Application Notes:

# Variable Area Gas Flow Meter Calibration Procedure Using Bios Met Lab® Series Primary Piston Provers

## Introduction:

The flow measurement professional is responsible for calibrating and/or verifying the accuracy of various flow measurement devices, such as variable area gas flow meters (variable area flow meters). This costly, time-consuming process typically involves sending variable area meters out for calibration or verifying them in-house. As the leader in primary gas flow measurement, Bios has developed a simple calibration procedure that combines the precision and high-speed of our Met Lab® Series of primary piston provers with carefully-selected instruments and gauges to enable accurate calibration of variable area flow meters.

## Flow Corrections:

Each variable area flow meter is designed to operate under a certain set of conditions which include the temperature, pressure and the type of gas. Usually, these conditions are documented directly on the tube enclosure of the variable area flow meter, with the flow rate scales referenced in mm (millimeter). A reference table is provided to enable you to match the millimeter readings against the equivalent flow rates at the specified standard temperature and pressure. Otherwise, direct scale variable area flow meters indicate the flow rates directly on the tube enclosure.

When calibrating variable area flow meters using a Bios Met Lab primary piston prover, correction must be applied to the Met Lab's indicated flow measurements in order to take into account the difference between the *actual* temperature, pressure and gas used versus the variable area flow meter's *specified* temperature, pressure, and gas requirements.

To properly calibrate variable area flow meters, refer to the following formula:

Variable Area Flow Meter's Corrected Flow = Variable Area Flow Meter's Indicated Flow X Correction Factor

Where:

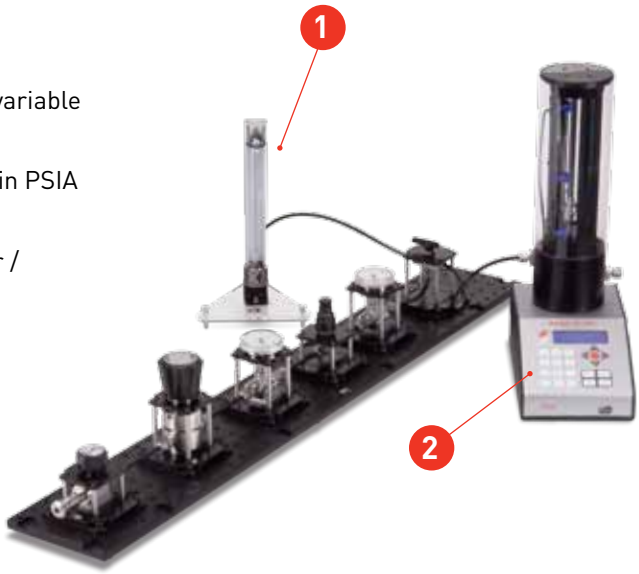
Correction Factor = √ (A x B x C)

Where:

A = The Specific Gravity of the calibration gas as specified by the variable area flow meter / The Specific Gravity of the calibration gas

B = The operating Pressure in PSIA during calibration / Pressure in PSIA as specified by the variable area flow meter

C= Temperature in ºK as specified by the variable area flow meter / Temperature in ºK during calibration




## Equipment required:

1. **Bios Gas Flow Delivery System (part number 100-030)**
2. **Bios Met Lab Series primary piston prover (models ML-800, ML-500 or Definer 220)**

The Bios Gas Flow Delivery System features an on/off valve, precision pressure regulator, high-side and low-side pressure gauges, needle valve, A-B switch (three-way valve), "quick connect" with male and female connectors, and breadboard.

# Variable Area Gas Flow Meter Calibration

## Installation:

### Step 1
Connect and/or verify all device connections. The Bios Gas Flow Delivery System comes with in-series, ¼" tubing connection of the on/off valve, pressure regulator, high-range pressure gauges, needle valve and A-B switch, as well as a "quick connect" with male/female connectors for connection of the on/off valve to the gas cylinder/ compressed air

### Step 2

Connect one end of the A-B switch to the inlet fitting of the variable area flow meter and the other end to the inlet fitting of your Met Lab

### Step 3

Using the quick connect, connect the on/off valve to the gas cylinder/compressed air. Gas inlet pressure should be approximately 80 to100 psi

## Procedure:

### Step 1

Close the needle valve, open the on/off valve and set the gas pressure by adjusting the pressure regulator to above 30 psi

### Step 2

If the variable area flow meter contains a built-in needle valve, open its needle valve fully for unrestricted gas flow

### Step 3

Turn on your Met Lab primary piston prover. Through its Setup menu, set your Met Lab's pressure unit to 'psi' and its flow readings to 'Vol' (Volumetric). For other flow measurement options (such as Continuous readings or the number of readings in the average), consult your Met Lab product manual

### Step 4

Press your Met Lab's **Read** button in order to record the ambient pressure and temperature

### Step 5

Flip the A-B switch to the variable area flow meter and gradually begin to open the needle valve.

### Step 6

Set the variable area flow meter's flow at the desired level using the needle valve. The flow rate is indicated by the point on the printed scale where the float's center stabilizes

### Step 7

Wait one to two minutes for the float to stabilize.
To ensure a particular flow point, flip the A-B switch back and forth a few times to check if the float returns to the previous scale point. If it needs adjustment, adjust the flow using the needle valve

### Step 8

Record the low range pressure gauge's pressure reading (in psia)

### Step 9

If you are not using a direct scale variable area flow meter, record the reflected flow rate reading from the reference flow table against the floating point

### Step 10

Refer to "Flow Corrections" in order to correct the variable area flow meter's indicated flow for the operating temperature, pressure and the type of gas

### Step 11

Flip the A-B switch to your Met Lab. Begin taking flow measurements with your Met Lab.

### Step 12

Determine the full scale accuracy of the variable area flow meter using the following formula:

% Accuracy = (Met Lab's Flow Measurement - Variable Area Flow Meter's corrected flow reading)*100 / Variable Area Flow Meter Full Scale %

## Application Notes:

- We recommend taking a minimum of ten flow measurements in an average. The more measurements in the average, the better the calibration results
- Allow the Met Lab to stabilize before beginning a calibration
- When calibrating a variable area flow meter, it's best to use its specified calibration gas (calibrating with a surrogate gas can add greater uncertainty). If a surrogate must be used, we recommend using one with specific gravity similar to the gas the variable area flow meter is designed for

# An Alternative Method of Calibrating Variable Area Flow Meter at Rated Temperature and Pressure Using MetLab Series Primary Piston Prover

## Introduction:

The previous Bios method recommends calibration of a variable area flow meter (rotameter) by applying a correction factor to the Met Lab's indicated flow reading for temperature and pressure, without subjecting the rotameter to the pressure specified for the variable area flow meter. This procedure is recommended as an alternative method for rotameter calibration where it will be subjected to its rated pressure using the Bios back pressure module. The back pressure module consists of a back pressure regulator and a pressure gauge

## Flow Corrections:

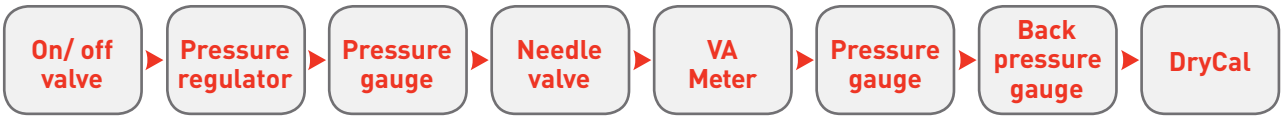
Each variable area flow meter is designed to operate under a certain set of conditions which include the temperature, pressure and the type of gas. Usually, these conditions are documented on the tube enclosure of the rotameter. A reference table is provided to match the millimeter readings against the equivalent flow rates at the specified temperature and pressure. Otherwise, direct scale variable area flow meter indicates the flow rates directly on the tube enclosure.

When calibrating a rotameter using a Bios MetLab piston prover, a flow correction factor (FCF) must be applied to the MetLab's indicated flow measurement in order to take into account the difference between the actual temperature versus the rotameter's rated temperature.

In this procedure, no correction is applied for the pressure as the equipment set up is designed to calibrate the rotameter at rated pressure. Correction is applied to the MetLab's indicated flow measurement only when the actual gas temperature differs to its rated temperature.

Flow correction factor, FCF = 1/ √ {(calibration temp in 0F +460)/ (operating temp in 0F +460)}

## Set up diagram:




## Equipment required:

**1. Bios Gas Flow Delivery System, consists of on/off valve, pressure regulator, pressure gauge, needle valve**

**2. Back pressure regulator and pressure gauge**

**3. Bios Met Lab series Primary Piston Prover ( Models ML-800, ML-500, or Definer 220)**

## Installation:

### Step 1

Connect all the devices as per the set up diagram. Connect tubing from the back pressure regulator to the inlet of the DryCal and leave the outlet open to atmosphere

### Step 2

The gas flow delivery system comes with a 'Quick-Connect' with male/female connector that connects the on/off valve to gas cylinder/compressed air. Connect the 'Quick-connect' to the gas flow source. Gas pressure should be approximately 80 to 100 psi

## Procedure:

### Step 1

Turn on the MetLab. Through its set up menu, set the flow reading type to 'STD' and Temp Correction Factor to rated temperature of the rotameter

### Step 2

Through the set up menu, enter the calculated flow correction factor (FCF) as a Sensor Factor in your MetLab if the actual gas temperature differs to the rated temperature of rotameter. Otherwise, set its value to default 1.00

### Step 3

Close the needle valve, open the on/off valve, and set the gas pressure by adjusting the pressure regulator to 30 psi above the rotameter's rated pressure

### Step 4

If the rotameter contains a built-in needle valve, open its needle valve fully for unrestricted gas flow

### Step 5

Open up the needle valve and adjust the back pressure regulator until the pressure gauge before the back pressure regulator indicates the rotameter's rated pressure

### Step 6

Set the variable area flow meter's flow at desired level using the needle valve. The flow rate is indicated by the point on the printed scale where the float's center stabilizes

### Step 7

If you are not using a direct scale rotameter, record the reflected flow rate reading from the reference flow table against the floating point

### Step 8

Press 'Measure' or 'Read' on the DryCal and begin taking readings

### Step 9

Determine the full scale accuracy of the variable area flow meter using the following formula

% Full scale accuracy = (MetLab's flow reading – VAF's indicated flow reading)/ VAF's full scale %

## About Bios

Bios is a recognized leader in **primary** gas flow measurement. We provide products, services and solutions for professionals in diverse disciplines, including environmental protection, occupational health and safety, industrial process control, research and development and calibration laboratories.

Our Butler, New Jersey facility is one of the world's most accurate gas flow measurement laboratories. Since 2004, we've been accredited to the calibration laboratory quality and proficiency standards set forth by ISO 17025, ANSI Z-540 and NIST Handbook 150, through the National Voluntary Laboratory Accreditation program (**NVLAP**) of the National Institute of Standards and Technology (**NIST**), the national lab of the United States.

We're pleased to state that our **Scope of Accreditation** uncertainty is ±0.071% of reading for gas flow measurements from 5 to 50,000 scc per minute. A current copy of our accreditation certificate and scope may be found on our website, at: **http://www.biosint.com/pdf/NVLAP-accreditation.pdf.**

PROVEN DryCal TECHNOLOGY



NVLAP Lab Code 200661

Bios

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