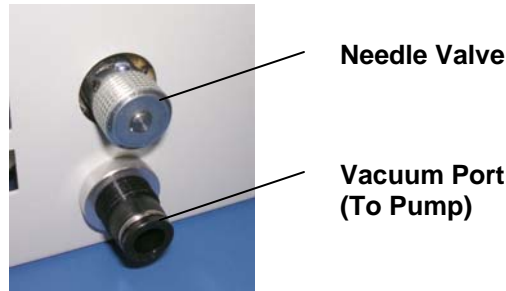


Manual Valve “Metered” Flow Calibrations for BAM-1020



Manual flow valve on the back of a BAM-1020

Metered flow calibration is only performed on BAM-1020 units which have a hand-operated manual needle valve on the back panel. This configuration is mostly found on some older PM₁₀ units that were produced before the automatic flow controller was available. All BAM-1020 units produced after 2006 have an automatic flow controller, so this procedure does not apply to newer units. See the BAM-1020 manual.

Because these older units do not have automatic flow control, the calibration procedure is much more complicated than on newer units. The flow must also be more frequently checked due to changes in ambient conditions and filter characteristics, which this type of unit cannot compensate for. Use the following steps for a Metered flow calibration. The process is easier if your reference flow meter can provide standard flow values (25 degrees C, 760 mmHg conditions).

Flow Checks and Adjustments for Metered Flow:

These steps can be used to perform flow check on BAM-1020 units equipped with manual flow valves. The unit will need to be taken out of normal operation during this process:

1. Remove the PM₁₀ inlet head and insert your flow reference device onto the inlet tube.
2. Enter the TEST > TAPE menu on the BAM and advance to a fresh spot of clean filter tape. Then enter the TEST > PUMP screen and turn the pump ON and allow the flow to stabilize for a moment.
3. Record the ambient temperature, ambient pressure, and the EPA standard flow reading from your flow reference device. If your flow meter only shows actual volumetric flow, then convert the actual flow to EPA standard conditions with the formula below:

$$Q_s = Q_a * (P_a / T_a) * (298 / 760)$$

T_a = Ambient Temperature in Kelvin (Celsius + 273)

P_a = Barometric Pressure (mmHg)

Q_a = Actual Volumetric Flow

4. Compare your standard reference flow to the BAM flow reading (shown in EPA standard conditions). Record the results. The two values should match within 2% regardless of the exact flow rate. If they do not match, stop and perform a BAM flow sensor slope and offset calibration as described at the end of this document, then continue to the next steps.



After verifying that the BAM flow values match your audit device in standard conditions, you need to adjust the flow valve on the back of the BAM so that the inlet flow is **17.3 LPM in ACTUAL conditions**. This is because the cut-point on the PM₁₀ inlet is rated at actual flow, not standard flow. The 17.3 LPM flow rate is used to compensate for the fact that the flow will reduce as the tape spot is loaded with dust, while staying within the 16.7 LPM ±4% rating of the inlet. **Note:** Older BAM-1020 manuals incorrectly instructed the user to set the flow valve for 17.5 LPM in standard conditions.

If you check to flow on the BAM-1020 monthly (preferred), then the easiest way to do this is simply to adjust the BAM flow valve so that the inlet flow is 17.3 LPM in actual conditions as measured with your flow reference device, regardless of what the BAM standard flow value says. If you only check the BAM flow on a quarterly or seasonal basis, or if your flow audit device does not show an actual flow, then you need to establish the seasonal flow correction based on typical local temperature and pressure values as described in the next section below.

Flow Compensation for Seasonal Changes:

1. Find out the average daily ambient temperature for the current season at the sample site. Or measure the ambient temperature at approximately 4:00 PM, which usually represents an average daily temperature. Record as **T_a** (Kelvin).
2. Find the average daily barometric pressure for the current season at the sample site. Or record the pressure from the OPERATE > NORMAL screen. Record as **P_a** (mmHg).
3. Calculate a volume correction term by the following formula:

$$V = (T_a / P_a) * 62.4$$

4. Divide V by 24.47 to determine the ratio of EPA flow to typical local actual flow and record as CALNUM.
5. Turn the pump on in the TEST > PUMP menu and allow the flow to stabilize for 5 minutes. Then divide the displayed standard flow value by CALNUM.
6. Adjust the flow adjustment knob on the back of the BAM-1020 until the BAM flow reading equals 17.3 / CALNUM.
7. Exit the TEST menu and put the unit back in operation. Record the results.

Example:

Temp = 300 Kelvin
Pressure = 710 mmHg
V = (300/710) * 62.4 = 26.4
CALNUM = 26.4/24.47 = 1.08
Adjusted Flow = 17.3/1.08 = 16.0 LPM
Adjust flow valve until BAM reads 16.0 LPM.

Adjusting the Flow Sensor Slope and Offset Constants.

If the BAM-1020 standard flow reading does not match your traceable flow reference device standard flow reading within 2%, then the BAM flow calibration constants must be adjusted as described below:

1. Advance the filter tape to a fresh spot.
2. Enter the SETUP > CALIBRATE menu. Set the C_v (flow slope) value to **1.000**, and the Q_0 (flow zero offset correction) value to **0.000**.
3. Disconnect the pump tubing from the back of the BAM, then turn the pump ON in the TEST > PUMP menu. There will not be any air flowing through the BAM. Record the standard flow reading from the BAM display. This is the zero flow Z_f value.
4. If the zero flow value was not 0.0 LPM, then enter the SETUP > CALIBRATE menu and set the Q_0 offset value to equal the negative of the zero flow value Z_f . Then go back to the TEST > PUMP menu and turn the pump back on and verify that the flow reading on the BAM display now reads 0.0 LPM.
5. Reconnect the pump tubing to the back of the BAM. Remove any PM₁₀ and PM_{2.5} heads, and connect your reference flow meter to the inlet tube.
6. Record the ambient temperature T_a (Kelvin) from your reference standard, and record the barometric pressure P_a (mmHg) from the OPERATE > NORMAL screen on the BAM.
7. From the TEST > PUMP menu, turn the pump on and allow the flow to stabilize for 5 minutes. Then record the EPA standard flow from your reference flow meter as Q_s , and record the EPA standard flow reading from the BAM display as Q_b . If your flow meter only shows actual volumetric flow, then convert the actual flow to EPA standard conditions with the formula below:

$$Q_s = Q_a * (P_a / T_a) * (298 / 760)$$

T_a = Ambient Temperature in Kelvin (Celsius + 273)

P_a = Barometric Pressure (mmHg)

Q_a = Actual Volumetric Flow

8. Calculate the final value for C_v :

$$C_v = Q_s / Q_b$$

9. Calculate the final value for Q_0 :

$$Q_0 = -C_v * Z_f$$

10. In the SETUP > CALIBRATE menu, enter the final values for C_v and Q_0 . In most cases, the final value for Q_0 ends up simply being zero.
11. Turn the pump on in the TEST > PUMP menu again and verify that the standard flow reading from the BAM display matches the standard reading from your reference device (Q_s) within 1%. If not, repeat the entire C_v and Q_0 adjustment process.