

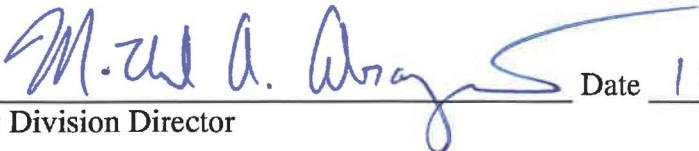
Standard Operating Procedure 2.49
Section 2:
BGI TetraCal Standard Procedures for Operators

Revision 2020



Standard Operating Procedure Approval

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1.0 SCOPE AND PURPOSE

The fundamental requirement of an air monitoring program is knowing how much pollution is in a sample of air so that the appropriate measures can be taken to eliminate or reduce it. Because knowing the volume of air is so fundamental to determining concentrations of particulate matter pollutants, calibration is a critical process. All instruments that use active flow control require regular flow checks and calibrations of flow, pressure and temperature to ensure that the data they produce is accurate and repeatable.

The objective of this Standard Operating Procedure (SOP) is to familiarize the operator with the operation of the BGI TetraCal flow device. The accuracy of data obtained from any instrument depends upon the instrument's performance and the operator's skill. It is important that the operator become familiar with both this SOP, as well as the monitor's operation manual in order to achieve a high level of data quality.

2.0 DESCRIPTION AND SETUP

2.1 Description

All BGI by Mesa Labs devices are based on the air flow measurement principle of the venturi. The calibrator measures volumetric flow rate by utilizing a pressure transducer to assess the pressure drop caused by air being drawn through a venturi. As the flow rate through the venturi increases, the pressure drop increases. Twice the flow rate yields four times the pressure drop. A desirable feature of the venturi is that most of the pressure drop created by the instrument is recovered in the expansion section of the venturi. Therefore, measurements are made at essentially the actual operating conditions of the sampler.

The signal from the pressure transducer is sent to the microprocessor which incorporates the barometric pressure and ambient temperature to calculate a standardized flow rate. To eliminate fluttering during the display of the volumetric flow rate, the first 20 readings are averaged and then carried on as a rolling average. Barometric pressure and temperature are monitored and displayed on a continuous basis.

The instrument provides an LCD indication of volumetric flow rate, standard flow rate, barometric pressure and ambient temperature, and filter temperature in some models. The unit is furnished with three auto ranging venturis and operates on either four AA alkaline batteries or a provided AC power module.



Figure 1. BGI TetraCal with Accessories.

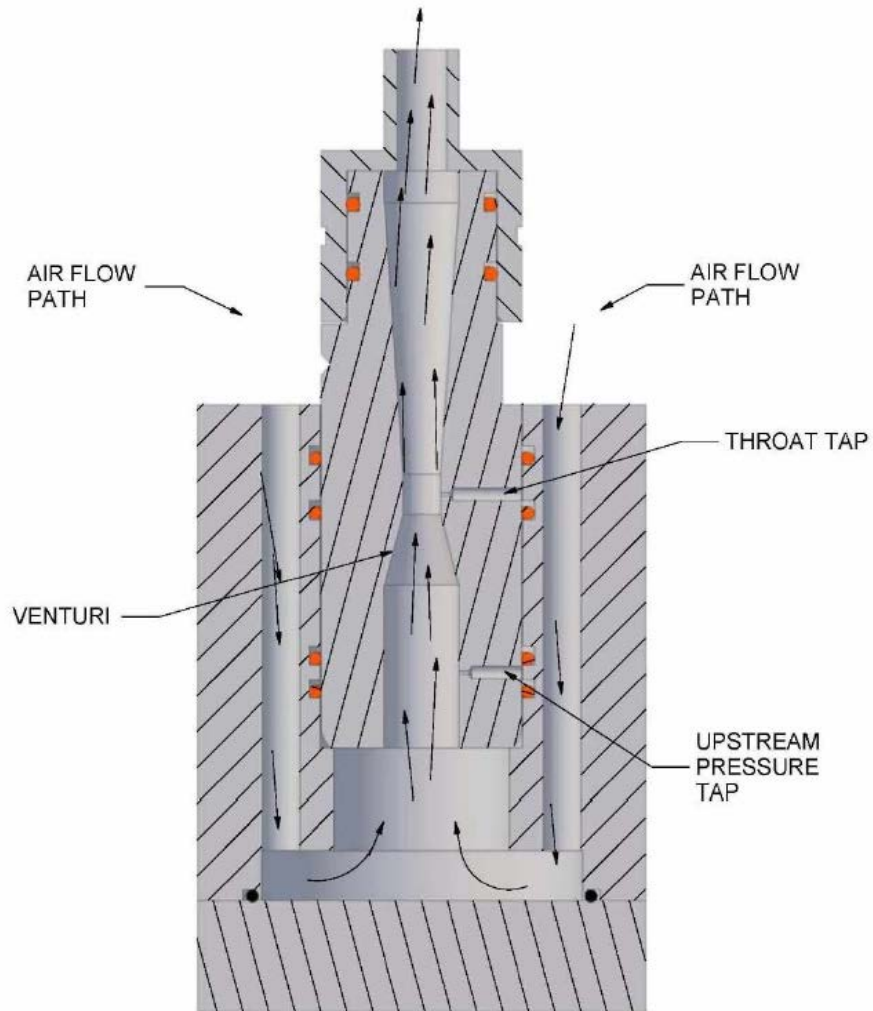


Figure 2. Venturi Cross Section.

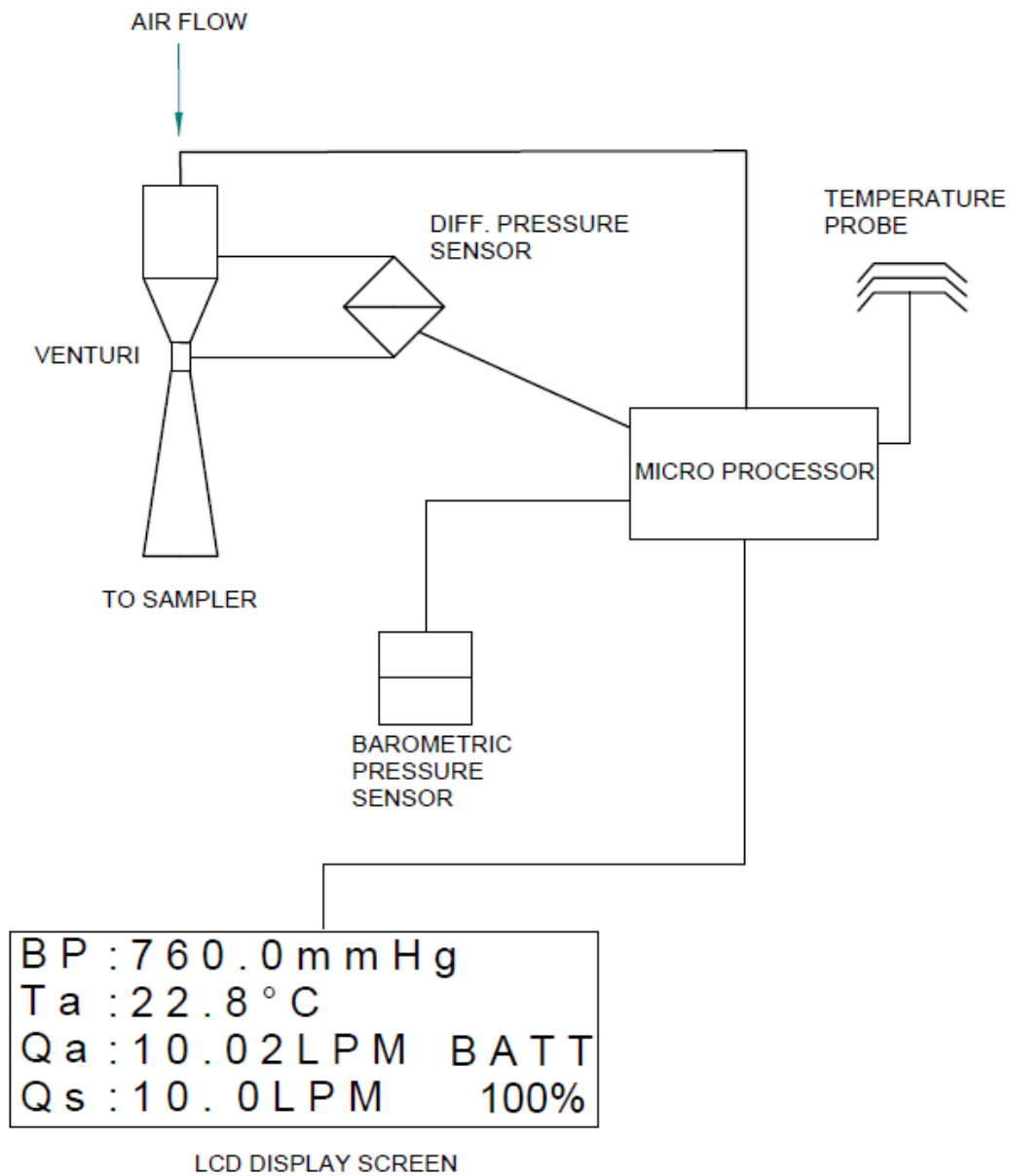


Figure 3. Schematic Diagram of the System.

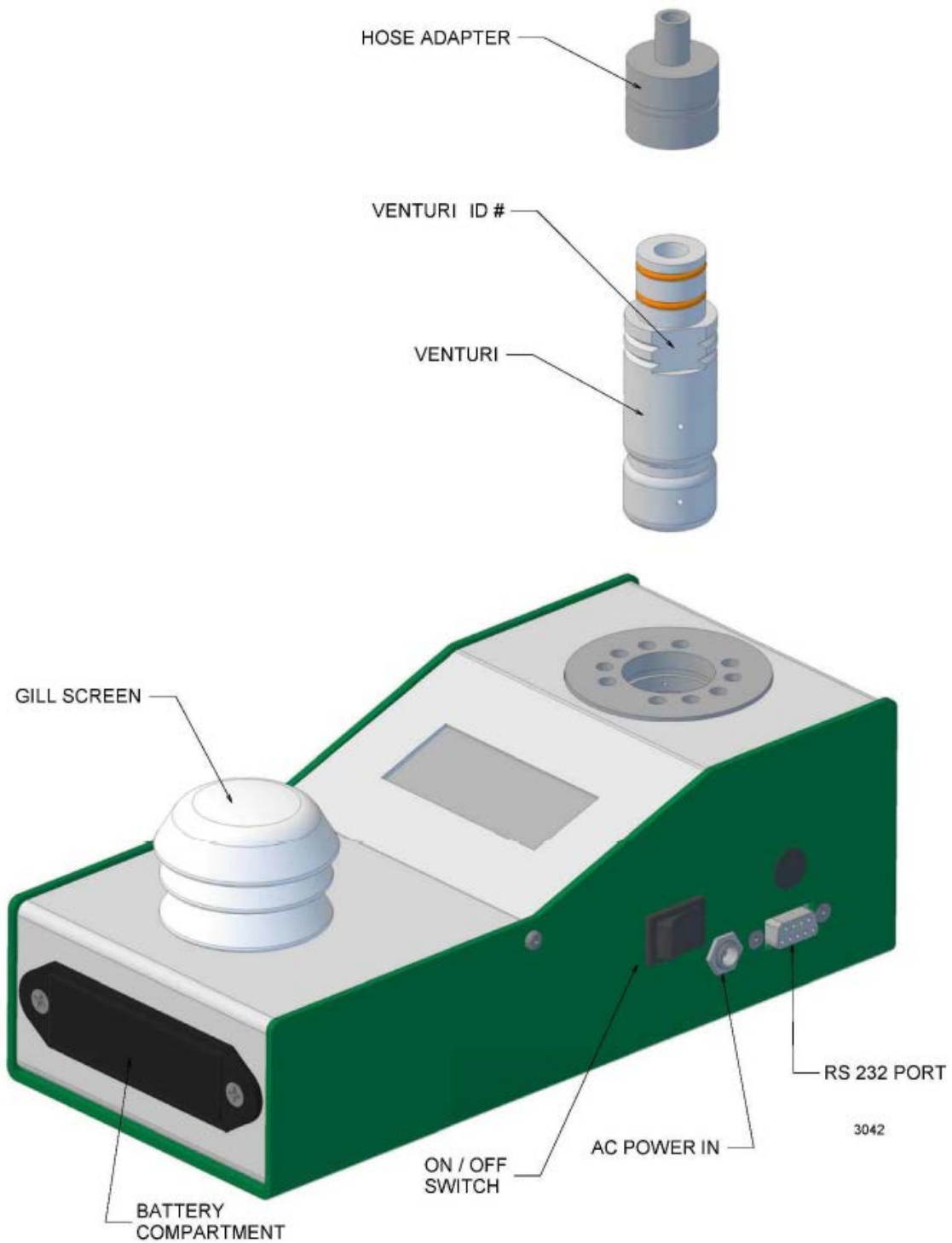


Figure 4. BGI TetraCal.

2.2 Setup

1. Remove the instrument from its carrying case. If the instrument is to be used in the laboratory, plug the power supply into a power source, otherwise it will operate from its AA batteries.
2. Plug the temperature probe into the port above the RS-232 port.



Figure 5. Temperature Probe Cable and Port.



Figure 6. Venturi and Adapters.

3. Select a venturi for the flow range of interest. Each venturi is marked with a number indicating the range:

1 = 6 – 30 LPM

2 = 1.2 – 6 LPM

3 = 0.1 – 1.2 LPM

4. Select a hose adapter for the venturi to match the tubing that will connect to the flow audit adapter. Be certain that the o-rings are lubricated and connect the adapter to the venturi.
5. With the serial and venturi numbers held right side up, insert the venturi into the hole in the top of the unit. Be certain that there is sufficient lubricant on the o-rings within the recess.
6. Turn the TetraCal on. At this point the instrument will automatically restart and auto range to the selected venturi. The final screen will then appear as follows:

B	P	:	7	6	0	.	0		m	m	H	g		
T	a	:	2	2	.	8	°	C						
Q	a	:	1	0	.	0	2	L	P	M	B	a	t	t
Q	s	:	1	0	.	0	0	L	P	M	1	0	0	%

Figure 7. BGI TetraCal Home Screen.

7. The ambient temperature (Ta) and the probe temperature (Tf) will display alternately in the screen.
8. Two flow rates (Qa and Qs) will be shown at the bottom. Volumetric flow (Qa) will be listed first. Standard flow (Qs) will be listed second. **Always use the first flow listed; volumetric flow (Qa).**

3.0 SUMMARY INFORMATION SPECIFIC TO THE INSTRUMENT



Figure 8. Zeroing the Flow.

Important notes about using the TetraCal:

- A. **When the unit is turned on, the venturi must have no air flowing through it.** Every time the instrument is switched on, it will re-zero itself. If air is flowing through the venturi when the unit is turned on, that flow rate will be set as zero.
- B. The control module must be level when switching on and when in use. The case houses the pressure transducers, which are subject to the force of gravity. Positional changes can give rise to minor errors. This effect applies to all devices containing pressure transducers.
- C. In order to achieve the most precise measurements, the TetraCal must be in thermal equilibrium with the ambient environment of the sampler to be audited. To achieve this equilibrium, remove the TetraCal from its carrying case **for at least 10 minutes prior to performing measurements.** The unit should be placed in a shaded spot near the general area of the sampler. Additionally, if the TetraCal is subject to a temperature change of more than five degrees during use, it should be restarted.
- D. When the calibrator is switched on, and no external power is being utilized, XX % battery capacity remaining is displayed on the screen. So long as more than 10% is indicated, you may perform your measurements; at least one hour of power is still available. If the provided AC adaptor is utilized, the screen will indicate “DC In” and there is no run time limit.

Note: Use of an AC power supply, other than the one provided, can cause severe damage to circuit components.

The four AA batteries should only be replaced with good quality alkaline energy cells and should be promptly removed when expired, to prevent leakage and chemical damage to the electronic components. When the instrument is placed in long term storage over two months, always remove the batteries. Do not substitute other power supplies. Use only the unit provided or severe electrical problems could occur.

Even though there is no reason to disassemble the electronics box, should the need arise, always unplug the line current power supply and remove the batteries. Adjustable potentiometers are contained within the electronic housing, which are factory set during calibration. If these are turned, the calibration will be lost and factory recalibration will be required.

4.0 OPERATION

One of two procedures can now be performed:

Procedure A.

1. With the monitor not running, using the elastomeric tubing and flow audit adapter, connect the TetraCal to the monitor under assessment.
2. Switch on the TetraCal. Wait for the unit to finish the startup process.
3. Turn on the monitor's pump.
4. Once the monitor's flow rate stabilizes, the reading may be taken from the TetraCal.

Procedure B.

1. Switch on the TetraCal. Wait for the unit to finish the startup process.
2. With the monitor running, using the elastomeric tubing and flow audit adapter, connect the TetraCal to the monitor. The flow resistance of the TetraCal may cause momentary instability in the monitor's flow control circuit.
3. Once the monitor's flow rate stabilizes, the reading may be taken from the TetraCal.

5.0 MAINTENANCE

Beyond battery replacement, the only part of the instrument requiring attention is the flow passage through the venturi. After long periods of use, some atmospheric dust can coat the interior flow surfaces. The presence of such a deposit may be ascertained by viewing the interior of the venturi under bright light; direct overhead sunlight being preferable. Glance into the interior, from either end, seeking any discoloration of the white or silver surface. If it is determined that cleaning is required, use the following procedure:

1. Rinse the entire venturi body in warm soapy water.
2. Any external deposits, which are not floated away, may be removed with a soft cloth.
3. If internal deposits are not removed by soaking, the best procedure is to immerse the unit in an ultrasonic bath containing soapy water. If an ultrasonic bath is not available, judicious use of a pipe cleaner is recommended.
4. Following cleaning, the venturi may be dried utilizing compressed air, or if not available, allowed to air dry.
5. Inspect the two o-rings on the venturi body. If any damage is observed, replace both.
6. Prior to reassembly, lubricate the o-rings with a wipe of grease.
7. There are two points which require careful lubrication. These points are the two o-rings at the top of each venturi to which the tubing adapter is attached and the four o-rings inside the socket into which the venturi is inserted. They should be sparingly lubricated with the tip of the finger.
8. Silicone grease seems to be the most successful all around lubricant.

The TetraCal is a NIST-traceable high-precision standard with a few moving parts. The calibration certificate received with the unit is valid for one year from the date of certification. Environmental factors, product wear, drift of sensors or inadvertent damage may adversely affect your device's measurement accuracy or general performance.

For these reasons, Mesa highly recommends that you return your TetraCal to their manufacturing and calibration facility in Butler, NJ on an annual basis to ensure its measurement integrity. Recertification at Mesa Lab's facility includes any necessary repairs, with the exception of replacing the electronic boards, which will incur a fee. All TetraCals returned to the manufacturer for recertification will receive both a pre- and post-calibration.

6.0 DATA HANDLING

All BGI calibrators are designed to operate with the OpenCal software. The software allows the user to change the display units for flow, temperature, and pressure. You can also view and save a real-time data stream. To download this data, visit Mesa Lab's website at:

<http://bgi.mesalabs.com/software/>.

All calibrators with the letter P in the Version number of the start-up screen are equipped with user selectable display parameters. All units are shipped from the factory with the following default parameters installed:

B	P	:	7	6	0	.	0		m	m	H	g		
T	a	:	2	2	.	8	°	C						
Q	a	:	1	0	.	0	2	L	P	M	B	a	t	t
Q	s	:	1	0	.	0	0	L	P	M	1	0	0	%

Figure 9. Default Parameter Display.

To change these measurement units, the BGI OpenCal software may be downloaded at bgi.mesalabs.com/software.

After you have downloaded this software, connect your calibrator to your computer with either an RS-232 serial cable or a USB-serial adapter prior to opening the software.

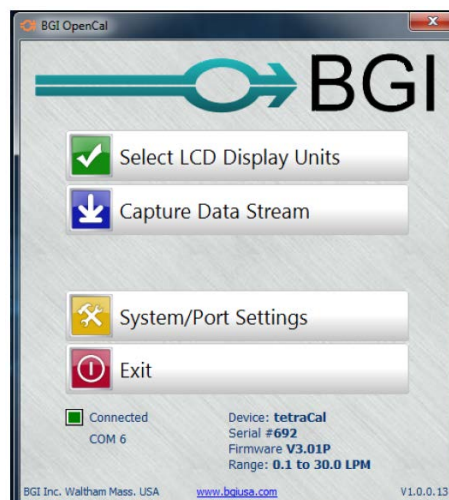


Figure 10: BGI OpenCal Home Screen.

If the connection is successful, a green box and the number of the com port will be displayed. You will also see the details of your calibrator.



Figure 11. Calibrator Information.

In the event that a com port is not automatically selected, select:



Figure 12. Settings Tab.

Click on it to go to:



Figure 13. System Setup Screen.

If there is no com port displayed, set the cursor on the down arrow to select the correct com port. Save this setting before exiting this screen.

In the future when the same calibrator is connected to the same computer a port connection will be instantly established. You may now select:



Figure 14. Units Tab.

Clicking on this icon will open the parameter selection area and permit a wide variety of measurement units to be displayed. The initial display will be the factory default values. **At this point it is important to note that these parameters may all be changed while air is flowing through the instrument.** This is a useful feature as it may aid the investigator to achieve a better "feel" for the most favorable units to utilize.

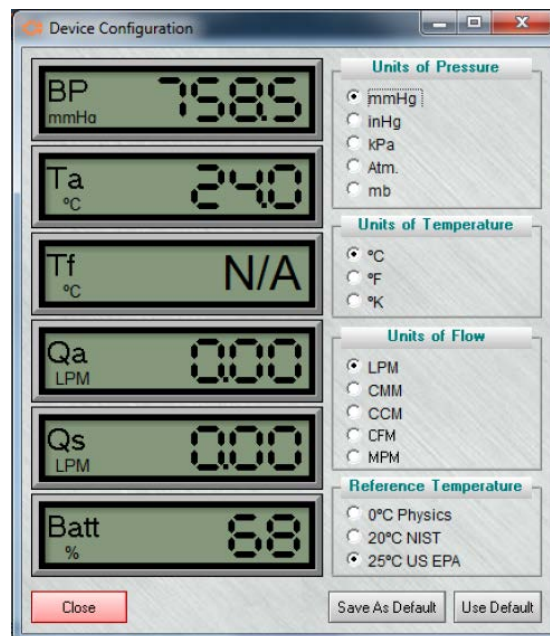


Figure 15. Configuration Screen.

Five choices of units of pressure are available:

mmHg – Millimeters of Mercury

inHg – Inches of Mercury

kPa – Kilo Pascals

Atm – Atmospheres

mb – Millibars

Three choices of units of Temperature are available:

°C – Celsius,

°F – Fahrenheit

°K – Kelvin

Five choices of flow rate units are available:

LPM – Liters per minute

CMM – Cubic meters per minute

CCM – Cubic centimeters per minute

CFM – Cubic Feet per minute

MPM – Moles per minute

The reference temperature is the "base" to which the Standard flow rate is presented. Choose the reference temperature that is appropriate for reporting standardized flow to your local air monitoring agency. In the USA and countries that follow the US EPA regulations, this temperature is 25°C.

Once your selections have been made, press the “save as default” button and unplug the cable.