosol lines.

To connect the aerosol line, follow these instructions:

1. Remove the protective cap from the **Aerosol Output** fitting.
2. Push  $\frac{1}{4}$  in tubing onto the **Aerosol Output** port and connect the other end of the tubing to your downstream detection/collection device.



4.



**Warning:** The aerosol particles created by the Model 3250 NanoAerosol Generator may pose a health risk if inhaled. If not connected to other instrumentation, select Dilution Gas Active and vent the aerosol output to a fume hood or through a particle filter.

### Connecting to the Sample Supply

The liquid sample can be introduced either from a regulated pressurized vessel or using a peristaltic or syringe pump. A peristaltic pump can be used for continuous long-term operation or a syringe drive pump for precise microflow sample injection. The sample pressure in the pressurized vessel is supplied from the NanoAerosol Generator main unit via the supplied sample pressure tubing.

**Figure 5: NanoAerosol Generator connected to a pressurized vessel.**



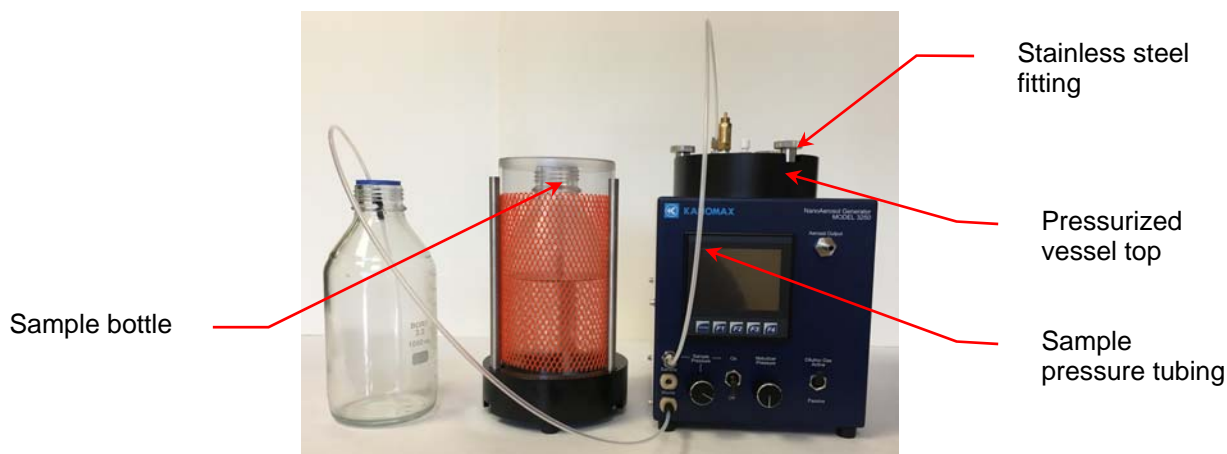
## NanoAerosol Generator Model 3250: Installation

To connect the pressurized vessel to the **Sample Pressure** port, follow these instructions:

1. Remove the 1/8 inch Swagelok protective cap from the stainless steel **Sample Pressure** port on the front panel.
2. Using the supplied length of 1/8 inch OD polyethylene tubing with Swagelok fittings on both ends, insert one end of the tubing into the **Sample Pressure** port.

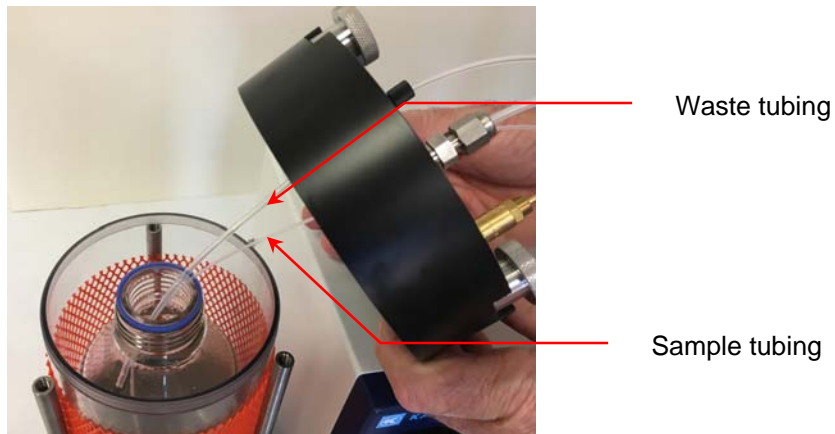


3. Using an adjustable wrench, tighten the Swagelok nuts slightly past finger tight. Do not over-tighten — the ferrules are pre-swaged.
4. Loosen the three steel fittings on the pressurized vessel lid to remove the lid. Note: Turn the fittings sequentially in a counterclockwise direction. If you loosen the fittings one by one the cap will tilt.
5. Insert the other end of the tubing into the Swagelok fitting on the pressurized vessel cap.
6. Insert a sample bottle of choice into the pressurized vessel chamber.



**Warning:** If you are recycling the waste, make sure the waste tubing reaches into the sample bottle. If the tubing does not reach into the bottle, water will collect in the base of the pressurized vessel. If you are not recycling the waste, proceed to step 7.





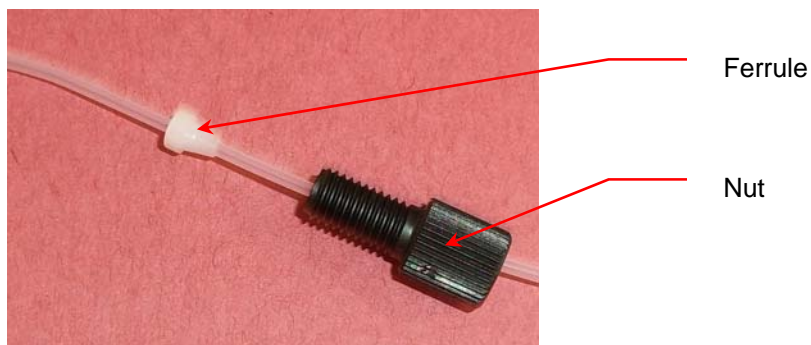
7. Replace the lid of the pressurized vessel and sequentially tighten the fittings in a clockwise direction.



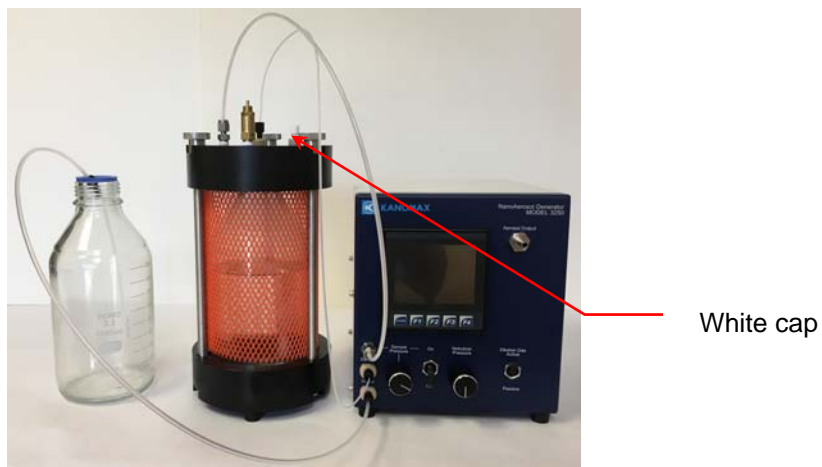
5.  
To connect the pressurized vessel to the Sample inlet, follow these instructions:
  1. Remove the 1/4-28 protective plug from the **Sample** inlet.



2. Place the supplied nut and ferrule on the supplied length of 1/16" OD tubing.



3. Insert the fitting into the **Sample Inlet**.  
**Warning:** Do not over-tighten the fitting or you will damage the tube and/or fitting.
4. Place a supplied nut and ferrule on the other end of the tubing and push them approximately one foot along the tubing.
5. Push the tubing through the fitting on the pressurized vessel top. The tubing should reach all the way to the bottom of the bottle inside the pressurized vessel.



6. If you are not recycling the waste, make sure the white plug is in place on the pressurized vessel top. If you are recycling the waste, make sure the waste tubing reaches into the sample bottle. If the tubing does not reach into the bottle, water will collect in the base of the pressurized vessel.



## NanoAerosol Generator Model 3250: Installation

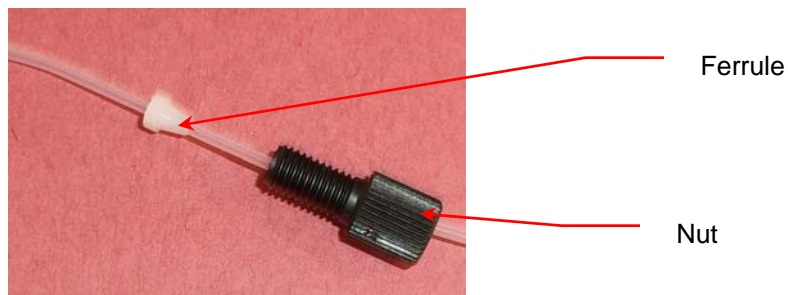
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To connect the Sample Inlet when using an external pump, follow these instructions:

1. Remove the 1/4-28 protective plug from the **Sample inlet**.



2. Place the supplied nut and ferrule on the supplied length of 1/16" OD tubing.



3. Insert the fitting into the **Sample Inlet**.  
**Warning:** Do not over-tighten the fitting or you will damage the tube and/or fitting.
4. Connect the other end of the tubing to your external pump of choice.

### Warming Up the NanoAerosol Generator

Using the rocker switch on the back panel, turn the power on. You see the instrument splash screen (shown below) and the generator automatically begins its warm-up procedure. Note: The warm-up procedure may take up to 15 minutes. Press **F1** to view the warmup status on the Device Status screen.

**Figure 6: NanoAerosol Generator Display Screen.**



If you experience any problems installing your NanoAerosol Generator, please contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

### Operation Instructions

Once all installation procedures have been completed, you are ready to begin standard operation of the NanoAerosol Generator.



**Warning:** Generated aerosol particles can be transported to downstream detection or collection instrumentation through the Aerosol Output outlet using either a Passive or Active Dilution Gas mode. When **Dilution Gas Passive** is selected, the Aerosol Output outlet is at near-atmospheric pressure with an internal vent. If the measurement device draws more than 1.5 L/min, ambient aerosol will be drawn into the sample stream. The device must draw more than 1 L/min to prevent condensation from forming in the aerosol lines.

**Warning:** The aerosol particles created by the Model 3250 NanoAerosol Generator may pose a health risk if inhaled. If not connected to other instrumentation, select **Dilution Gas Active** and vent the aerosol output to a fume hood or through a particle filter.

### The Back Panel

Components of the NanoAerosol Generator back panel include the following:

- Shipping Drain and Air Inlet.
- Power switch.
- Data Communication port.

**Figure 7: NanoAerosol Generator Back Panel.**

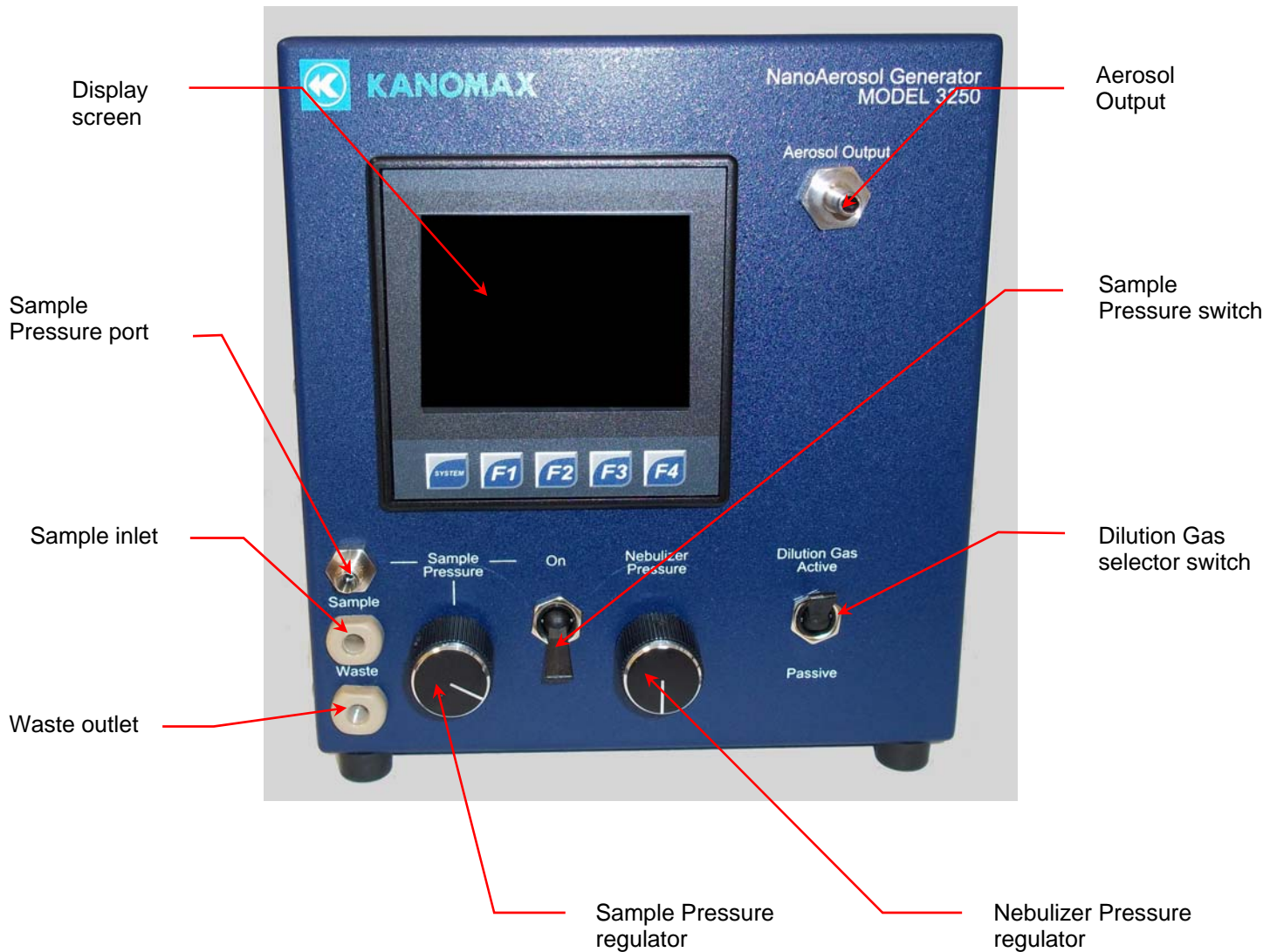


### The Front Panel

Components of the NanoAerosol Generator front panel include the following:

- Aerosol Output, Sample Pressure port, Sample inlet, Sample switch, Waste outlet, and Dilution Air switch.
- Sample Pressure regulator and Nebulizer Pressure regulator.
- Touch-screen Display.

**Figure 8: NanoAerosol Generator Front Panel.**



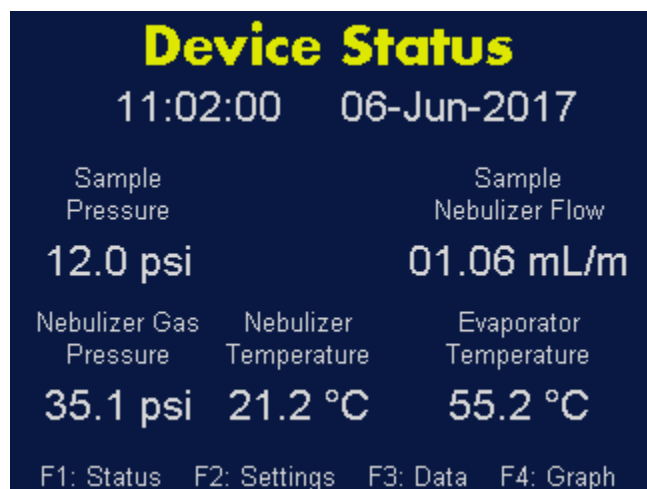
The NanoAerosol Generator is operated using the touch-screen display and the F1, F2, F3, and F4 buttons. The F buttons perform the following functions:

- F1: Press **F1** to view instrument status.
- F2: Press **F2** to view/change instrument settings.
- F3: Press **F3** to view/change data collection options.
- F4: Press **F4** to view onscreen graphs.
- System: the **System** button is for factory use only and is non-functional for the customer.

### Checking the Status

On the front panel, press **F1** to see the **Device Status** screen. The current time and date (hh:mm:ss, dd-mm-yyyy) is displayed below the screen heading. Any status readings displayed in red indicate that the status is outside the acceptable range or the set point has not been reached.

Figure 9: NanoAerosol Generator Device Status Screen.



The Device Status screen displays the following instrument statuses:

- **Sample Pressure:** Displays the pressure of the pressurized vessel in psi. The nominal value is 12 psi. Adjust the Sample Pressure using the Sample Pressure regulator on the front panel. Note: This pressure directly affects the sample nebulizer flow rate injected into the generator nebulization module.
- **Sample Nebulizer Flow:** Displays the sample flow to the nebulization module in ml/min.
- **Nebulizer Gas Pressure:** Displays the Nebulizer Gas Pressure in psi. The nominal value is 35 psi. Adjust the nebulizer gas pressure using the Nebulizer Pressure regulator on the front panel.
- **Nebulizer Temperature:** Displays the nebulizer temperature in °C. The nominal value is 19 °C, but may need adjustment based on the ambient



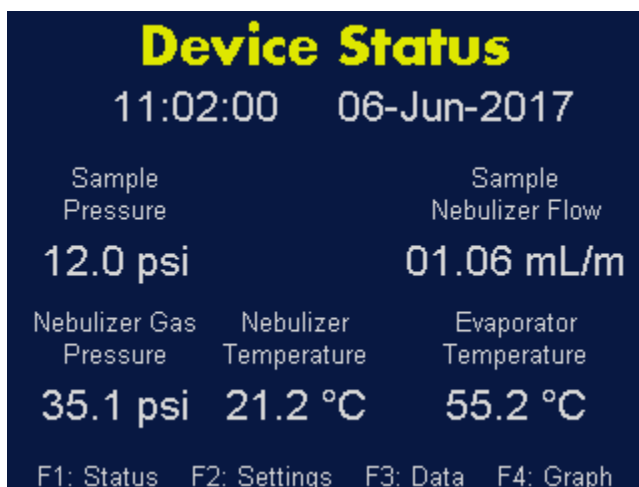
temperature and the sample temperature. Adjust to a point where the temperature is stable. (For instructions on adjusting the nebulizer temperature, see page 28.)

- **Evaporator Temperature:** Displays the evaporator temperature in °C. The nominal value is 60°C. (For instructions on adjusting the evaporator temperature, see page 29.)

### Adjusting the Nebulizer Gas Pressure

To adjust the Nebulizer Gas Pressure, follow these instructions:

1. Press **F1** to view the **Device Status** screen.



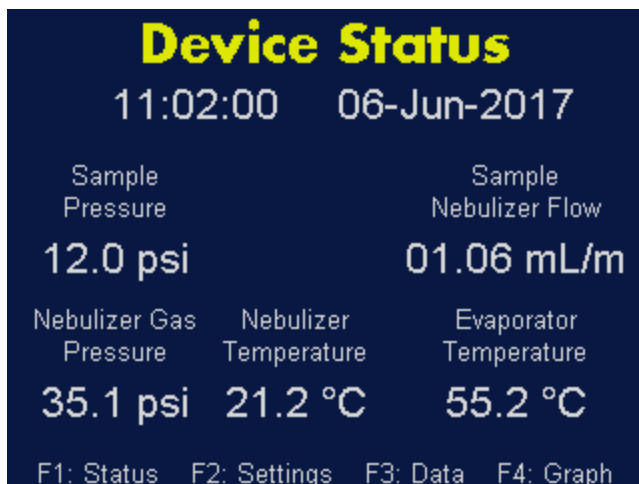
2. Turn the **Nebulizer Pressure** regulator on the front panel until the **Nebulizer Gas Pressure** reads 35psi on the **Device Status** screen.



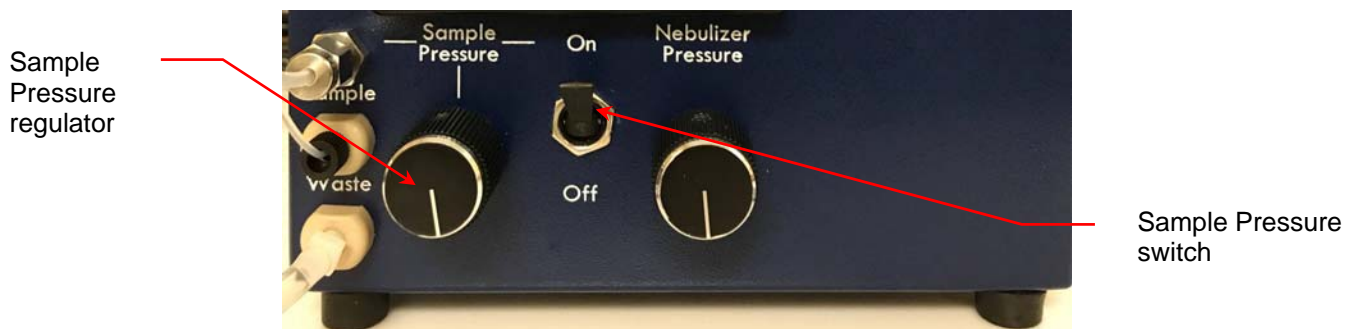
### Adjusting the Sample Pressure/Nebulizer Flow

To adjust the Sample Pressure, follow these instructions:

1. Press **F1** to view the **Device Status** screen. Note: The Nebulizer Gas Pressure should be 35 psi. If it is not refer to Adjusting the Nebulizer Pressure on page 26.



2. Turn on the sample pressure supply by switching the **Sample Pressure** switch to "On".



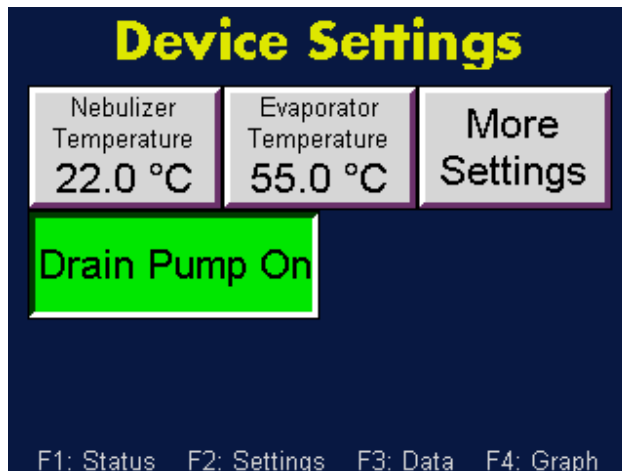
3. Turn the **Sample Pressure** regulator on the front panel until the **Sample Pressure** reads 12.0 psi on the **Device Status** screen. Make this adjustment slowly to allow time for the pressure to stabilize. The sample pressure directly affects the sample nebulizer flow rate: the higher the pressure applied to the pressurized vessel, the higher the sample flow rate it can force out of the bottle into the Sample inlet. Do not exceed 18.0 psi. If the pressure falls below 10.0 psi gas may back-flow into the pressurized vessel. The **Sample Nebulizer Flow** is displayed on the **Device Status** screen.



### Changing the Instrument Settings

On the front panel, press **F2** to see the **Device Settings** screen.

Figure 10: NanoAerosol Generator Device Settings Screen.



The **Device Settings** screen displays the following:

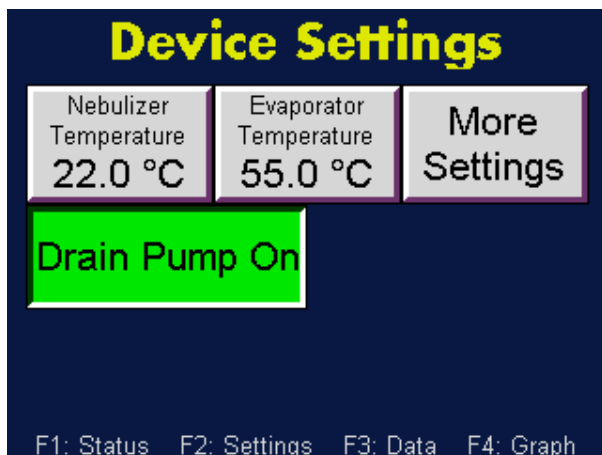
- **Nebulizer Temperature:** Allows you to set the nebulizer temperature.
- **Evaporator Temperature:** Allows you to set the evaporator temperature.
- **Drain Pump:** Allows you to turn the pump on and off to lengthen its life.
- **Calibration:** Allows you to see options for Calibration, setting the injection pump direction and loading new firmware.

### Adjusting the Nebulizer Temperature

If the Nebulizer Temperature status indicator is red, the temperature is not within 2°C of the temperature set point (as seen on the Device Status screen). If the status indicator is red and the temperature is below 22°C, set the temperature to 17°C. If the status indicator is red and the temperature is above 22°C, set the temperature to 27°C.

To adjust the Nebulizer Temperature, follow these instructions:

1. Press **F2**.
2. On the Device Settings screen, touch **Nebulizer Temperature**.



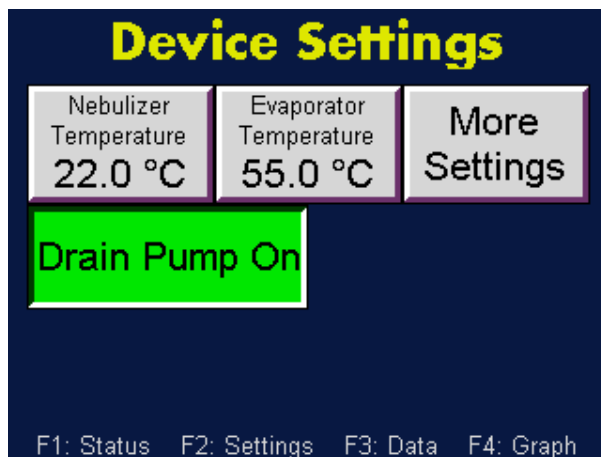
3. On the resulting on-screen keyboard, touch the numbers to enter the required temperature and then touch **Enter**. The updated set point appears on the **Device Settings** screen. Note:  $\Delta$   $\nabla$  buttons index the temperature.  $\triangleleft$   $\triangleright$  buttons set the cursor.  $\pm$  sets the sign on the number.



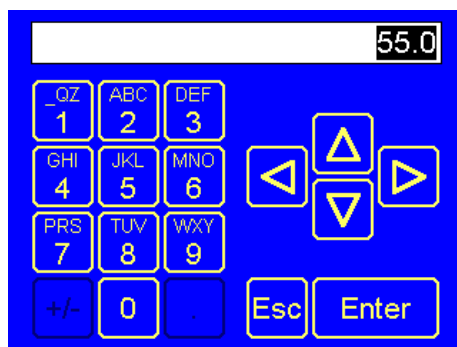
### Adjusting the Evaporator Temperature

The operational range for the evaporator temperature is 40-70°C. If the **Evaporator Temperature** status indicator is red, the temperature is not  $\pm 2$  °C of the temperature set point (as seen on the **Device Settings** screen). To adjust the Evaporator Temperature, follow these instructions.

1. Press **F2**.
2. On the **Device Settings** screen, touch **Evaporator Temperature**.



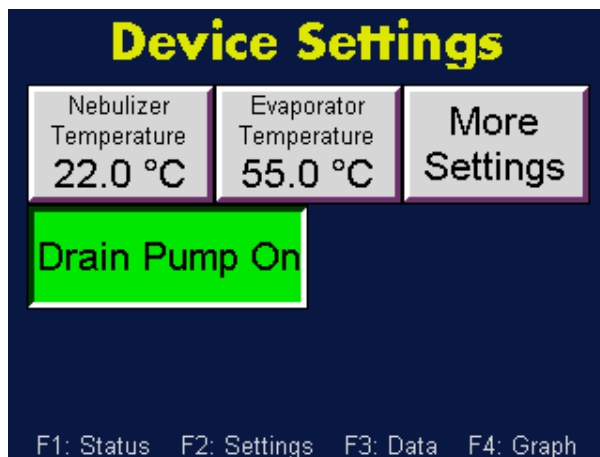
3. On the resulting on-screen keyboard, touch the numbers to enter the required temperature and then touch **Enter**. Note:  $\Delta$   $\nabla$  buttons index the temperature.  $\triangleleft$   $\triangleright$  buttons set the cursor.  $\pm$  sets the sign on the number. The updated set point appears on the Device Settings screen.



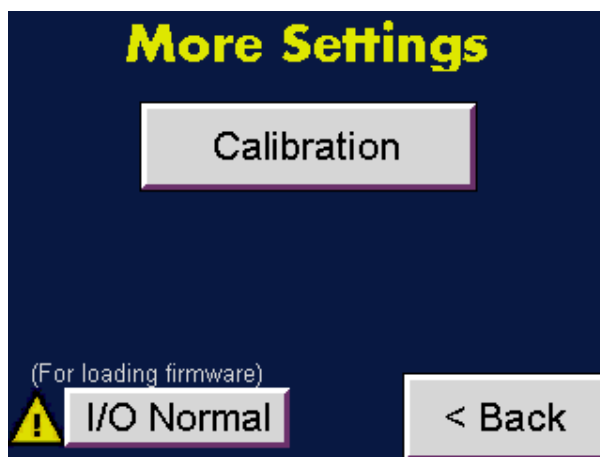
### Changing the Date and/or Time

To change the date and time, follow these instructions:

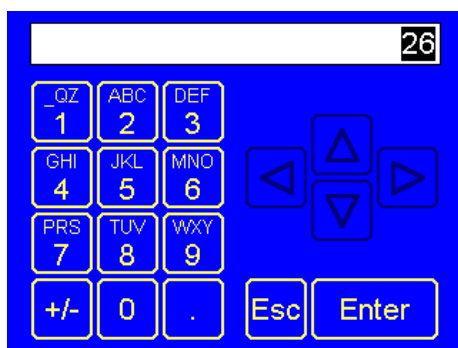
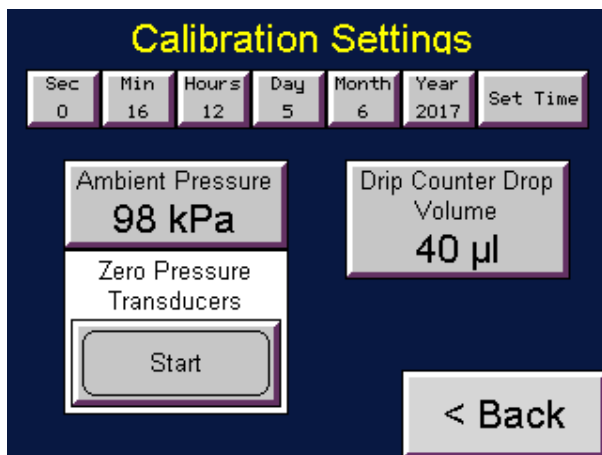
1. Press **F2**.
2. On the **Device Settings** screen touch **More Settings**.



3. On the **More Settings** screen touch **Calibration**.



4. On the **Calibration Settings** screen touch **Sec** to change the seconds, **Min** to change the minutes, **Hours** to change the hours, **Day** to change the day, **Month** to change the month, and **Year** to change the year. Use the on-screen keypad to enter a value for any of the parameters you wish to change, then touch **Enter**.



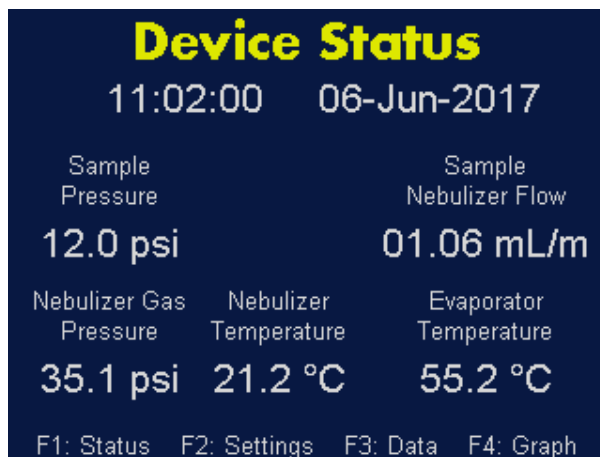
Note:  $\Delta$   $\nabla$  buttons index the temperature.  $\triangleleft$   $\triangleright$  buttons set the cursor.  $\pm$  sets the sign on the number.

5. Press **Set Time**. The date and time appear below the heading on the **Device Status** screen.

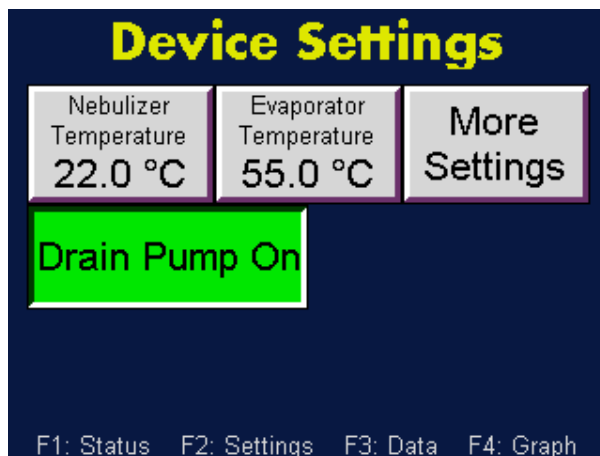
### Calibrating the Drip Counter Drop Volume

The **Drip Counter Drop Volume** is set at the factory and is used to calibrate the drip flow meter used to indicate the flow rate to the nebulizer module. If necessary, the Drip Counter Drop Volume can be calibrated using a peristaltic injection pump. To calibrate the drip counter drop volume, follow these instructions:

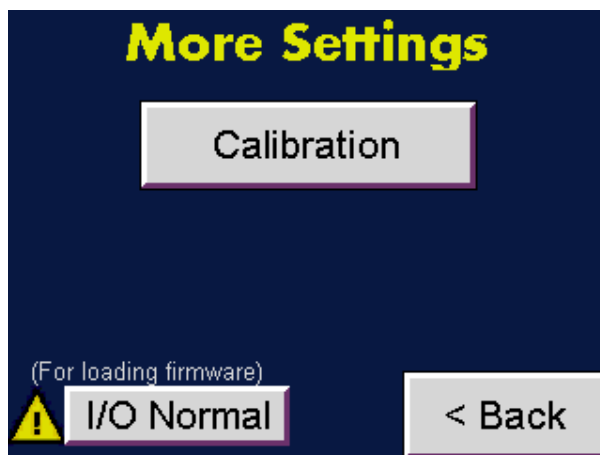
1. Inject a set volume flow rate using the peristaltic injection pump set at 1 ml/min of UPW into the **Sample** inlet.
2. After 2 minutes, record the **Sample Nebulizer Flow** rate displayed on the **Device Status** screen. Note: You will use this information in step 6.



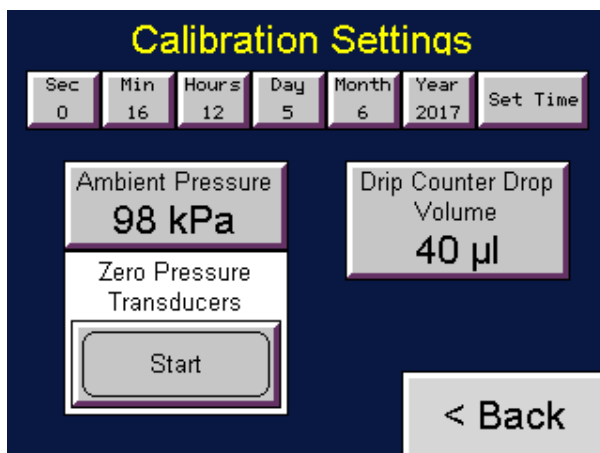
3. Press **F2**.
4. On the **Device Settings** screen touch **More Settings**.



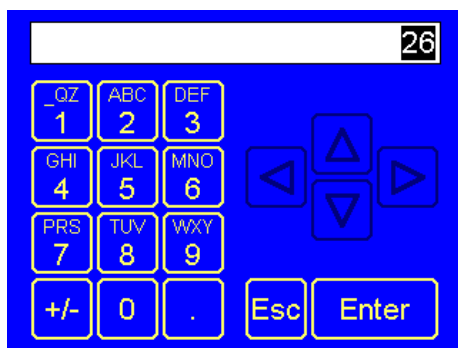
5. On the **More Settings** screen touch **Calibration** to see the **Calibration Settings** screen.



6. Calculate the new **Drip Counter Drop Volume** using the following formula:  
$$\text{Drip Counter Drop Volume (New)} = \text{Drip Counter Drop Volume (Old)} \times \frac{\text{Pump flow}}{\text{Sample Nebulizer Flow rate reading}}$$
7. On the **Calibration Settings** screen, touch **Drip Counter Drop Volume**.



8. Use the on-screen keyboard to change the **Drip Counter Drop Volume** to the Drip Counter Flow (new) value calculated in step 6 above.



Note:  $\Delta$   $\nabla$  buttons index the value.  $\triangleleft$   $\triangleright$  buttons set the cursor.  $\pm$  sets the sign on the number.

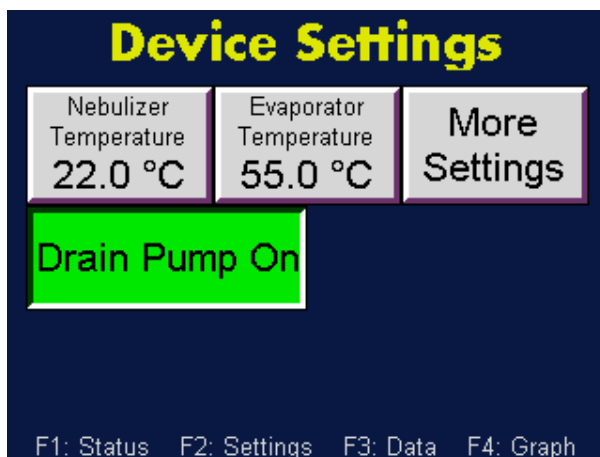
9. Wait two minutes and then check the **Sample Nebulizer Flow** on the **Device Status** screen. The Sample Nebulizer Flow should match the peristaltic pump flow. (Note: 1ml/min suggested in step 2 above.)

### Setting the Nebulizer Gas Pressure to Zero

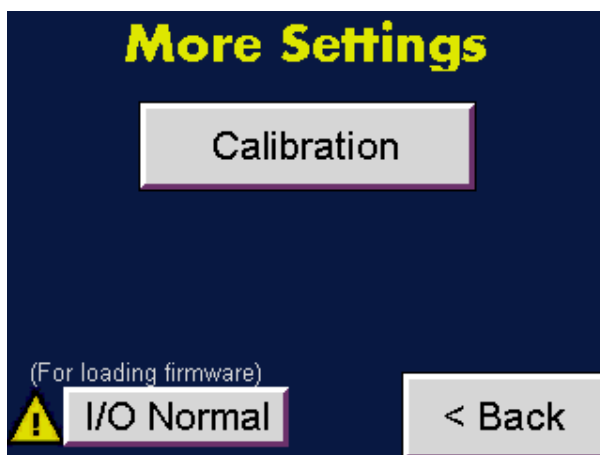
If the air supply to the instrument is turned off, the **Nebulizer Gas Pressure** on the **Device Status** screen should be zero. If it is not, you must recalibrate the baseline of the pressure transducer (reset the Nebulizer Gas Pressure to zero),

To reset the Nebulizer Gas Pressure to zero, follow these instructions:

1. With the air supply turned off, press **F2**.
2. On the **Device Settings** screen, touch **More Settings**.



3. On the **More Settings** screen, touch **Calibration**.

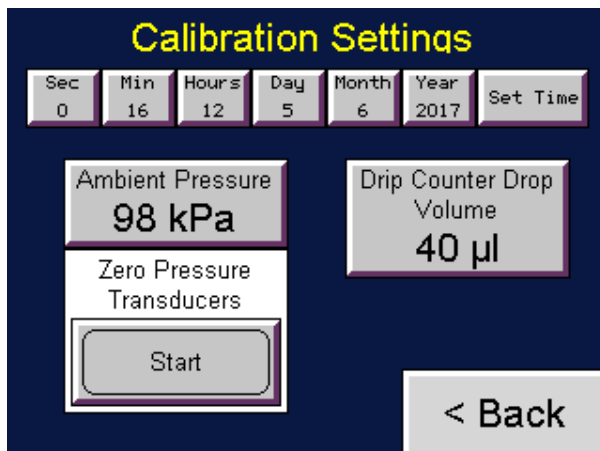


4. On the **Calibration Settings** screen touch the **Ambient Pressure** button. Use the on-screen keyboard to enter the ambient pressure value and then press **Enter**.





5. Touch the **Zero Pressure Transducers Start** button. The zero is reset.

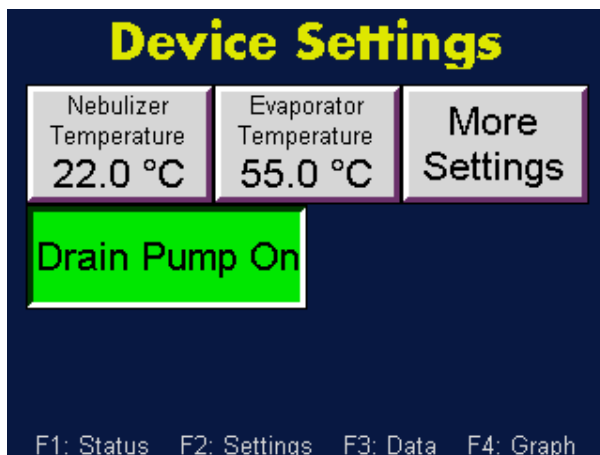


6. Press **F1** and check that the **Nebulizer Gas Pressure** is 0 on the Device Status screen.
7. Press **F2>More Settings>Calibration**. On the **Calibration Settings** screen touch the **Zero Pressure Transducers** button to end the reset.
- 3.

### Managing Internal Pump Life

The NanoAerosol Generator contains a solenoid-type liquid pump to remove sample that has been nebulized but removed from the aerosol before evaporation. Note: Only 0.1% of the nebulized sample is aerosolized and measured by the device. The pump has a finite life which can be extended by turning off the pump when no liquid sample is being delivered to the system. To turn the drain pump on/off, follow these instructions:

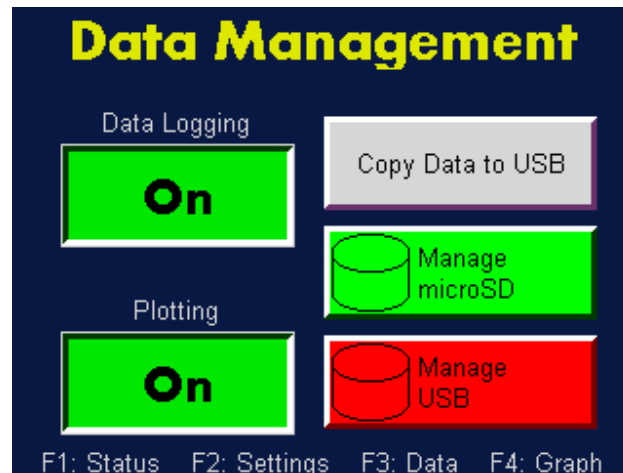
1. Press **F2**.
2. On the **Device Settings** screen, touch the **Drain Pump On/Off** toggle button to turn the pump On or Off.



### Data Collection and Data Plotting

On the front panel, press **F3** to see the **Data Management** screen.

Figure 11: NanoAerosol Generator Data Management Screen.

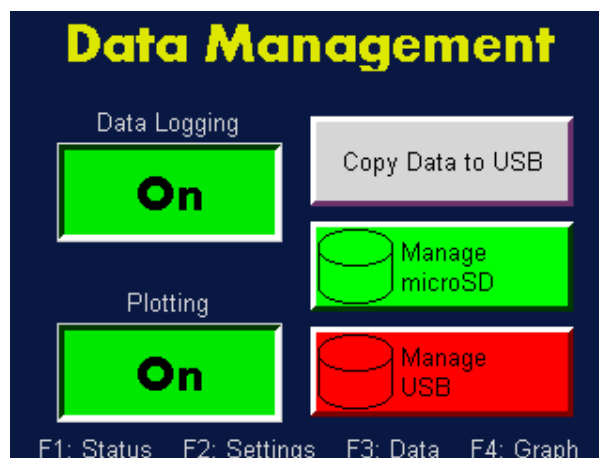


When the data logging function is turned on, the NanoAerosol Generator stores status data in its internal memory. You can transfer the stored data to an external Flash memory drive. The sample pressure, temperature, and drip rate data can be viewed as either a 2-hour or 12-hour trend plot. To see the trend plot, press **F4**. For more information, see **Viewing Graphs** on page 39.

#### Turning Data Logging On/Off

To turn data logging on/off, follow these instructions:

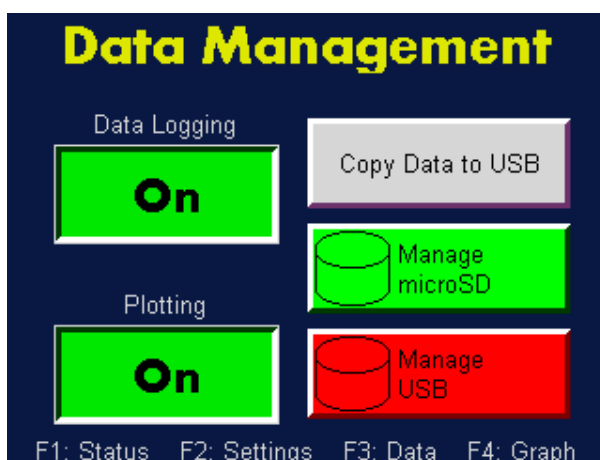
1. Press **F3**.
2. On the **Data Management** screen touch the **Data Logging On/Off** toggle button to turn data logging On or Off.
- 4.




### Managing Internal Memory

To manage the internal memory you can view the data record files, check the available memory and the total memory used, format the drive, and delete the stored data. To manage the stored data, follow these instructions:

1. Press **F3**.
2. On the **Data Management** screen touch **Manage microSD**.



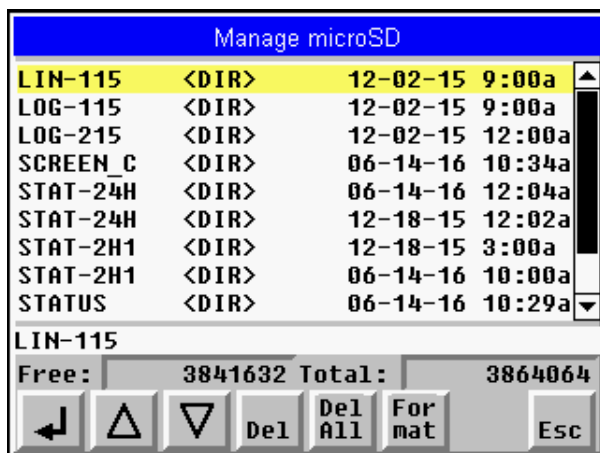
3. A list of data folders is displayed on the Manage microSD screen. Use the  $\Delta$   $\nabla$  arrows to scroll between the folders and then press  (Enter) to see the contents of the folder. Note: The data files for each day that data was collected are displayed in comma delimited records.

**Free:** indicates the amount of memory available in kB.

**Total:** indicates the memory usage in kB.

**Del** deletes the selected folder or data file.

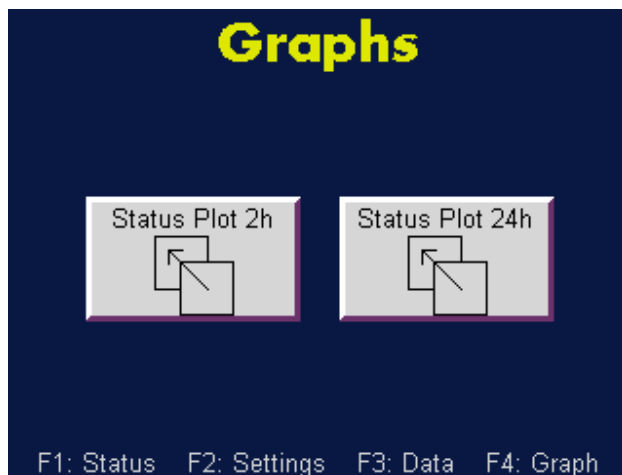
**Del All** deletes all folders or data files.



### Viewing Graphs

On the front panel, press **F4** to see the **Graphs** screen.

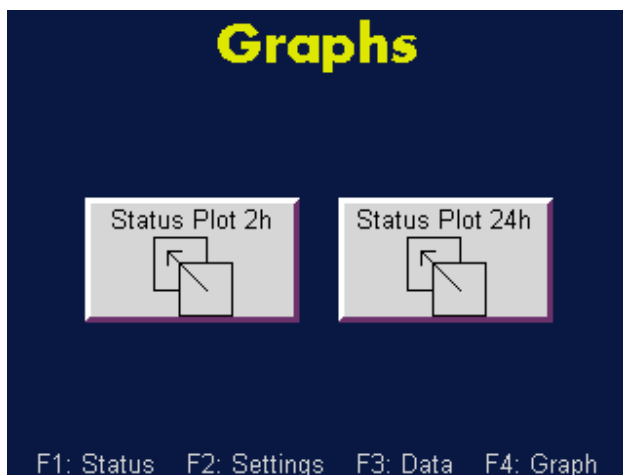
Figure 12: NanoAerosol Generator Graphs Screen.



When the data plotting function is turned on, the NanoAerosol Generator displays either a two-hour or a 24-hour status graph.

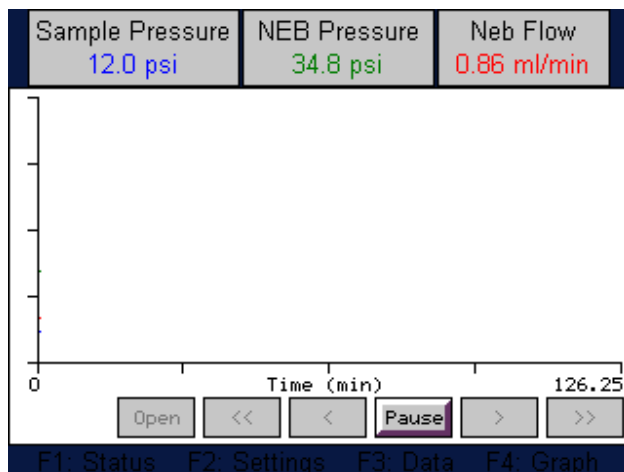
To view graphs, follow these instructions:

1. Press **F4** to see the **Graphs** screen.

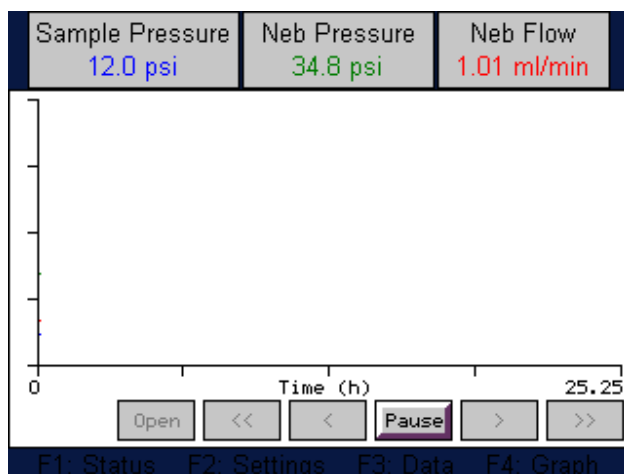


2. Touch **Status Plot 2h** to see a plot of nebulizer pressure, sample temperature and nebulizer flow (Neb Flow) over a two-hour period.

## NanoAerosol Generator: Operation



Touch **Status Plot 24 h** to see a plot of nebulizer pressure, Sample temperature and Nebulizer flow (Neb Flow) over a twenty-four-hour period



Note: Nebulizer Pressure is plotted with a blue line, Sample Temp is plotted with a green line and Neb Flow is plotted with a red line.

5.

### Sample Introduction

Injection of a sample into the NanoAerosol Generator can be accomplished using a pressurized vessel, peristaltic pump, or syringe drive pump. Note: Only a pressurized vessel is shipped with the NanoAerosol Generator; peristaltic pumps and syringe drive pumps must be purchased separately and are available from Kanomax FMT Inc.



**Warning:** Do not inject sample without first confirming that the Nebulizer Gas Pressure is set to 35 psi.

**Figure 13: Pressure Vessel Configuration with the NanoAerosol Generator.**

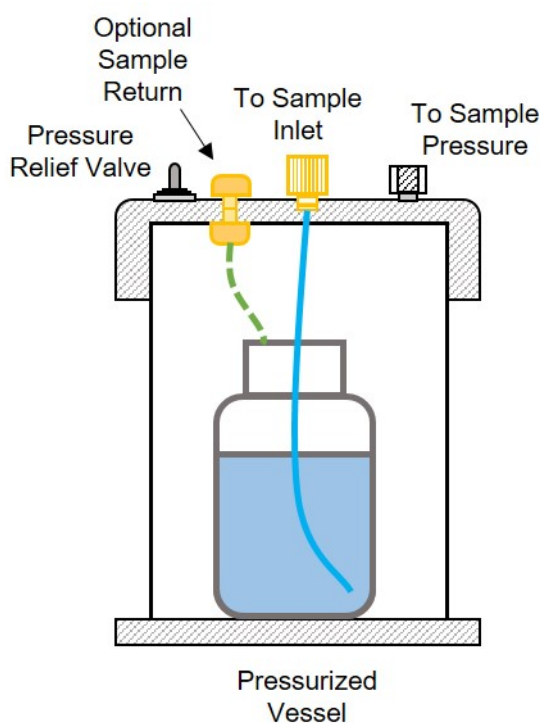


Figure 14: Pressurized Vessel Setup with Recycled Waste.



Sample bottles used in the pressurized vessel may vary in size and may be glass or plastic; they are not supplied by Kanomax FMT Inc. The injection rates for either a syringe or peristaltic pump should not exceed 2 ml/min. Lower flow rates result in smaller droplets and lower aerosolization rates. When the sample is introduced from the pressurized vessel, the vessel pressure should match the normal online sample pressure (12 psi). Figure 10 shows a pressure vessel configuration.

Note: The vessel must withstand the total pressure which can be supplied by the compressed air system.

### How to Shut Down the NanoAerosol Generator for Moving or Shipping

If you need to move the NanoAerosol Generator to another lab or facility, or ship it for service, read this section to familiarize yourself with the precautions you should take and the procedures you should follow.

Performing any of the following improper handling techniques may damage the instrument and will invalidate the warranty:

- Shipping/transporting an undried/undrained instrument.
- Tipping > 30° during normal operation.
- Subjecting an undried/undrained instrument to freezing temperatures.

To prepare the NanoAerosol Generator for shipping, follow these instructions:

1. Turn the **Sample Pressure** switch to Off.
2. Press **F1** to see the **Device Status** screen and wait for the Sample Pressure and Sample Nebulizer Flow to be zero.
3. Keep the power turned on and the compressed air flowing into the **Air Inlet** on the back panel. Operate until liquid is no longer present in the waste line.
4. Disconnect and remove all tubing between the pressurized vessel and the NanoAerosol Generator.
5. Insert the supplied drain plug fitting into the **Shipping Drain**. Water will drain from the fitting. Tilt the device towards the back to allow the nebulizer module reservoir to empty completely. Note: If necessary, you can install tubing to take the waste flow to a suitable drain. Remove the drain plug fitting when the water has finished draining.
6. Disconnect the air or nitrogen supply line and turn off the power.
7. Disconnect the power cable.
8. Place all the caps that you received with the instrument on the inlets and outlets to prevent contaminants from entering the instrument. **Note:** If you did not save the original protective caps, find suitable alternatives.
9. The NanoAerosol Generator is now prepared for shipping or moving.
10. Place the instrument in its original packing materials for shipping.

If you have any questions about shipping or moving the NanoAerosol Generator, contact Kanomax FMT, Inc. at 651-762-7762. (Customers in Asia please call +81 6-6877-0183.)

6.



## Troubleshooting

All repair and maintenance of the NanoAerosol Generator must be performed by a qualified service technician. When working with the NanoAerosol Generator:

- Do not remove any parts from the instrument unless this manual tells you to do so.
- Do not remove the instrument housing or covers while power is supplied to the instrument.

Problem	Cause	Action
Water leaking from NanoAerosol Generator.	Loose fitting.	Check all fittings and tighten any that are loose. Note: Do not over-tighten.
Water leaking from base of NanoAerosol Generator.	Waste pump not operating correctly or sample flow is too high	See Inspecting the Waste Outlet Pump on page 46.
Sample pressure > or < desired operating pressure $\pm$ 0.1 psi.	Sample pressure changed.	See Changing the Sample Pressure/Nebulizer Flow on page 26.
	Sample pressure not able to reach set point.	Check the pressurized vessel and all connections along the sample introduction line for leaks.
Nebulizer gas pressure not reading 35 psi.	Gas supply pressure changed.	See Adjusting the Nebulizer Gas Pressure on page 26.
Evaporator temperature does not reach set point (nominally 55°C).	Nebulizer evaporator may be flooded or sample flow too high.	Check the drain pump operation. See (See Inspecting the Waste Outlet Pump on page 46.)
Water present in aerosol output fitting.	Nebulizer evaporator may be flooded.	Check the drain pump operation. (See Inspecting the Waste Outlet Pump on page 46.)
Nebulizer Flow is 0.	Sample pressure is too low.	If no liquid is present in the sample tubing from the pressure chamber and bubbles are seen in the sample vial, increase the chamber pressure until liquid flows. Do not exceed 18 psi.

## Troubleshooting

Nebulizer Flow is 0 (continued).	Liquid not draining correctly.	If no liquid is present in the drain line, confirm the drain pump is set to On in the Device Settings screen. Confirm that the Nebulizer Gas Pressure is at 35 psi.
	Sample flow rate too high.	If liquid is present in the drain line but no bubbles are observed, the sample flow is exceeding the drain pump flow rate. Reduce the Sample Pressure until bubbles are observed in the drain line.
NanoAerosol Generator unable to hold set point temperature.	Extreme ambient temperature conditions or defective cooling components.	Contact Kanomax FMT, Inc. for instructions.
NanoAerosol Generator does not recognize external USB Flash drive	<b>Media Card not Present</b> is displayed on <b>Manage Data-&gt;Manage USB</b> screen.	Power cycle the NanoAerosol Generator.
Aerosol output is erratic.	Drip counter trap may not be set.	Verify that the Shipping Drain is capped.
	Flow and or pressure at Aerosol Output is not in the specified range.	The aerosol output must be near ambient pressure (+/- 1 cm H <sub>2</sub> O) and within 1-1.5 LPM.

### Inspecting the Waste Outlet Pump (Drain Pump)

If the Waste Outlet is leaking, follow these instructions:

1. Check for the presence of gas bubbles in the waste line and the direction of movement of the gas bubbles.
  - a. If no gas bubbles are present, verify that the pump is clicking. If the pump is not clicking confirm that it is turned on.
  - b. The gas bubbles should only travel away from the Waste Outlet; they should not move back and forth. If gas bubbles rock back and forth there is probably debris in the drain pump valves. Contact Kanomax FMT Inc. for further instructions.

7.

### Appendix A: NanoAerosol Generator Model 3250 Specifications

Peak droplet diameter	< 1.0 micrometer (nominally 0.5 micrometer)
Droplet $dN/d\log D_p > 10\mu m$	< Peak $dN/d\log D_p \times 10^{-5}$
Inspection volume rate	0.2-1.0 $\mu L/min$
Nebulizer Flow Rate (direct)	0.5-3.0 mL/min
Aerosol Flow Rate	1.0 – 1.5 LPM
Response time to concentration change	< 90 seconds
Compressed air flow rate/pressure	3 std L/min CDA or Nitrogen, (345-414 kPa, 50-60 psi)
Wetted Surface Materials	PFA Teflon®, PTFE, sapphire, 316L, stainless steel, PEEK, Acetal, Polypropylene, EPDM
Ambient Temperature Range	15-35°C, 59-95°F
Ambient Relative Humidity Range	0-85%
Dimensions (WxDxH)	23 (9) x 23 (9) x 35.5 (14) (46 (18) with fittings)
Weight	6 kg (13.2 lb)
Power	Universal 100 - 230 VAC 50/60 Hz, 90 W max
Internal storage	Micro SD with USB port access
Shipping Drain	¼ inch colder connector
Compressed Air inlet	¼ inch SS Swagelok®
Sample Pressure inlet	1/8 inch SS Swagelok®
Display	3.5 inch TFT Color, touch panel

Swagelok® is a registered trademark of Swagelok Company.

Teflon® is a registered trademark of E.I. DuPont de Nemours and Company, Inc.

Windows® is a registered trademark of Microsoft Corporation.

Specifications subject to change without notice.

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