XC-623 Operator's Manual

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Follow all relevant instructions to avoid fire, explosions, electric shocks or other hazards that may result in damage to property and/or severe or fatal injuries.

The product shall only be used by persons who have fully read and understood the contents of this user manual.

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1 Preface

1.1 Product Introduction

The XC-623 Source Sampler from Apex Instruments is designed for manual sampling of gaseous pollutants from stationary sources, e.g. stacks, flues, vents or pipes. The console is most commonly used for EPA Method 6.

The Source Sampler is easily adapted to test for a wide range of pollutants from stationary sources, such as analytes including sulfur dioxide and many more pollutants with adaptations of the sample train, including filters, glassware and solutions used.

1.2 Purpose of this manual

The purpose of this manual is to provide a basic understanding of the Apex Instruments XC-623 source sampling console. The XC-623 is applicable for use with a variety of US EPA sampling methods.

Additionally, this manual provides the users with a reasonable amount of reference information on system configuration, calibration procedures, maintenance and troubleshooting as it applies to the specific product and the US EPA Regulations.

1.2.1 Relevant US EPA method descriptions

Method 6 - Determination of Sulfur Dioxide Emissions From Stationary Sources

Detailed information on method sampling may be found through the US EPA website - please visit https://www.epa.gov/emc/emc-promulgated-test-methods for complete method descriptions

1.3 Safety Instructions

1.3.1 Safety information related to the intended use

Source sampling is intended to be performed by technicians who have been trained in source sampling methods. Personnel conducting source sampling are expected to understand basic gas laws and chemistry.

In addition, all technicians should have adequate general safety training to identify, abate and prevent job-related hazards including site-specific training.

Please visit the following link for more information on Stack Sampling Safety Procedures and Protocols: *http://www.sesnews.org/*

1.3.2 Explanation of safety warnings

⚠ **DANGER**

“DANGER” indicates a hazard with high level of risk which, if not avoided, will result in death or serious injury.

⚠ **WARNING**

“WARNING” indicates a hazard with medium level of risk which, if not avoided, could result in death or serious injury.

⚠ **CAUTION**

“CAUTION” indicates a hazard with low level of risk which, if not avoided, could result in minor or moderate injury.

NOTICE

“NOTICE” Indicates information considered important, but not hazard-related.

1.3.3 Electrical shock

⚠ **CAUTION**

Use and maintenance of the source sampling console presents potential electrical hazards.

Ensure that the console is protected from wet conditions such as rain or process emissions. If the console is wet, do not continue to operate the console until it has been adequately dried.

Do not perform maintenance on this console when it is still plugged into a power source and the main power switch is turned on.

Do not continue to use the console if wires are exposed or loose from their connectors.

1.3 Safety Instructions cont.

1.3.4 Weight

⚠ CAUTION

Although the unit is compact and lighter than previous versions, the unit itself can present risks due to its weight. When carrying the unit, make sure to use proper form to lift using your legs. Lift and carry the unit using the provided handles or by holding the entire unit close to the body. If a user is not comfortable carrying the unit, a partner may provide the necessary assistance in moving the unit around.

1.3.5 Elevated surfaces

⚠ DANGER

Use of the unit on elevated surfaces also poses risks that range from minor to fatal. Be sure to operate the unit on a level, stationary surface. If necessary, secure the unit using straps or braces to ensure that vibration or accidental contact does not knock the unit off of its surface.

1.4 What To Do When the Unit Arrives

1.4.1 Unpack and inspect

Unpack the unit from its shipping container. Inspect the exterior of the unit for visible damage or missing components. Remove the lid by using the four butterfly latches and visually inspect the front of the unit.

NOTICE

Do not tamper with the internal components unless otherwise recommended.

Check the packing list to ensure that everything has arrived. The console comes with a pre-test calibration certificate for the dry gas meter and temperature sensors. A power cord will also be included for any units that use 120V supplied power.

1.4.2 Become familiar with console operations

Perform mock sample runs to ensure operation of console follows proposed test plan and EPA Method procedures.

1.4.3 Leak checks

Perform the console leak checks as explained in *Section 3.2.5 Console Leak Check Procedure* on page 21 of this manual.

1.4.4 Calibration audits

The unit is sold with a factory dry gas meter calibration at flow rates appropriate for the unit. Apex Instruments suggests performing audits of the dry gas meter before and after each testing period and performing a full calibration on the dry gas meter, sensors and thermocouples annually. Ensure that you verify calibration standards with your local administrator.

Perform the unit calibration audits as explained in *Section 4.1 Pre-Test Calibrations* on page 26 of this manual.

1.4.5 Test plan and methods

Begin the sampling operation procedures as directed by the applicable EPA Method and local compliance regulations.

1.5 How To Transport and Store the Unit

1.5.1 Dimensions

Case: Mini 8U
Height: 17” (43 cm)
Width: 17” (43 cm)
Depth: 12” (30.5 cm)
Weight: 28 lbs (12.7 kg)

1.5.2 Lifting and handling

⚠ **CAUTION**

Avoid dropping the unit and other forms of collision during transport. When lifting, make sure to use the handles on the sides to lift. Do not try to lift the unit by anything other than the handles or the carrying strap.

1.5.3 Storage

Store upright, if possible, in a controlled environment on a shelf off of the ground. The unit should be stored in the case with the lid attached and disconnected from power.

1.5.4 Shipping

While the unit features a rugged design, the components and integrity of the build are delicate; the unit should be treated as a lab instrument when considering transport. Sudden jarring movements or drops could damage the internal components or cause faults within the electrical subsystem and various sensors.

The unit should not be shipped independently. Ensure proper shipment of the unit by packing it in a foam-lined box or an appropriate shipping container that provides adequate protection.

2.0 Description of the Product

2.1 Intended Use and Reasonably Foreseeable Misuse

2.1.1 Source sampling

The sampling console is the operator's control station. The XC-623 sampling console includes a precision dry gas meter fitted with a high-resolution rotary encoder, a leak-free pump, a vacuum gauge, flow control valves and a rotameter for monitoring the gas flow rate. A 32-bit microcontroller converts the sensor inputs and displays the totalized sample volume, temperatures and pressures into user-selectable units. The transflective LCD display is sunlight readable and backlit so it can be seen in the dark. Three advanced, self-tuning 1/32 DIN temperature controllers with individual solid-state relays are used for controlling heaters for the probe, filter and auxiliary heaters such as valve heaters.

The digital LCD screen displays the elapsed time, the dry gas meter pressure (P_m), totalized sample volume collected (V_m) and the temperature of the selected thermocouple channel. A rotary switch is used for monitoring up to six different temperatures. Coarse and fine valves are used to control the sample flow rate and for adjusting the vacuum during leak checks. A female sample inlet quick connect provides convenient connections for the sample vacuum and pitot lines.

2.1.2 Versatile use

The XC-623 console can be easily adapted to various gaseous sampling train systems. Using different configurations of sampling trains, the XC-623 console can be used to test for sulfur dioxide, carbon dioxide, TRS (total reduced sulfur), methanol and an ever-increasing group of other pollutants.

2.2 Product Compliance

This product complies with all relevant US EPA sampling regulations and was designed based on the schematics and sampling practices established by the EPA in the Code of Federal Regulations.

2.3 System Overview

NOTICE

This manual covers the sampling console part of the train. The rest of the sampling train is sold separately.

The first step to effective sampling is to become familiarized with the standard equipment. To illustrate the necessary components of source sampling, we've included an overview of the five main components of the Apex Instruments Source Sampling Train. The main components of a Source Sampling system are: probe assembly, filter, glassware (impingers and bubblers), sample line(s) and the console with an internal or external sampling pump.

2.3.1 Sampling Console (XC-623)

The sampling console houses the dry gas meter, internal sampling pump (standard), temperature controllers, PIC32 microcontroller module (MCM), vacuum gauge, flow adjustment valves and a user interface display.

Some sampling trains use an external pump assembly to pull the sample; an external pump is not necessary when a console, such as the XC-623, uses an internal sampling pump to extract the sample gas.

Sample gas enters the console from the sample line and then through the pump and dry gas meter.

The console is housed in a strong and durable polyethylene case with a carrying strap on top.

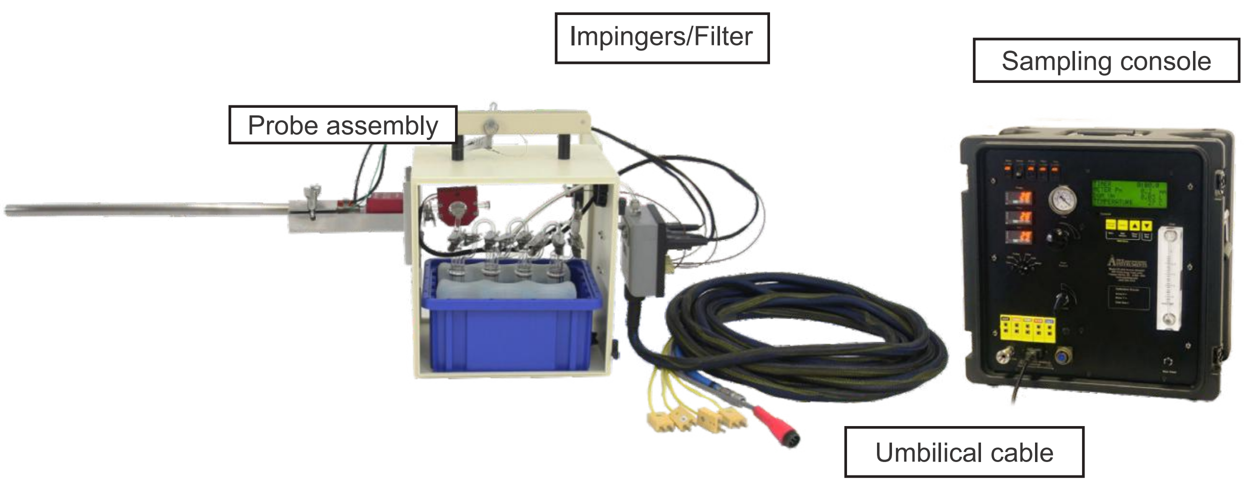

Fig. 1 *Example Sampling System: Ancillary components of the sampling system are sold separately.*

2.4 Technical Specifications

Dry Gas Meter
Model SK25EX-100 multi-chamber positive displacement meter (fitted with a quadrature encoder),
Qmax for air 41 LPM at 150 Pa, Qmin 0.26 LPM, Resolution 0.2 Liter, cyclic volume 0.7 Liter,
Type K thermocouple for meter exit temperature (optional Type K thermocouple for meter inlet temperature)

Internal Sample Pump (Standard, Optional Without)
Dual head diaphragm, 8 LPM free flow, max vacuum 23” Hg (-230 mbar abs.), 12 VDC brushless motor

Display
4x20 character backlit transflective liquid crystal display, 160x96 dot matrix, viewing area 74 mm x 45 mm, operating temperature -20 to 70 °C (-4 to 158 °F)

Keypad
Display controlled by four button, long-life membrane keypad for display operation, tactile feedback keys control the timer and menu operations, ability to zero the meter pressure transducer and DGM volume and reset the timer

Temperature Measurement
Cold junction compensated Type K thermocouple-to-digital converter °C/°F selectable, -200 to 1372 °C range (-328 and 2502 °F), 6 channel rotary switch, up to 5 additional Type K thermocouple inputs, standard size jacks

Temperature Controllers
Probe, Filter and AUX. Fuji PXR3 compact, 1/32 DIN self-tuning PID temperature controller with 3 button keypad, SSR driver for 25A solid state relay, Type K thermocouple jack for input

Digital Pressure Transducers
High resolution, digital, factory calibrated and temperature compensated -20 to 70 °C, proof pressure 49 kPa
P_m 5.0” (1245 Pa) range with 0.01” (1 Pa) resolution

Vacuum Measurement
Bourdon tube, dual-scale, 0 to -30” Hg (0 to -100 kPa)

Umbilical Connection
Electrical multi-conductor circular connector, instrumental grade stainless steel quick connects
Sample inlet - 1/2”, Type K thermocouple plugs - AUX, STACK, PROBE, FILTER, EXIT

Processor
Apex Instruments PIC32 Microcontroller Module

Firmware
Scaling factor gamma correction input, pressure sensor damping, temperature sensor damping, user-selectable unit types (Metric, Metric Pa, Imperial)

Power
Supply 120VAC/60Hz 15 amps max. or 240VAC/50Hz 10 amps max., IEC C-14 Inlet

Dimensions and Weight:
H17” x W17” x D12” (43 cm x 43 cm x 30.5 cm), 28 lbs (12.7 kg) base configuration

2.5 Faceplate Components

Reference the image below for an introduction to the essential components of the XC-623 Source Sampling console.

For specific part numbers and a detailed look at the internal components, go to *Sections 6.3 and 6.4* on pages 36 and 37 of this manual.

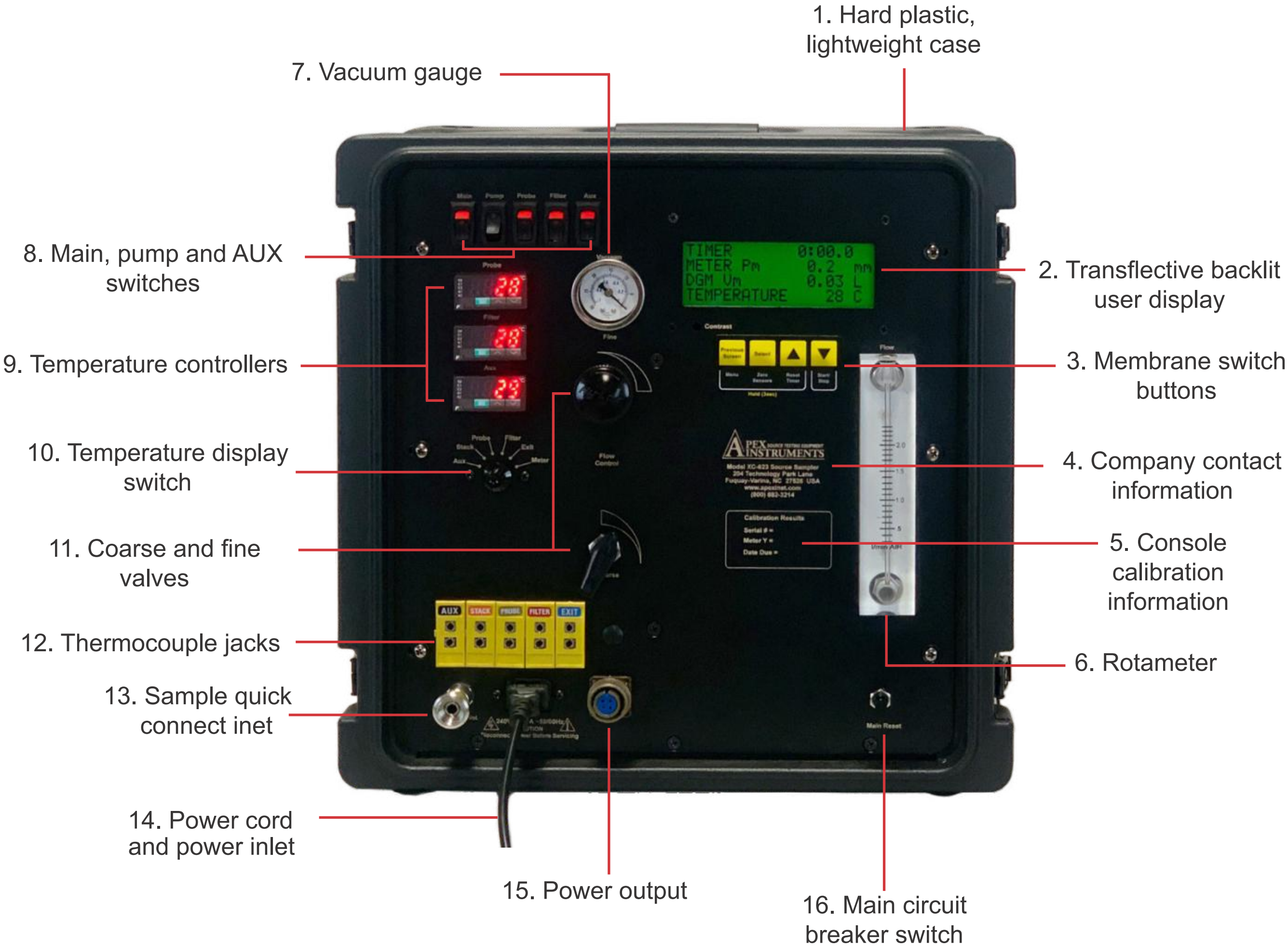

Fig. 2 *Front Panel Overview: Standard version shown, depiction of options may differ.*

3.0 Console Operation

3.1 User Control Overview

3.1.1 Home screen overview

The home screen on the XC-623 console allows the operator to view and manage run data.

Timer: Run time displayed in MM:SS.ms format and can be started, stopped and reset using the membrane switch pad buttons.

Meter P_m: The current dry gas meter pressure measured by the transducer. The averaging (or damping) of this value can be adjusted in the console menu.

DGM Vm: The totalized DGM volume. This value can be reset by holding the Reset Timer button for 6 seconds (this will also reset the timer at the 3 second mark of the hold).

Temperature: The current temperature of the selected TC channel which is controlled by the TC switch on the console.

Fig. 3 *User Interface*

3.1.2 Membrane switch pad buttons

Previous Screen	- Press once to return to the previous screen (only available while in the Menu) - Press and hold for 3 seconds to open the Menu
Select	- Press once to select and enter a menu option (only available while in the Menu) - Press and hold for 3 seconds to zero the sensors to ambient conditions (only available on the home screen and timer as at 0:00)
▲	- Press once to move upward through menu options (only available while in the Menu) - Press and hold for 3 seconds to reset the run timer (only available on the home screen) - Press and hold for 6 seconds to reset the DGM volume (only available on the home screen)
▼	- Press once to move downward through menu options (only available while in the Menu) - Press once to start or stop the run timer (only available when on the home screen)

3.1 User Control Overview cont.

3.1.3 Menu overview

The menu on the XC-623 console allows the operator to set data averaging values, change units and provide TC offsets. The menu can be accessed by pressing and holding the Previous Screen (Menu) button for 3 seconds.

Fig. 4 *Menu Overview*

NOTICE

An abbreviated menu will appear if the run timer is not at 0:00.

Meter P_m and TC Damping: "Block size" is the averaging rate of the transducer readings. Each "block" is equal to a sample every 1/4 second. Four damping "blocks" would be a 1 second averaging period.

Meter P_m Damp. Band: A tolerance based on the full scale of the measuring transducer. The meter pressure (P_m) transducer used in the XC-623 sampling console has a range of 5" H_2O. To ensure that the data stream displayed is smooth, the damping band should be configured to restart after an outlier is measured. For example, P_m values could be averaging out at 1.00" H_2O. If the damping band is set to 10% (of full scale), any reading outside of 0.95 to 1.05" H_2O would start a new average.

Unit Types: Allows the user to change unit types displayed on the console. There are 3 options included (Note: All unit options display DGM Vol. in Liters):

Imperial: Press. - Inches H_2O, Temp. - °F
Metric: Press. - mm H_2O, Temp. - °C
Metric Pa: Press. - Pascal, Temp. - °C

TC Offset: After completing an audit of the temperature sensors, the displayed value may need to be adjusted. Use this menu option to change the displayed value of the temperature display to match the audit device's output.

AC Line Frequency: Thermocouple readings could be unsteady dependent upon multiple factors such as AC line and thermocouple wire length. If the readings are bouncing after damping adjustments, ensure that this setting is correct. Typically, the setting will be defaulted for 120V models at 60Hz, while 240V models operate at 50Hz. Match this value with the source AC line supplied frequency.

3.2 Pre-Field Test Operations

3.2.1 Console configuration

Ensure that the following console settings are configured in the lab before performing a field test: unit types, meter pressure (P_m) damping, TC offset and TC damping.

To access each of these settings on the console, enter the Menu by pressing and holding the Previous Screen button for 3 seconds (timer must be at or reset to 0:00).

Use the Up and Down buttons to scroll to a menu option with the indicated (”less-than” symbol). Press the Select button to enter a menu option. Use the Up and Down buttons to adjust values, press the Select button to confirm changes, and press the Previous Screen button to exit submenus and again to return to the home screen.

Fig. 5 Menu Configuration

3.2.2 Moisture determination (if applicable)

At the sampling location, prior to testing, determine the percent moisture of the stack gas using the wet and dry bulb temperatures or, if appropriate, a relative humidity meter. Another option is a moisture approximation through procedures outline in EPA Method 4.

3.2.3 Preparation of impinger train

Follow procedures outlined in an applicable EPA Method to prepare the impinger train.

3.2.4 Preparation of sampling train

Assemble the sampling train as shown in the applicable EPA Method. Adjust the probe and oven/filter heaters to a temperature warm enough to prevent water condensation or as dictated in the sampling method using the respective temperature controller on the left side of the console faceplate; keep in mind the previously determined moisture content of the gas stream. Place crushed ice and water around the impingers in the sample case as applicable.

Refer to *Section 3.5 Setting the Temperature Controller* on page 25 of this manual for instructions on how to operate the temperature controllers.

3.2 Pre-Field Test Operations cont.

3.2.5 Console leak check procedure (front side):

NOTICE

DO NOT EXCEED THE TRANSDUCER PRESSURE RATING OF 100 INCHES OF H2O. DOING SO MAY RESULT IN OPERATIONAL SENSOR FAILURE.

1. Position the valves
    a. Close the coarse valve by turning the handle clockwise to the horizontal position ("3:00").
    b. Decrease the fine tune knob fully by turning all the way to the left (counter-clockwise).

2. Block airflow of sample inlet
    a. Insert a capped quick connect into the 1/4" sample inlet.

3. Initiate flow
    a. Turn on the pump and open the coarse valve all the way counterclockwise to the vertical position ("12:00").

4. Adjust vacuum (if necessary)
    a. If the vacuum value displayed by the gauge is below 10 inches Hg (250 mm Hg), slowly turn the fine tune knob clockwise until the vacuum is at least 10 inches Hg.

5. Monitor the console leak rate
    a. Start the timer using the Start/Stop button on the membrane switch keypad and monitor the DGM Volume value on the LCD screen for 1 minute. If the flow through the DGM exceeds 2% of the average sample rate (e.g. 0.02 L/min for a 1.00 L/min target sample rate), the leaks must be found and corrected.

6. Complete the console leak check procedure
    a. Remove the plug from the sample inlet. Be sure to return the valves to a lower flow starting position. Reset the timer by pressing and holding the Up, or Reset, button for 3 seconds and the DGM Volume reading can remain at the current value or can be zeroed by holding the Up, or Reset button, on the membrane switch pad for 6 seconds.

Fig. 6 Front-Side Leak Check

3.2 Pre-Field Test Operations cont.

3.2.6 Sample train leak check procedure

A leak check before the sampling run is recommended, but not required. The leak check procedure includes the following steps:

1. Close the coarse valve by rotating the handle 1/4 turn right (clockwise) until it is horizontal or the arrow is pointing to “3:00.” Decrease the fine tune knob by rotating all the way to the left (counterclockwise).

2. Plug the probe inlet or nozzle tip using a clean finger or a clean cap.

3. Turn the pump on using the switch in the upper-left corner of the console and open the coarse valve fully by turning to the left (counter-clockwise until it is pointing straight up.

4. Adjust the fine valve by rotating it clockwise to pull a vacuum of at least 10 inches Hg (250 mm Hg), which can be observed by the vacuum gauge on the console.
    a. If this vacuum level is overshot, either complete the leak check at this value or slowly release the cap from the probe or nozzle and close the coarse valve.
    b. Adjust the fine valve by rotating it counter-clockwise and then repeat the leak check process.

5. Observe the leak rate as indicated by the DGM Volume on the LCD screen for one minute and ensure that the volume is not increasing during this time. A leakage rate in excess of 2% of the target average sample rate is not acceptable (e.g. 0.02 L/min for a 1.00 L/min target sample rate).

The operator can use the timer to track and quantify leak rates. The timer can be started or stopped by pressing the Start/Stop button (Down) once. If the timer needs to be reset, the Reset button (Up) can be pressed and held for 3 seconds.

Fig. 6 System Leak Check

6. Remove the plug from the sample inlet and turn off the pump. Be sure to return the valves to a lower flow starting position. Reset the timer by pressing and holding the Up, or Reset, button for 3 seconds. The DGM Volume reading can remain at the current value or can be zeroed before the run by holding the Up, or Reset, button on the membrane switch pad for 6 seconds.

NOTICE Slowly release the probe inlet plug before closing the coarse valve.

3.3 Field Test Operations

3.3.1 Performing a Method 6 sampling test

This operation guide is written based on US EPA Method 6 sampling. Ensure that you follow the appropriate procedures outlined in the applicable gaseous method to be performed.

Ensure probe and heated filter, as applicable, have reached the set point. If either has not reached the suggested temperature, turn the heaters on using the appropriate switch in the upper-left corner of the console and/or allow time to reach the set point.

Ensure that the timer is at 0:00. If it is not, press and hold the Up, or Reset, button for 3 seconds. Zero the meter pressure sensor by pressing and holding down the Zero Sensors button (Select) for 3 seconds. With the coarse valve closed, start the pump using the switch in the upper-left corner of the console.

Record all applicable site data such as plant name, location, date, personnel, etc. Record the initial DGM reading displayed on the console LCD screen and barometric pressure using a local airport reading or NIST-traceable barometer adjusted for elevation on the field data sheet. The DGM reading can begin at the current value or can be zeroed before the run by pressing and holding the Reset button (Up) on the membrane switch pad for 6 seconds.

To begin sampling, position the tip of the probe at the sampling point. Open the coarse valve, note the clock time for the start, and turn on the timer.

Adjust the sample flow to a constant rate of approximately 1.0 L/min as indicated by the rotameter using the fine valve. Maintain this constant rate (±10 percent) during the entire sampling run.

Take readings (clock time, DGM volume, rotameter flow rate, meter pressure, vacuum, temperatures at DGM and at impinger train outlet) at least every 5 minutes. Add more ice or a fresh ice pack to the impinger train during the run to keep the temperature of the gases leaving the last impinger between 0°C (32°F) and 20°C (68°F).

At the conclusion of each run, close the coarse valve and record the final readings (clock time and final DGM volume). Now the pump can be turned off and the probe can be removed from the stack. Once the probe has cooled down, conduct a leak check as described in Section 3.2.6 Sample train leak check procedure on page 22 of this manual (this leak check is mandatory). If a leak is detected, void the test run or use procedures acceptable by the administrator to adjust the sample volume for the leakage.

Drain the ice bath and purge the remaining part of the train by drawing clean, ambient air through the system for 15 minutes at the sampling rate (typically 1.0 L/min). Clean, ambient air can be provided by passing air through a charcoal filter or through an extra midget impinger containing 15 ml of 3 percent H_2O_2. Alternatively, ambient air without purification may be used. Before purging the train using the console's pump, be sure to record all final readings on the field data sheet. Turn the pump on by using the appropriate switch in the upper-left corner of the console and open the coarse valve fully. The console's valves should already be adjusted to draw air in around ~1 L/min from the sample run. If the flow rate is not at 1 L/min, use the fine valve to adjust the flow rate. Once 15 minutes has passed, close the coarse valve and turn off the sample pump using the switch in the upper-left corner of the console.

Follow applicable EPA method for post-run sample recovery procedures.

3.4 Post-Field Test Operations

3.4.1 Post-test calibration check

After each field test series, conduct a calibration check using the procedures outlined in EPA Method 6 Section 10.1.1.2 (or Section 10.1.3), except that three or more revolutions of the DGM may be used, and only two independent runs need to be made.

Determine the Y_i using both volumes and equation Y_{ref} / Y_{dgm} x 100. If the average of the two post-test calibration factors do not deviate by more than 5 percent (95% < Y_i < 105%) from Y_i, then Y_i is accepted as the DGM calibration factor (Y), which is used in EPA Method 6, Equation 6-1 to calculate collected sample volume (see Section 12.2). If the deviation is more than 5 percent, re-calibrate the metering system as in Section 10.1.1, and determine a post-test calibration factor (Y_f). Compare Y_i and Y_f; the smaller of the two factors is accepted as the DGM calibration factor.

If re-calibration indicates that the metering system is unacceptable for use, either void the test run or use methods, subject to the approval of the Administrator, to determine an acceptable value for the collected sample volume. (EPA Method 6, Section 10.1.2)

3.5 Setting the Temperature Controller

3.5.1 Set value setting

1. The current temperature of the equipment is shown on the Fuji controller. To change the set value (SV) press SEL once.

2. Current value is displayed and SV is lit. Press the ︿ ﹀ to increase or decrease the displayed value (set value).

3. After the new setting is entered, press SEL to lock in the value and return to the C1 (control 1) display.

Repeat procedure to check value if necessary.

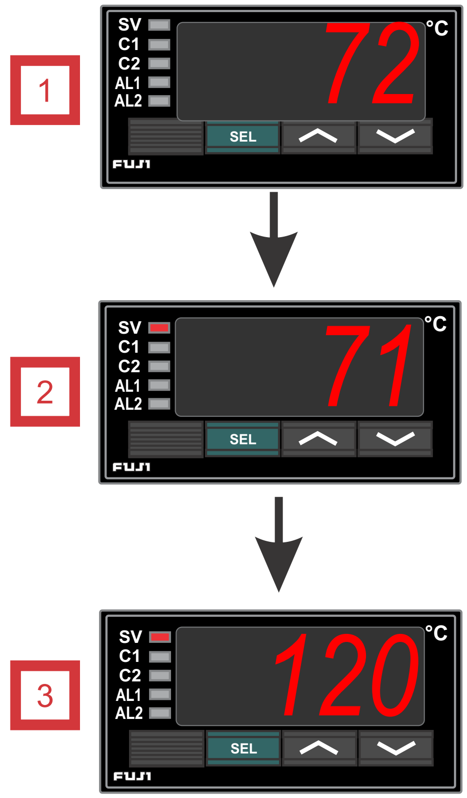

Fig. 8 Temperature Controller Configuration

3.6 Operation using software (reserved)

The XC-623 does not currently use software for operation, all functions are controlled on the console itself.

4.0 Maintenance

4.1 Pre-Test Calibrations

4.1.1 Factory meter calibration

Apex Instruments performs an initial 5-point calibration following the procedures outlined in EPA Method 6. The result of the calibration is an average calibration factor Yi (Vw / Vm, adjusted to a standard reference temperature and pressure) that is used as the calibration factor for subsequent test runs. Calibration flow rates are performed at 5 points dependent upon the rotameter of the model of console purchased (can be specified by the customer):

XC-623☐-A☐☐ = 1.0, 0.8, 0.6, 0.4, 0.3 L/min = DGMC-5A-LFA Calibration

XC-623☐-B☐☐ = 2.5, 2.0, 1.5, 1.0, 0.5 L/min = DGMC-5A-LFB Calibration

XC-623☐-C☐☐ = 4.0, 3.0, 2.0, 1.0, 0.5 L/min = DGMC-5A-LFC Calibration

4.1.2 Initial end user audits

Apex Instruments suggests that the end user perform audits using a critical orifice (rated for approximately 1.0 L/min) plugged in to the sample inlet on the console. Run the audit at 1-2 in. Hg (25-50 mm Hg) above the calculated critical vacuum. Calculate the Y (Gamma) using the standardized orifice's flow rate and compare this value to the standardized flow rate metered by the dry gas meter after a minimum of 10 minutes using this formula:
$(Q_{cr(std)} / Q_{m(std)}) \times 100$

If these values differ by more than 5%, check the integrity of the console before beginning sampling.

To audit the thermocouples, use a calibrated temperature simulator (NIST-traceable preferred) to simulate a known temperature and compare the value on the simulator to the console's displayed value by plugging in directly to one of the thermocouple jacks on the front of the console. If the displayed value on the console does not match the simulator, use the console's menu to offset the displayed value to match the simulator's value.

Another quick check is done by taking the TC out of the dry gas meter outlet and dipping it in an ice bath that also has a calibrated thermometer dipped inside. Ensure the dry gas meter thermocouple channel reading matches the calibrated thermometer at or near freezing, 32 °F (0 °C). If it is not, adjust the console reading to match the ice bath's thermometer.

4.2 Post-Test Calibrations

4.2.1 Dry gas meter

Apex Instruments and the EPA recommend that the user perform post-test audits following a field test series using the procedures outlined in EPA Method 6, Section 10.1.2 Post-Test Calibration Check. This procedure closely mirrors the pre-test calibration, except only three or more revolutions of the reference meter are required and only two independent runs need to be made that are at or near the sample rate metered during the test.

The average of the post-test audit factors, Y, is not allowed to deviate more than 5% from the pre-test calibration factor Y_i. If this deviation is greater than 5%, a post-test calibration factor needs to be redetermined using the Pre-Test Calibration procedure. This new post-test calibration factor is then compared to the post-test audit factor and whichever is smaller is accepted as the DGM calibration factor.

Conduct a post-test audit using the audit procedure outlined in *Section 3.4 Post-Field Test Operations* on page 24 of this manual. If the $Q_{m(std)}$ obtained before and after the test differs by more than 5%, void the test run; if not, calculate the volume of the gas measured with the critical orifice.

If re-calibration indicates that the metering system is unacceptable for use, void the test results or use approved methods by the administrator to determine an acceptable value for the collected sample.

4.2.2 Temperature sensors

Audit against mercury-in-glass thermometers. An alternative thermometer may be used if the thermometer is, at a minimum, equivalent in terms of performance or suitably effective for the specific temperature measurement application (EPA Method 5, Section 10.5).

The user can also audit the temperature sensors following the procedure outlined in *Section 4.1.2 Initial end user audits* on page 26 of this manual.

4.3 Post-Test Maintenance

4.3.1 Purging

At the conclusion of a test series, it is highly recommended to “purge” the console plumbing by drawing in clean, ambient air for 10 minutes or greater. This process will extend the life of the internal tubing, fittings, dry gas meter and flow meter. The purge can be conducted by turning the internal sample pump on and opening the valves to draw air through the inlet of the sample port on the front of the console when it is not connected to other equipment or a sample train.

4.3.2 Cleaning

Maintaining the cleanliness of the console will also extend the life of its components. The outside of the case and console can be cleaned with a non-abrasive, weak degreaser or soapy water. Ensure that exposed electrical components are not sprayed during this process.

⚠ **CAUTION**

Never clean the console while it is connected to power or powered on.

4.3.3 Inspections

⚠ **CAUTION**

Periodically inspect components of the console to ensure everything is in working order and nothing is exhibiting a sign of future issues. Check for things such as exposed or frayed wires, melted or damaged electrical components, discolored or cloudy tubing, and any sign of oil or moisture. The console can be safely vacuumed out while disconnected from power in a dry location. Vacuuming the internals of the console will remove any dust or particulate buildup that could cause issues in the long term. Any signs of damage to the internal or external components of the console should be replaced immediately.

4.4 Semi-Annual Maintenance

All components of the console should be audited and evaluated on a semi-annual schedule (once a quarter or every six months). This comprehensive procedure should include audits of the dry gas meter thermocouples and electrical components. Post-test calibrations and audits satisfy this suggestion.

4.5 Annual Maintenance

Apex Instruments highly recommends that the console be returned to Apex Instruments on an annual basis. The Technical Services Group will perform an evaluation of all components of the system including functionality and build-integrity checks. All sensors and the dry gas meter can also be calibrated at this time.

4.6 Manufacturer Support for the Product

4.6.1 Technical services

Our knowledgeable service staff includes skilled industry professionals, stack testers and technicians ready to help with specific service needs. From basic troubleshooting to full equipment overhauls and repairs, our technical service team can help.

Phone: (919) 346-5754, Toll Free (877) 726-3919
Email: support@apexinst.com

4.6.2 Calibration services

Apex Instruments offers dedicated, climate-controlled precision calibration services for a variety of measuring instruments to help keep all equipment up to date and within US EPA calibration requirements. Calibration services are available for consoles, reference meters, critical orifice, orifice sets, pitot tubes (geometric and wind tunnel) and thermocouple simulators.

Please contact the service department or a sales representative for more details on our calibration services. Certification of calibration available upon request. The part number for the annual calibration is as follows:

XC-623□-A□□ = 1.0, 0.8, 0.6, 0.4, 0.3 L/min = DGMC-5A-LFA Calibration

XC-623□-B□□ = 2.5, 2.0, 1.5, 1.0, 0.5 L/min = DGMC-5A-LFB Calibration

XC-623□-C□□ = 4.0, 3.0, 2.0, 1.0, 0.5 L/min = DGMC-5A-LFC Calibration

4.6.3 Obtaining documentation and information

Internet

Detailed product information, firmware and/or software, stack sampling guides and EPA regulation references are available on our website: https://www.apexinst.com

Support and service

Any requests for field data sheets, calibration spreadsheets, diagrams or component supporting documentation, please reach out to our Technical Services Group for assistance.

5.0 Troubleshooting

5.1 LCD Screen

5.1.1 No power to LCD screen

⚠ CAUTION

1. Connector in the bottom-right corner of the board is not secure
   Resolution - Ensure that all wires are firmly clamped inside of the connector and that the connector is plugged into the board

2. Console main power switch is not turned on
   Resolution - Turn on the main power switch

3. Console is not plugged in to a working power outlet
   Resolution - Find an appropriate power source with the correct voltage output and plug the power cord in to the outlet

4. Main circuit breaker on the front of the console is extended out showing red shank
   Resolution - Push in the main circuit breaker. If this is happening repeatedly, turn the console off immediately, disconnect power and remove from service until the console is inspected and repaired.

5.1.2 Screen contrast too dim or bright, cannot read characters on screen

1. Console is not plugged into a working power outlet of the correct voltage
   Resolution - Find an appropriate power source with the correct voltage output and plug the power cord into the outlet

2. Console contrast needs to be adjusted
   Resolution - Use the screw-through access hold on the front of the faceplate just under the LCD screen. Using a Phillips head screwdriver, making small turns counter-clockwise to decrease contrast or clockwise to increase contrast.

5.2 Pressures

5.2.1 Vacuum gauge non-zero

⚠ CAUTION

1. Vacuum gauge reads a non-zero value with no flow going through the system
   Resolution - Replace the vacuum gauge
   Resolution - Check the tubing connections between the inlet to the console and the vacuum gauge

5.2.2 Meter pressure reading is changing quickly and is difficult to read

1. Meter pressure reading is too sporadic
   Resolution - Adjust meter pressure damping settings in the console menu. If the value is jumping large amounts, increase the damping band. If the value jumping small amounts, increase the damping block size.

5.2.3 Pump motor running abnormally

1. Console is not plugged into a working outlet of the correct voltage
   Resolution - Ensure the console is powered off and then plug into a working outlet of the correct voltage

5.2.4 DGM volume not increasing or is decreasing

1. Console is not being operated upright
   Resolution - Reposition the console to be standing upright

⚠ CAUTION

2. Console has a leak
   Resolution - Check all fittings and tubing inside of the console for a leak, repair if necessary

3. Console scaling factor is not correct or is set at 0.0000
   Resolution - Find the scaling factor on the most recent full calibration and input this value into the settings through the console menu option

5.2.5 Rotameter ball bouncing

1. In-line filter (pipe cleaner) is not installed on the rotameter outlet
   Resolution - Replace the filter with a new, or clean, filter

2. Exhaust tubing is not installed on the rotameter outlet
   Resolution - Place a length of tubing on the on the rotameter outlet barb (4” minimum recommended) with the exit of the tubing vented to ambient air

5.3 Temperatures

5.3.1 TC displayed values are changing too quickly to read

1. TC values are too sporadic
   Resolution - Adjust TC damping settings in the console menu. If the value is jumping large amounts, increase the damping band. If the value is jumping small amounts, increase the damping block size.

5.3.2 TCs reading inaccurately (or not reading at all)

1. TC channels reading inaccurately
   Resolution - Adjust TC offset in the console menu using calibrated temperature simulator

⚠ **CAUTION**

2. TC channels not reading
   Resolution - Ensure all TC wires are connected at the rear of the TC jacks inside of the console
   Resolution - Ensure all TC wires are in good condition and are in their plugs on the umbilical and other sampling equipment

5.3.3 Probe, oven or AUX not heating or receiving power

1. Temperature controller or power switch for appropriate equipment is not turned on
   Resolution - Turn on the switch for the appropriate temperature controller

2. Power output is not connected or secure on the console and the umbilical power adapter
   Resolution - Make sure the power output is connected securely on the console faceplate and the umbilical cable

3. Temperature controller is not setup properly
   Resolution - Verify that the Fuji controller settings are correct and adjusted to the correct set point

5.4 Additional Common Console Problems

⚠ CAUTION

Issue	Resolution
Maximum vacuum or flow rate decreases	- Filters are dirty and need to be replaced - Obstruction in sample flow path - Blockage or kinks in plumbing - Leak in console plumbing or sample train
Pump motor fails to start or hums	- Check for correct current (5 to 6 Amperes) - Check to see if fuse is blown - Unit has frozen due to ambient temperature, move pump to a warmer environment to "heat" it up and then return to the sampling location - Unit has overheated - Console is connected to incorrect voltage power source (240V console powered by 120V power source, for example)
Probe doesn't heat or heats slowly	- Verify that the correct thermocouple is plugged in - Verify that the Fuji controller settings are correct and adjusted to the correct set point - Auto-tune the temperature controller - Check all connections for probe power (output on console end, output on oven end, power plug from probe to oven, and TCs)
Oven doesn't heat or heats slowly	- Verify that the correct thermocouple is plugged in - Verify that the Fuji temperature controller settings are correct and adjusted to the correct set point - Check all connections for the oven power (output on console end, output on sample case end, and TCs)
User display doesn't power on	- Check connections on the board for proper power input - Ensure console is being used in operational range -13 to 158 °F (-25 to 70 °C)
Console doesn't power on	- Check the position of the circuit breaker switch, if pop-out switch is popped out and red is showing, push it back in - Check to make sure the console is plugged in to a working power source

6.0 Diagrams and Schematics

6.1 Electrical Diagram (XC-623 120V Shown)

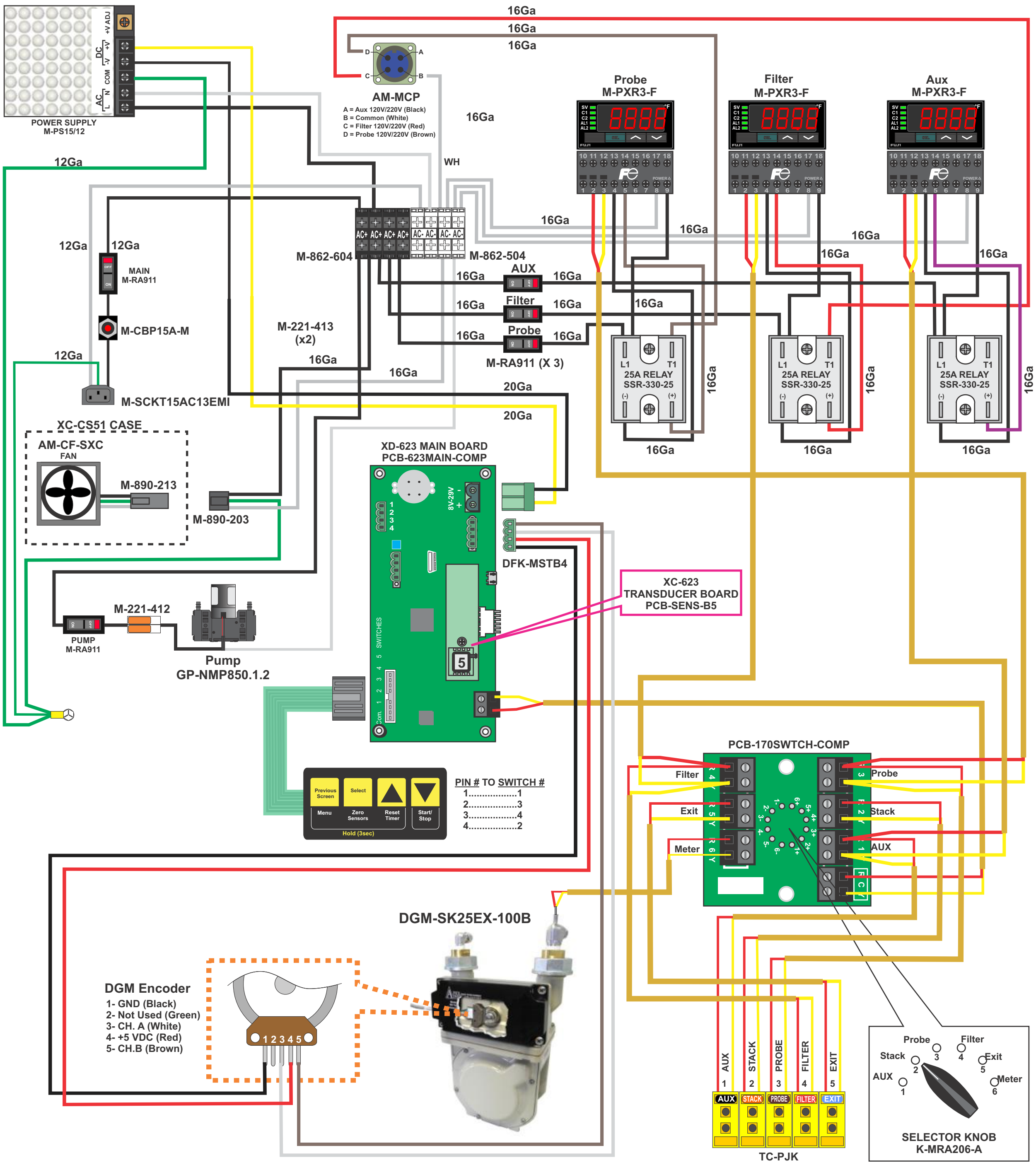

Fig. 9 Electrical Diagram

6.2 Plumbing Diagram

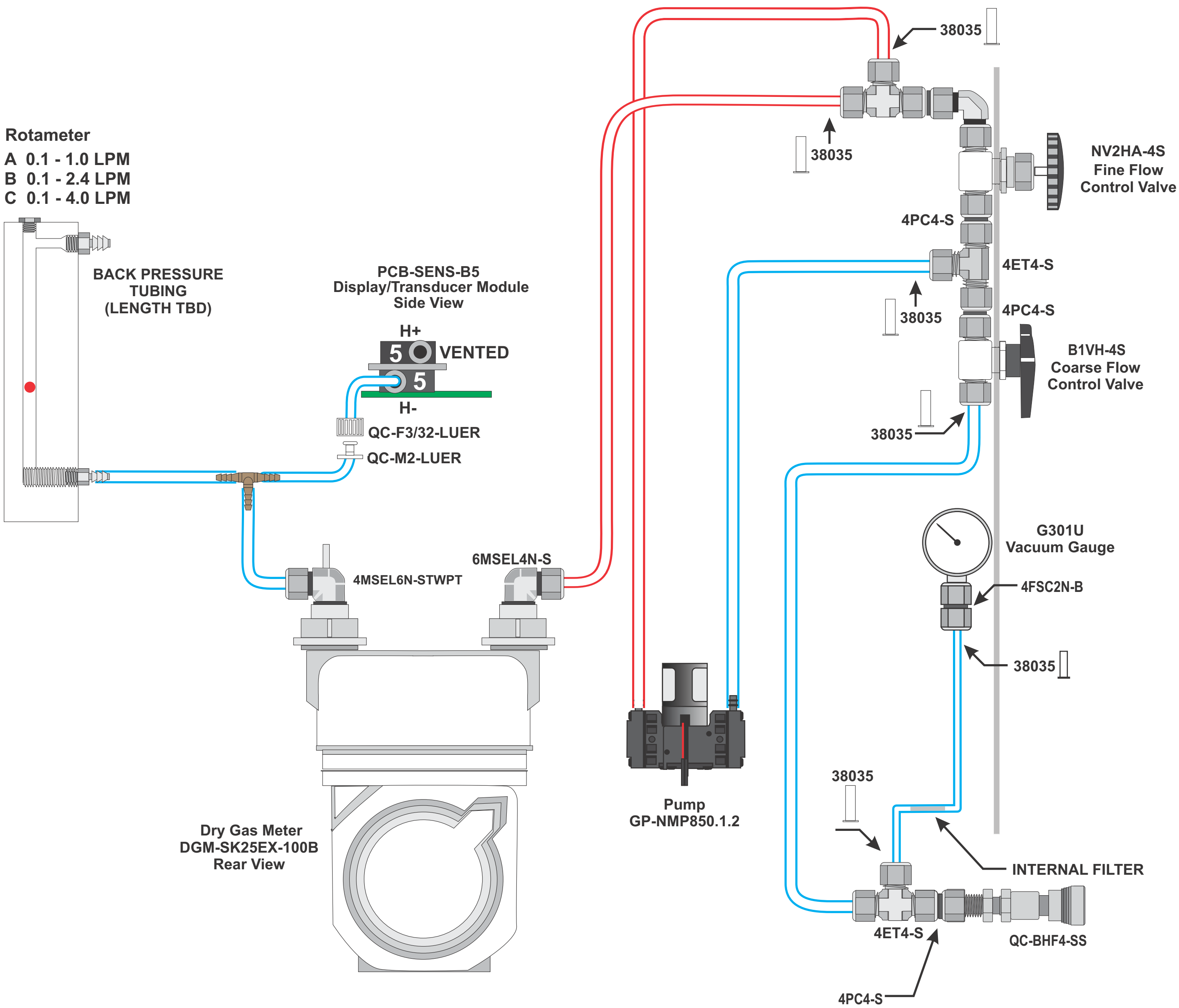

Fig. 10 Plumbing Diagram

6.3 Parts List - Front Panel (XC-623-BMV 240V Shown)

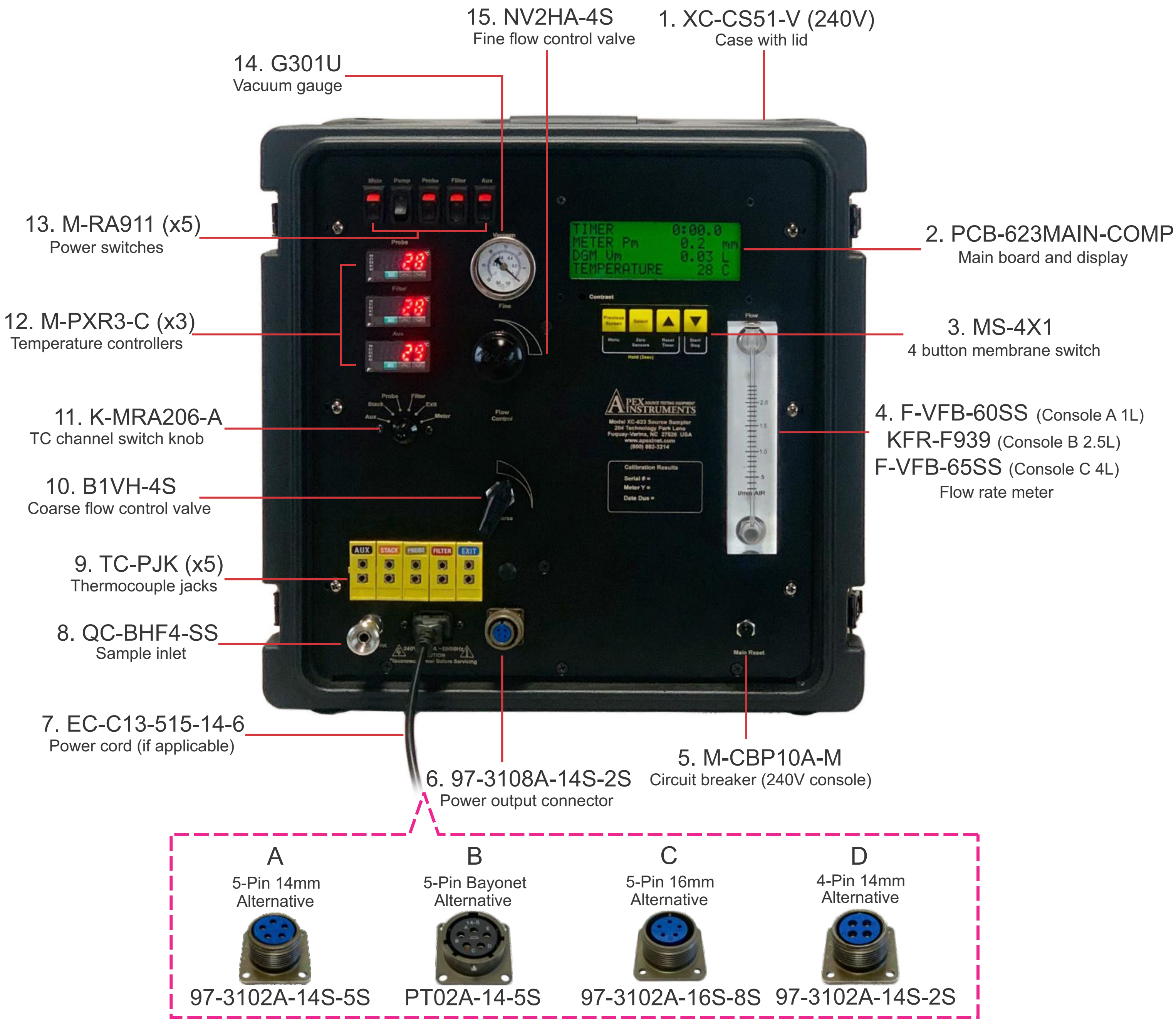

Fig. 11 Parts List - Front Panel: *Standard version shown, depiction of options may differ*

6.4 Parts List - Interior (XC-623-BMV 240V Shown)

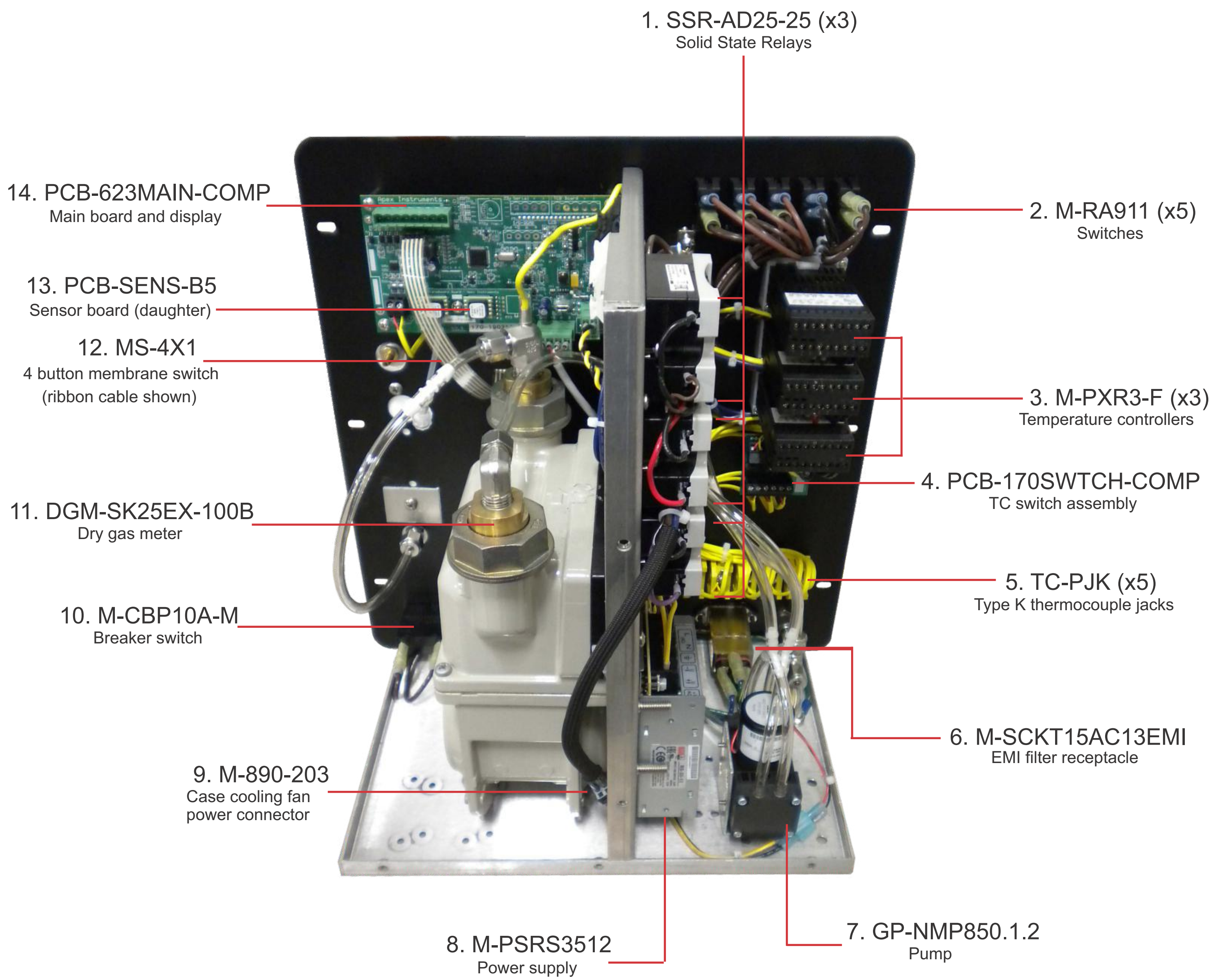

Fig. 12 Parts List - Interior: *Standard version shown, depiction of options may differ*

7.0 References and Related Documentation

7.1 References

7.1.1 EPA and CFR

EPA EMC Promulgated Test Methods
Method 6
Code of Federal Regulations (CFR) 40 Part 60

7.2 Related Documentation

7.2.1 Apex Instruments documentation

Apex Instruments Gaseous Sampling Handbook

Gaseous Pollutant Sampling Field Data Sheet

Method No. (✓) 6 ___ 11 ___ 18 ___ 26 ___ 0040 ___ Project No. ________

Stack Name ________________ Date ________

Facility Name ________________ Personnel ________

Facility Location ________________ Ambient Temperature °C ________

Meter Box No. ________________ DGM Calibration Factor Y ________

Start Time ________ Stop Time ________ Barom Pressure ________

θ	Clock Time	DGM Reading	Rotam Setting	P_m (mm H_2O)	Vac. (KPa)	Temp (°C)		Flow Rate Deviation	
						DGM	Exit	ΔV_m	$\Delta V_m/\Delta V_{avg}$
0									
5									
10									
15									
20									
25									
30									
35									
40									
45									
50									
55									
60									
		V_m		Avg	Max	Avg	Max	Avg	0.90-1.10?

Probe Heat (no condensation?) ________

Purge Rate ________ at avg rotameter rdg?

Purge Time ________ min (≥ 15 min?)

Sample Recovery	
Fluid level marked?	________
Sample Container sealed?	________
Sample Container labeled?	________

Leak Checks	
Pre-Test (optional) cc/min	
Post-Test (mandatory) cc/min	
Vacuum (≥ 34 kPa?)	
≤ 0.02 Avg Flow Rate at ≥ 34 KpA vac?	

Checked By: ________________ ________________

Personnel (Signature/Date) Team Leader (Signature/Date)

APEX INSTRUMENTS SOURCE TESTING EQUIPMENT

Updated: 2020/06/11

Console Calibration

Pre-Test - 5-Point Metric Units (Critical Orifice)

Meter Console Information

Model #:	
Serial #:	
DGM Model #:	
DGM Serial #:	

Calibration Conditions

Bar. Press. (mm Hg):	
Relative Humidity (%):	
Ambient Temp. (ºC):	

Factors/Conversions

Std. Temperature (°K):	293.15
Std. Pressure (mm Hg):	760.0
K_1 (°K/mm Hg):	0.3857

Orifice Information

Orifice Set ID:	
Cal. Due Date:	
Theoretical Critical Pressure (in. Hg)[1]:	

Calibration Data

Console Test Meter (DGM)							Critical Orifice				
Run Time[5]	Meter Pressure[6]	Volume			Outlet Temperature		Serial Number	Coefficient[2]	Actual Vacuum[1]	Ambient Temperature	
		Initial	Final	Total	Initial	Final				Initial	Final
Θ (minutes)	P_m (mm H_2O)	V_{mi} (m^3)	V_{mf} (m^3)	V_m (m^3)	t_{mi} (ºC)	t_{mf} (ºC)	# (ID)	K' (Metric)	P_w (mm Hg)	t_{ai} (ºC)	t_{af} (ºC)

Calibration Results

Standardized Data					Calculated Results				
Dry Gas Meter		Critical Orifice			Gamma		Flowrate	$\Delta H_@$	
Std. Volume	Std. Flow Rate	Std. Volume	Std. Flow Rate	Raw Volume	Value	Variation[3]	Std & Corr	@ 0.0212 SCMM	Variation[4]
Vm_{std} (m^3)	Qm_{std} (m^3/min)	Vcr_{std} (m^3)	Qcr_{std} (m^3/min)	V_{cr} (m^3)	Y	ΔY	$Qm_{std/corr}$ (m^3/min)	$\Delta H_@$ (mm H_2O)	$\Delta\Delta H_@$ (mm H2O)
						Y Avg.			$\Delta H_@$ Avg.

Initial Scaling Factor

New Scaling Factor[7]

Notes

[1] For valid test results, the Actual Vacuum during calibration should be 1 to 2 in. Hg greater than the Theoretical Critical Vacuum shown above.

[2] The Critical Orifice Coefficient, K', must be entered in Metric units, [(m3)(°K)1/2)]/[(mm. Hg)(min)].

[3] For Calibration Factor Y, the ratio of the reading of the calibration meter to the dry gas meter, acceptable tolerance of individual values from the average is ±0.02.

[4] For $\Delta H_@$, orifice pressure differential that equates to 0.75cfm (0.0212m^3/min) at standard temperature and pressure, acceptable tolerance of individual values from the average is ±0.2in (5.1mm) H_2O.

[5] Recommended minimum run time per orifice is 10 minutes.

[6] Theoretical meter pressure (gauge) ΔH: 09 orifice - ~0, 40 orifice - ~7, 48 orifice - ~13.5, 55 orifice - ~27, 63 orifice - ~43, 73 orifice - ~76 (mm H2O).

[7] For a digital console calibration, enter the initial scaling factor for the console to get an updated scaling factor after the completed calibration. With the new scaling factor, the Y (Gamma) is now 1.0000.

Technician: ____________ Signature: ____________ Date: ____________

I certify that the above Dry Gas Meter was calibrated in accordance with US EPA Methods, CFR 40 Part 60.

7.3 Equations and Nomenclature

7.3.1 Equations

- $$V_{m(std)} = \frac{(V_m Y T_{std} P_{bar})}{(T_m P_{std})}$$
- $$C_{SO_2} = \frac{K_2 N (V_t - V_{tb})(V_{soln}/V_a)}{V_{m(std)}}$$
- $$V_{sb(std)} = V_{sb}(T_{std}/T_{amb})(P_{bar}/P_{std})$$
- $$Q_{std} = \frac{V_{sb(std)}}{\theta}$$
- $$V_{m(std)} = \frac{\bar{Q}_{std}\theta_s(1 - B_{wa})(P_{bar} + P_{sr})}{(P_{bar} + P_c)}$$
- $$V_{m(std)} = \frac{\bar{Q}_{std}\theta_s(1 - B_{wa})(P_{bar} + P_{sr})(M_a/M_s)^1}{(P_{bar} + P_c)}$$

7.3.2 Nomenclature

acf	=	actual cubic feet
acfm	=	actual cubic feet per minute
A	=	effective area of flue in square feet
acm	=	actual cubic meters
acmm	=	actual cubic meters minute
A_n	=	inside area of sampling nozzle in square feet
B_{ws}	=	water vapor in gas stream, proportion by volume
%C	=	percent carbon by weight, dry basis
%CO	=	percent carbon monoxide by volume, dry basis
%CO_2	=	percent carbon dioxide by volume, dry basis
C_p	=	pitot tube coefficient
D_I	=	dust loading per heat input in pounds (grams) per million Btu (calories) per Fr constant
D_I^3	=	dust loading per heat input in pounds (grams) per million Btu (calories) per Fr calculated
dscf	=	dry standard cubic feet
dscfh	=	dry standard cubic feet per hour
dscm	=	dry standard cubic meters
dscmh	=	dry standard cubic meters per hour
fps	=	feet per second
F_r	=	ratio factor of dry flue gas volume to heat value of combusted fuel in dry standard cubic feet (meters) per million Btu (calories)
gms	=	grams
gm-mole	=	gram-mole
grs	=	grains
ΔH	=	orifice pressure drop in inches water, average
%H	=	percent hydrogen by weight, dry basis
H_c	=	heat of combustion in Btu per pound, dry basis
hr	=	hour
%I	=	percent isokinetic
in. Hg	=	inches mercury
lbs	=	pounds
lbs-mole	=	pound-mole
%M	=	percent moisture by volume
mmBtu	=	million Btu
mmcal	=	million calories
mm Hg	=	millimeters mercury
mps	=	meters per second
M_s	=	molecular weight in pound (gram) per pound (gram) mole (wet basis)
%N	=	percent nitrogen by weight, dry basis
%N_2	=	percent nitrogen by difference, dry basis
%O	=	percent oxygen by difference, dry basis
%O_2	=	percent oxygen by volume, dry basis
P_b	=	barometric pressure in inches mercury
P_{std}	=	standard absolute pressure (29.92 in Hg)
P_s	=	absolute pressure in flue in inches (millimeters) mercury
P_f	=	static pressure in flue in inches water, average
$\sqrt{\Delta P}$	=	square root of velocity head in inches water, average
%S	=	percent sulfur by weight, dry basis
scf	=	standard cubic feet
scm	=	standard cubic meters
T_{std}	=	absolute temperature of air in degrees Rankine at standard conditions (528 degrees)
T_s	=	absolute temperature of flue gas in degrees Rankine, average
T_m	=	absolute temperature at meter in degrees Rankine, average
V_s	=	velocity of flue gas in feet (meters) per second
V_l	=	volume of condensate through the impingers in millimeters
V_{lc}	=	volume of liquid collected in condenser in millimeters plus weight of liquid absorbed in silica gel in grams indicated as milliliters
V_m	=	volume of metered gas corrected to dry standard conditions in cubic feet (meters)
V_{ms}	=	volume of metered gas measured at meter conditions in cubic feet
V_o	=	volume of flue gas at actual conditions in cubic feet (meters) per minute
Q_{sd}	=	volume of flue gas corrected to dry standard conditions in cubic feet (meters) per hour
V_t	=	total volume of flue gas sampled at actual conditions in cubic feet (meters)
V_w	=	volume of water vapor in metered gas corrected to standard conditions in cubic feet (meters)
V_{wc}	=	volume of water condensed in impingers corrected to standard conditions
V_{wsg}	=	volume of water collected in silica gel corrected to standard conditions
W_a	=	total weight of dust collected per unit volume in grains (grams) per actual cubic feet (meters)
W_d	=	total weight of dust collected per unit volume in pounds (grams) per dry standard cubic feet (meters)
W_g	=	total weight of dust collected in grams
W_h	=	total weight of dust collected per unit volume in pounds (grams) per hour, dry basis
W_p	=	total weight of dust collected in pounds
W_s	=	total weight of dust collected per unit volume in grains (grams) per dry standard cubic feet (meters)
W_{sg}	=	impinger silica gel weight gain in grams
Y	=	metered gas volume correction factor
θ	=	total elapsed sampling time in minutes

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