PRO903

Instruction Manual

Dilution Probe Conditioning Assembly &
Remote Probe Controller Assembly
Part Number 111984-00
24Sep2001

Thermo
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3. Copy of the packing list.

4. Photographs of damaged equipment and container.

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	REVISION HISTORY		
Revision No.	Revision Made	Pages Affected	Revision Date
2.0	Revise document to Word format, incorporate ECN 99-013 for internal AL flange.	All	September 24, 2001
3.0	Changed Logo	All	September 24, 2001

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1.0 PRODUCT DESCRIPTION

1.1 Introduction

The Installation and Operation Manual provides instruction for basic installation, preventive maintenance, corrective maintenance, and trouble shooting procedures for the PRO903 Dilution Probe Conditioning Assembly and Remote Probe Controller Assembly. This manual contains four sections:

Section 1 - Product Description: Hardware description, instrument operating parameters, and physical characteristics.

Section 2 - Theory of Operation: Complete functional description.

Section 3 - Installation and Operation: Instructions for installation and operation of the Dilution Probe Conditioning Assembly.

Section 4 - Maintenance: Routine inspection, trouble shooting, corrective procedures, and repair/replacement for major assemblies.

1.2 PRO903 Description

The PRO903 Dilution Probe Conditioning Assembly is a three-part package. Part one is the stack or duct mounted Dilution Probe Conditioning Assembly, Part two is the Wiring and Tubing Umbilicals, and Part three is the Remote Controller Assembly. The Dilution Probe Conditioning Assembly draws, conditions, and dilutes the process emissions to be transported for analysis. The Tubing and Wiring Umbilical connects the Dilution Probe Conditioning Assembly to the analyzers, calibration gas supply, purge instrument air supply, dilution air supply, and the Remote Probe Controller Assembly. Part three, the Remote Probe Controller Assembly, monitors and controls temperatures of subassemblies in the probe conditioning assembly and connects the Dilution Probe's alarm and control contact closures with the customer's control system.

PRO903 Dilution Probe Conditioning Assembly (please refer to the 7000 series Probe Box Assembly Drawings):

1. 24" x 24" x 9 3/4" Nema 4X Enclosure
2. Enclosure Heater
3. Dilution Air Regulator
4. Heated Filter, Dilution Eductor, and Probe Barrel Assembly
5. Heat Exchanger and Drain Valve Assembly
6. Heated filter control module
7. Valve control module (Watchdog)
8. Valve Manifold

Tubing and Wiring Umbilical (please refer to the 1200 series Umbilical Drawings):

1. Tubing Umbilical
2. Wiring umbilicals - Paired Wiring Umbilical, 12 Shielded Pairs, #20 AWG in PVC Jacket.

Remote Probe Controller Assembly: please refer to the 7000 series Probe Controller Drawings.

1.3 Dilution Probe Conditioning Assembly Hardware

The PRO903 Dilution Probe Conditioning Assembly consists of seven subassemblies used to condition, analyze, and transport the sample:

1. Probe Enclosure.
2. Enclosure Heater.
3. Valve Manifold and Dilution Air Regulator.
4. Heated Filter, Dilution Eductor, and Probe Barrel Assembly.
5. Heat Exchanger and Drain Valve Assembly.
6. Probe Power, Purge and Temperature Control.
7. Absolute Pressure Transducer.

1.3.1 Probe Enclosure

The Dilution Probe and Conditioning Assembly is housed in a fiberglass enclosure that measures approximately 24 inches (H), by 24 inches (W), by 9.75 inches (D). The enclosure is designed to protect the instruments and electrical controls from highly corrosive atmospheres. The PRO903 enclosure has an internal ½-inch aluminum mounting plate with 4 holes that match to standard 4-inch/150# ASI pipe flanges. The threaded holes accept ½”-13 studs (please refer to Figure 3.1, Enclosure Mounting Diagram).

1.3.2 Enclosure Heater

The enclosure heater is located on the bottom, right-hand side of the enclosure (please refer to the 7000 series Probe Box Assembly Drawing, item 17). The assembly consists of one 400-watt heat element, a 30 CFM fan, and an adjustable thermostat switch. The fan motor runs continuously when power is supplied to the probe conditioning enclosure heater. The heat element cycles on and off according to the temperature inside the enclosure and the temperature of the enclosure is maintained at 100°F by the adjustable thermostat.

1.3.3 Valve Manifold and Dilution Air Regulator

The Air Valve Manifold provides distribution of the box purge and heated filter purge air, and a place to conveniently mount the four valves for the Probe Conditioning Assembly. The four valves include: SV-1, the calibration valve used to inject calibration gas in the heated filter chamber; SV-2, the 3-way purge valve; and SV-3 and SV-4 , used to purge the heat exchanger.

The dilution air regulator is located on the left side of the Air Valve Manifold (please refer to the 7000 series Probe Box Assembly Drawings). The regulator is 0-60 PSI, set at 30 PSI, with a 0-60 PSI gauge.

1.3.4 Heated Filter, Dilution Eductor, and Probe Barrel Assembly

The Dilution Probe Assembly consists of a Hastelloy Probe Barrel and an Eductor Probe Head as shown in Figure 1.3. An Eductor Assembly and a Heated Filter Body make up the Eductor Probe Head. A heated, high capacity, sub-micron filter is housed in a Teflon® filter body, located within the Probe Head, and can be easily replaced during preventive maintenance.

The sampling probe barrel is typically a section of pipe with an outer diameter of 0.67 inches and an inner diameter of 0.50 inches. Probe barrel material is selected for compatibility with the process stream and is supplied in Hastelloy C-276. The standard four (4) foot probe barrel has an approximate 5° bend to prevent excess water buildup within the probe barrel in saturated processes.

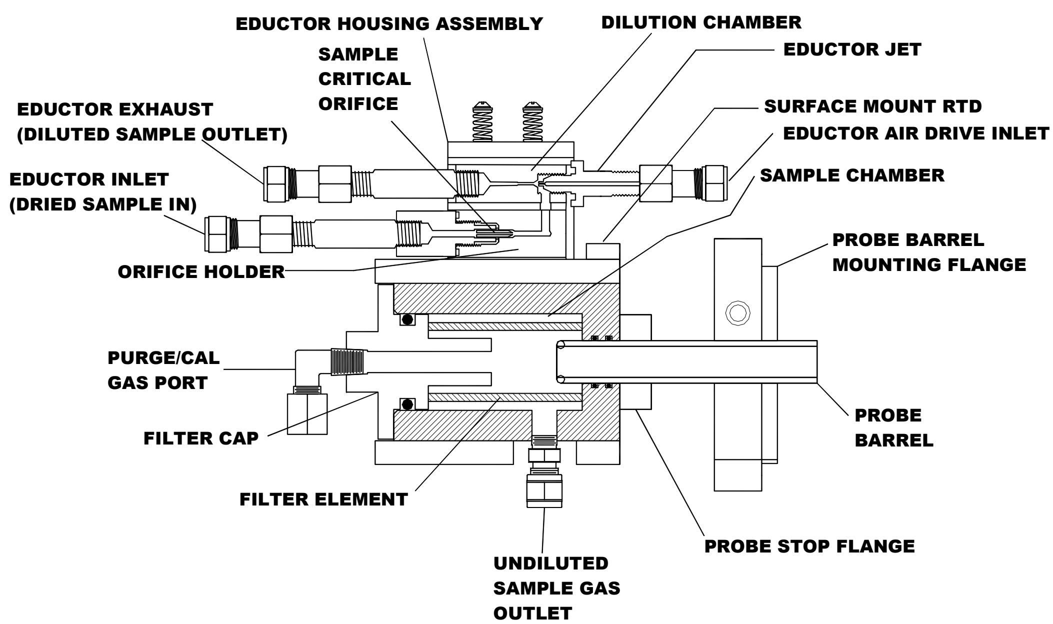

Figure 1.3 Dilution Probe Assembly

1.3.5 Heat Exchanger and Drain Valve Assembly

The Heat Exchanger and Drain Valve are located on the left wall of the Dilution Probe Assembly. A thermoelectric cooled Teflon® block, a moisture collection reservoir, an ambient exposed aluminum heat sink, and purge valve comprise the Heat Exchanger system.

The Heat Exchanger system removes moisture from the filtered sample immediately before dilution. The drain valve (SV-5) also allows the moisture trapped by the Heat Exchanger to dump during the blow-back purge mode.

A thermoelectric (TE) cooler cools the Heat Exchanger block to its operational temperature of 45°F. The Heat Exchanger control module contains an AC to DC bridge rectifier circuit to provide the necessary DC power for driving the TE cooler. A shroud fan directs 100 CFM of air over a heat sink to dissipate the heat generated by the TE cooler.

1.3.6 Probe Power, Purge and Temperature Control

Probe power, purge and temperature control are maintained by three sections: a power distribution section, a valve controller (Watchdog) module section, and a heated filter control module section. These three sections handle all power distribution and the digital interface from the Probe Controller Assembly (please refer to the 7000 series Probe Assembly drawings).

1.3.6.1 Power Distribution

The power requirement is 120VAC, 800 watts, 60 Hz. AC hot is supplied to Disconnect DC1. From DC1, AC hot is distributed to the Valve Controller Watchdog Module, the Heat Exchanger Control Module, the Enclosure Heater, and the Enclosure utility light and outlet. TB-2 supplies power and control for the heat exchanger temperature control. Please refer to the 7000 series drawings for the fuse schedule.

1.3.6.2 Valve Controller (Watchdog) Module

The Valve Controller (Watchdog) Module controls all valves and contains an internal timer for watchdog functions. Purge watchdog control is jumper-selectable for intervals of 8, 16, 32 or 64 minutes.

1.3.6.3 Heated Filter Control Module

The Heated Filter Control Module interfaces with the Watlow controller in the remote probe controller assembly to control the A/C heater for maintaining the factory set temperature of 285°F in the heated filter.

1.3.6.4 Heat Exchanger Control Module

The Heat Exchanger Control Module interfaces with the Watlow controller in the remote probe controller assembly to control a cartridge heater for cooling the heat exchanger block to a factory set temperature of 45°F.

1.3.7 Absolute Pressure Transducer

The Absolute Pressure Transducer is mounted on top of the purge valve (SV2) and produces a 4-20 mA signal, representing 16-32 inches Hg absolute pressure.

1.4 Tubing and Wiring Umbilicals

The tubing and wiring umbilicals are the main link between the Dilution Probe Assembly and the analyzer rack.

1.4.1 Tubing Umbilical

The tubing umbilical supplies purge and blow-back air, dilution air, calibration gas, and the sample return line for the analyzers in the analyzer rack. Purge and blow-back air is supplied by the 1/2" black polyethylene tube at 60 PSI to the Valve Manifold. Dilution air is supplied by the 1/4" black polyethylene tube at 60 PSI to the dilution air regulator. Calibration gas is supplied by a 1/4" clear Teflon® tube at 30 psi (limited to 2500cc/minute by flow orifice) to the calibration gas inlet on the Valve Manifold. The sample outlet is connected to a 1/4" clear Teflon® tube, to supply the analyzers in the analyzer rack with diluted sample.

1.4.2 Wiring Umbilical Table

Pair Number	Function	Signal
1	Heat Exchanger RTD Signal	4-20 milliamp
2	Heat Exchanger Control Signal	0-24 VDC Pulse Modulation
3	Heated Filter RTD Signal	4-20 milliamp
4	Heated Filter Control Signal	0-24 VDC Pulse Modulation
5	Spare	
6	Spare	
7	Absolute Pressure	4-20 milliamp
8	Spare	
9	Spare	
10	Spare	
11	Calibration Valve Control	0-24 VDC Contact Closure
12	Purge Control	0-24 VDC Contact Closure

1.5 Remote Probe Controller Assembly

The Remote Probe Controller Assembly monitors and controls temperatures of subassemblies in the Dilution Probe Conditioning Assembly. Subassemblies of the Remote Probe Controller Assembly include:

1. 3-1/2" X 15" X 17" Rack Mount Enclosure with Optional Slides
2. Interface Printed Circuit Assembly
3. Probe Heated Filter Temperature Controller
4. Heat Exchanger Temperature Controller

1.5.1 Remote Probe Controller Enclosure

The enclosure total length is 15 inches and the enclosure will mount in a standard 19-inch rack, excluding the additional space required on the back for connection of the two multiple-pin plugs. Connection clearances require the rack to be at least 24-inches deep.

Cannon plug #1 connects to the Dilution Probe Conditioning Assembly, and cannon plug #2 connects to the rack controller. A power entry module for a standard 115VAC cord connection is also on the back of the enclosure.

1.5.2 Interface Printed Circuit Assembly

The printed circuit assembly is manufactured by TFS. The card has one channel with an on-board, 24 VDC power supply for the 4-20 mADC outputs and digital control signals.

1.5.3 Temperature Controllers

Two Watlow Series 965 temperature controllers, located in the front of the CTL903 Probe Controller Assembly, provide readouts in degrees Fahrenheit (°F) or degrees Celsius (°C), as selected in the controller setup menu. Each upper display is the actual temperature of the controlled device and each lower display is the temperature set point.

On the face of each controller, located to the right of the temperature displays, are two LED's, labeled "L1" and "L2." L1 indicates that power is being applied to a heat element or to the TE cooler in the Heat Exchanger. L2 indicates that the temperature has strayed past the alarm set point and, if an alarm device is connected to the alarm output, an alarm will be sounding.

The Watlow controllers monitor and control the Probe Heated Filter temperature (275-285°F) and the Heat Exchanger temperature (35-45°F).

1.6 Specifications

The PRO903 Dilution Probe Conditioning Assembly was designed to operate within the following specifications:

Power Requirements:	120 VAC, 800 Watts
Power Connection:	CSA/UL Approved screw terminal. Terminal wire capacity up to 10 AWG.
Operating Temperature Range:	-20°C to 50°C (-4°F to 122°F)
Maximum Process Temperature:	600°C (1112°F)
Calibration Gas Flow Rate	2.0 L/minute minimum 2.5 L/minute maximum
Enclosure Temperature:	37.7°C ± 3°C (100°F ± 5°F)
Instrument Air Supply:	60 PSIG (400 kPa) minimum, 80 PSIG (550 kPa) maximum, via ½-inch tubing, 0.300 inch minimum I.D.
Eductor Flow Rates:	
Heated Eductor Assembly:	
Sample Flow:	approx. 100-300 cc/minute
Dilution Flow:	approx. 5-10 L/minute
Eductor Pump Assembly:	
Sample Flow:	approx. 100 cc/minute
Dilution Flow:	approx. 5 L/minute
Heat Exchanger:	
Cooler Block Temperature:	7.2°C (40°F - 50°F)
Heated Eductor/Filter Body Temperature:	140.5°C ± 5.5°C (285°F ± 10°F)
Materials of Construction:	
Enclosure:	Fiberglass
Mounting Method	4 each, ½-13 x 3 SS bolts, mates to customer's 4"-150# flange
Sample Orifice:	Quartz
Eductor Jet:	Torlon® or suitable material
Eductor Body:	Torlon®
Orifice Holder Body	Torlon® or suitable material
Heated Filter Body:	Stainless Steel or suitable material
Probe Barrel:	Hastelloy - C276
Heat Exchanger/Cooling Block:	Teflon® or suitable material
Connecting Lines/Sample Lines:	Teflon®
Weight:	
Dilution Probe Conditioning	

Assembly:	73 lbs (33.1 kg)

2.0 THEORY OF OPERATION

2.1 General

The PRO903 Dilution Probe Conditioning Assembly extracts a continuous sample from a stack or duct, removes entrained liquids and water vapor and delivers a clean dry sample for transport to a gas analysis system.

2.2 Gas Flow Functional Description

A regulated source of instrument air is connected to the dilution eductor jet through the pressure regulator (PR-1) and pressure gauge (PI-1). The pressure regulator precisely regulates the air pressure to within 0.04 PSI (.3kPa) for a 10 PSIG (70kPa) change in input pressure. The flow through the air jet creates a vacuum that pulls the sample gas through the Dilution Probe Conditioning System and is also used to dilute the sample gas to lower concentrations: therefore, the air supply quality and pressure are vital for proper probe operation.

The dilution eductor air flow rate is set and controlled by a dilution critical orifice in the air jet, operated at 30 PSIG (200kPa) to provide the sample gas critical orifice pressure drop of 15 inches Hg (50kPa), or greater. The dilution air and sample gas flow rate may be set by selecting different orifice combinations. Dilution flow rates (between 5 and 10 liters/minute) may be chosen in combination with different process sample gas flow rates (between 50 and 300 cc/minute) to yield dilution ratios between 16:1 and 100:1. The process sample gas and dilution air are combined within the eductor, and the diluted sample gas exits the Dilution Eductor Assembly through the eductor exhaust port.

In the primary sample path (the dilution path), the Heated Eductor Assembly pulls a portion of the dry, undiluted sample gas from the heat exchanger into the heated eductor sample inlet. Please see Figure 2.2, Probe Head Flow Diagram. It is then carried through a protection filter and sample critical orifice into the dilution chamber for dilution. The protection filter protects against particulate matter that may be dislodged during the heated filter replacement. Installed immediately downstream of the heat exchanger, this one-micron filter protects the heated eductor assembly. The filter does not normally require maintenance, but visual inspection will reveal when contamination may be present.

The eductor sample critical orifice, contained within the filter/jet cartridge, is fabricated from quartz. The orifice temperature is maintained at 140.5°C ± 5.5°C (285°F ± 10°F). From the orifice, the process gas passes to the vacuum cavity of the dilution eductor. The Dilution Eductor Assembly is heated by an extension of the heated aluminum housing.

From the eductor exhaust port, the diluted process gas passes to a vent bulkhead on the Conditioning Assembly enclosure. A portion of the diluted sample is pulled through a sample bulkhead and the unheated Teflon® sample line by a sample transport pump to the remote analysis system. In some cases, the Sample Transport Assembly may be eliminated if the distance between the probe assembly and the remote analyzer is 50 feet or less.

Typical transport flow rates from the Conditioning Assembly to an external analysis system range from 1.5 to 3.0 liters per minute. This gives the analytical instruments a response time of 2 to 5 minutes, depending upon application, which is adequate for most process control and environmental monitoring requirements. System response time requirements have been met with the PRO903 Dilution Probe Conditioning Assembly by a three-step process. Upon extraction from the stack, the process sample gas is filtered, dried via the heat exchanger, and diluted.

To further simplify the gas conditioning system, the process stream is immediately diluted at the sample source using dry air with dew points in the range of -40.0°C to -73°C (-40°F to -100°F). The dew point of the gas stream leaving the PRO903 Probe is primarily a function of the dilution air dew point. Dilution ratios of 16:1 to 100:1 are easily achieved. The exit sample dew point of -7.8°C to -37.2°C (0°F to -35°F) allows use of unheated sample lines in all but the most extreme environments.

Operation of the Dilution Probe Conditioning Assembly consists of three modes: Sampling, Blow-back Purge, and Calibration.

2.2.1 Sampling Mode

Process gas enters the sampling system at the probe tip and flows down the probe at a low flow rate of 50-300 cc/min. Particles larger than 5 microns settle out on the probe walls due to the low sample velocity.

From the sampling probe, the gas enters the heated filter chamber shown in the cross section in Figure 2.2, below. The filter body is heated and controlled by an external temperature controller and cartridge heating element between 135°C - 146.1°C (275°F - 295°F). The sample gas then flows from the heated filter chamber through the heated filter and exits from the heated filter body through the filter chamber outlet. The glass fiber filter element, with a Teflon® binder having a 0.1-micron efficiency rating, is selected for its inertness to the process gas. The filter element may be replaced by removing the filter cap and 0-Ring. The filtered sample gas is then conditioned by the heat exchanger.

The sample gas is extracted using two precision, low flow Eductor Assemblies that are driven by instrument quality air. The Heated Eductor Assembly and the Eductor Pump Assembly pull a portion of the total sample flow through the heated filter and the heat exchanger.
Once the filtered sample gas enters the Teflon® heat exchanger cooling block, any condensable or entrained liquids are condensed and collected in the liquid reservoir at the lower extreme of the cooling block. The heat from the cooling block is removed using a thermoelectric cooler and then transferred to the externally mounted aluminum heat sink. The temperature of the block is maintained by the heat exchanger controlling the electronics.

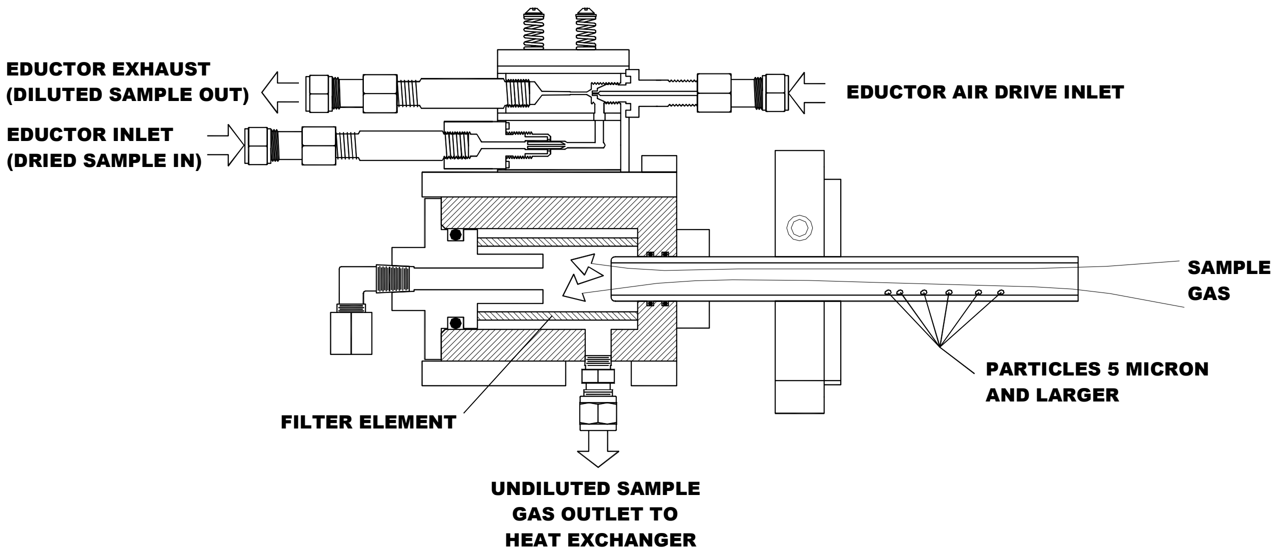

Figure 2.2 Probe Head Flow Diagram

2.2.2 Purge Mode

A purge cycle occurs periodically to clear various sections of the Dilution Probe Assembly and Heat Exchanger from moisture and particulate matter. The purge solenoid valves are operated automatically through a controller in the remote or local analysis system. The filter body and probe barrel are purged in a simultaneous two part process while the moisture collection reservoir is dumped to clear the Heat Exchanger. Purge frequencies may vary from every 15 minutes, for applications with extremely heavy particulate concentrations, to several hours for cleaner applications. The blow-back pulse lasts approximately 10 seconds. Longer purge times could result in dilution probe cooling.

Particulate matter is removed from the probe barrel and the heated filter by the periodic introduction of high pressure blow-back air from the blow-back solenoid valve (V-2), and the heated filter/exchanger purge solenoid valve (V-4), into the filter body and exiting into the process through the probe barrel. The heated filter/exchanger purge is used to remove particulate buildup from the inside surface of the heated filter. When the particulate is dislodged, it is carried out of the filter chamber and through the probe barrel with the blow-back air. The heated filter/exchanger purge air enters the heated filter body through the sample gas outlet and simultaneously enters the Heat Exchanger cooling block inlet. The purge air is introduced through the filter cap that houses the blow-back/calibration gas inlet.

Moisture is removed from the Heat Exchanger sample inlet line and the moisture collection reservoir during the purge cycle. The moisture reservoir drain valve (V-3) opens to drain collected moisture from the Conditioning Assembly. The high-pressure purge air from the heated filter/exchanger purge solenoid valve (V-4) enters the cooling block inlet to force out the moisture from the block through the drain opening (V-3).

2.2.3 Calibration Mode

The PRO903 Dilution Probe Conditioning Assembly is calibrated by passing a gas of known concentration through all the components in the sample analysis system and adjusting the response of the gas analysis system to reflect the known value of the calibration gas. Calibrating in this manner compensates for total system losses in filter elements or other pneumatic components, changes in dilution air flow rates and changes in process gas flow rates.

A typical calibration gas flow path is as follows: from the calibration gas cylinder, the gas flows through a flow controlling device and calibration gas valve, located in a remote or local gas analysis system, through the calibration gas line to the PRO903 Dilution Probe Conditioning Assembly calibration gas inlet. The gas enters the Dilution Probe through the calibration gas solenoid valve (V-1) and then into the filter body through the blow-back/calibration gas inlet. The calibration gas solenoid valve allows the flow of calibration gas to be initiated remotely through a controller in the remote or local analysis system. The calibration gas valve is located as close as possible to the blow-back/calibration gas inlet to prevent process condensation from forming in the calibration line between calibrations. From the heated filter body, the calibration gas passes through all system components at the same flow rates and conditions as the process sample gas.

3.0 INSTALLATION AND OPERATION

3.1 Site Location and Preparation

40 CFR Performance Specification Two (2) provides a guide to proper site selection, and lists several points that should be considered for most applications. The most accurate readings will usually be obtained when Performance Specification Two (2) is followed.

The PRO903 Dilution Probe Conditioning Assembly is installed on a customer-supplied four (4) inch pipe flange. The pipe flange must be installed on a pipe nipple extending six (6) inches from the outer wall of the stack. The nipple is used to allow clearance behind the Conditioning Assembly for installation of the four (4) ½-13 x 3 stainless steel mounting bolts. Also allow a clear space, at least the width of the probe enclosure, in front of the enclosure door to allow the door to be opened. The four (4) inch pipe flange must be aligned as shown in Figure 3.1. A slip-type pipe flange is recommended to insure that the Conditioning Assembly can be leveled.

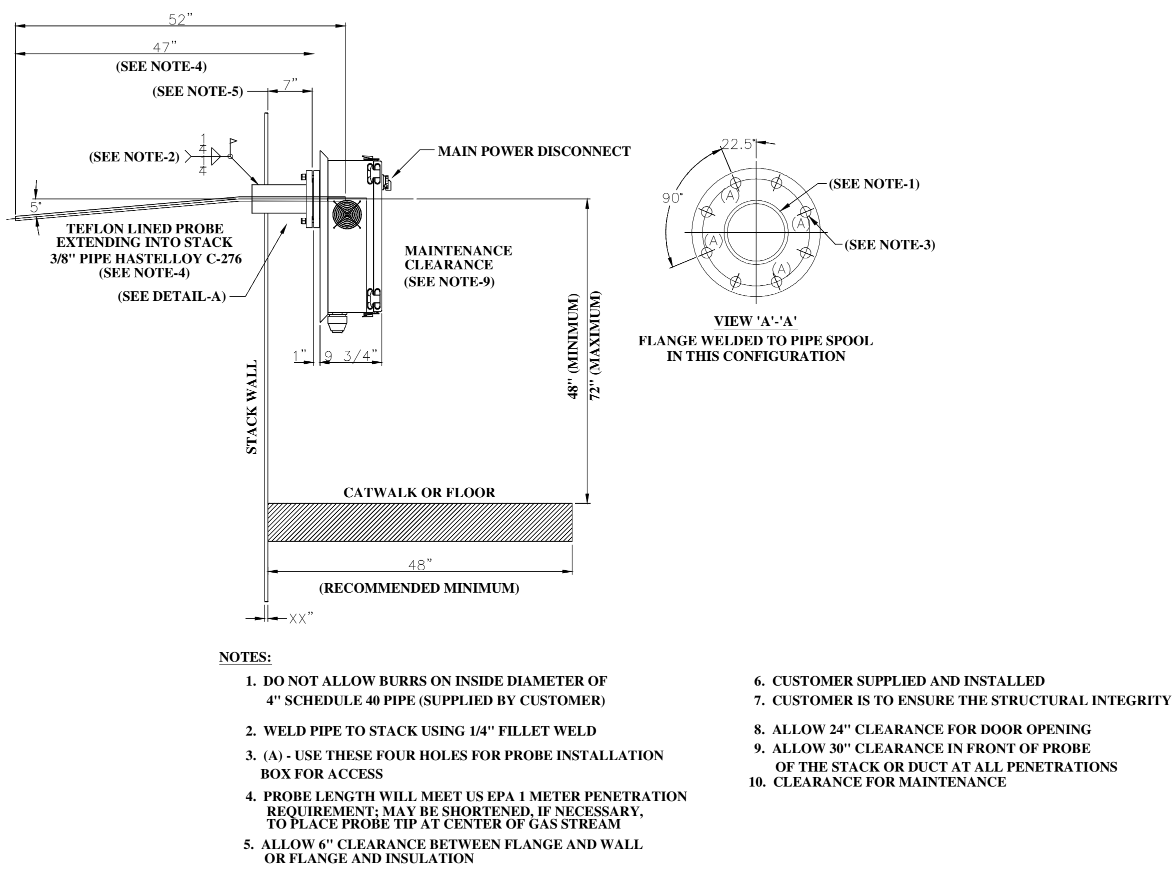

Figure 3.1 Enclosure Mounting Diagram

The Dilution Probe Conditioning Assembly should be installed in a location that will allow maintenance personnel access to the front of the enclosure. All maintenance can be performed from the front of the unit.

3.2 Limitations at the Probe Site

The placement of the PRO903 Dilution Probe Conditioning Assembly is important to achieve its maximum reliability.

3.2.1 Stack Temperature Extremes

The PRO903 Probe Barrel was supplied using Hastelloy C-276, Teflon® Lined Hastelloy C-276, or other suitable material specific to the application. The Teflon® lined Hastelloy probe barrel may be used at temperatures up to 190.5°C (375°F) and lengths up to six (6) feet long. Use the shortest possible probe barrel length (less than six feet) for proper response times and consistent sampling.

3.2.2 Ambient Temperature Extremes

The PRO903 Dilution Probe Conditioning Assembly may be operated at a maximum ambient temperature of -20°C to 50°C (-4°F to 122°F). This upper temperature is selected to assure proper operation of the electronic circuitry and solenoid valves contained in the enclosure. Optimum operation of the sampling system will always be achieved if a sampling location is selected with moderate temperatures.

3.2.3 Process Pressure

The sampling system should not be installed in sampling locations that have pressures which exceed +5 inches H_2O (1.2kPa) or -10 inches H_2O (-2.5kPa). Positive pressure ducts are a special problem because process gases may escape into the area of maintenance personnel when the filter body is opened for maintenance. Positive pressure stacks or ducts may be easily sampled if a small portion of the stream is vented to atmosphere and the probe installed to sample this atmospheric vent. The probe typically pulls between 50 and 300 cc/minute, requiring only a small bypass flow.

3.3 General Installation

3.3.1 Dilution Probe Conditioning Assembly

The Dilution Probe Conditioning Assembly is shipped in two separate containers. The Conditioning Assembly is installed first and then the probe barrel is installed through the back of the Conditioning Assembly into the stack. To install the Dilution Probe Conditioning Assembly, perform the steps outlined in the following three sections.

Conditioning Assembly Installation

Install the Conditioning Assembly on the four (4) inch flange using a proper flange gasket and four ½-13 x 3” stainless steel bolts: please see Figure 3.1.

Probe Head Removal

A) Open the Conditioning Assembly door and locate the Dilution Probe Head. Carefully cut and remove the shipping tie wrap from the probe head and support bracket.

B) Note the placement of all five (5) Teflon® tubes connected to the probe head. Loosen each of the Teflon® tube connection fittings and remove the tubes.

C) Disconnect the cartridge heater and the RTD from the probe box wiring.

D) Loosen the probe head securing wing nut, located underneath the support bracket.

E) Remove the probe head from the bracket and place in a safe, clean area during probe barrel installation.

Probe Barrel Installation

A) Inspect the Probe Barrel Assembly for proper flange spacing and orientation (factory set): please see Figure 3.3 on the following page.

B) Install the probe flange gasket (factory supplied) over the process end of the probe barrel, for sealing process gases from the Conditioning Assembly enclosure.

C) Insert the Probe Barrel Assembly through the flange porthole, in the back of the Conditioning Assembly, with the bend downward. Align the three-hole probe mounting flange and flange gasket to the three-hole pattern of the Conditioning Assembly flange porthole.

D) Insert the three (3) supplied 1/4-20 X 1-3/4 inch bolts through the probe mounting flange into the threaded holes, and tighten.

E) Coat the polished probe tip surface with a liberal amount of silicone-based high vacuum grease. This allows a proper O-Ring seal of the probe head.

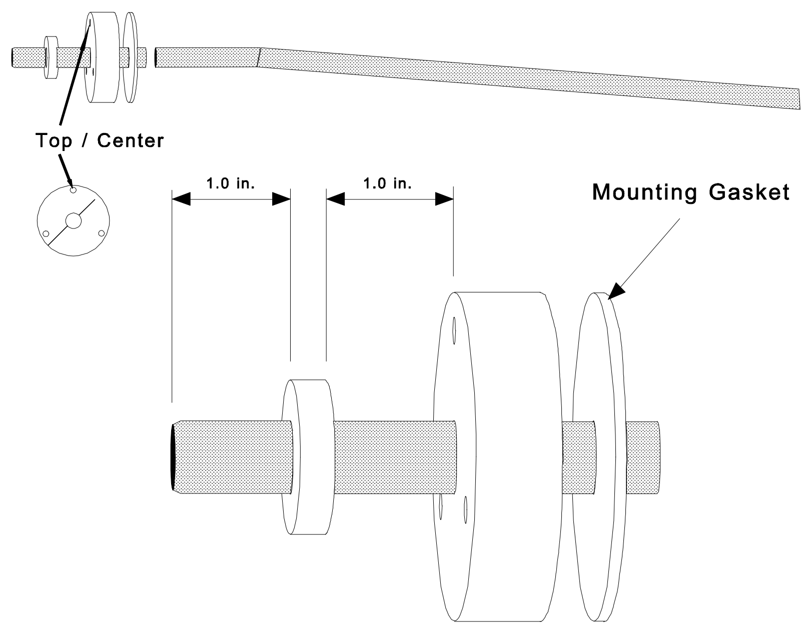

Figure 3.3 Probe Barrel Assembly

Probe Head Installation

NOTE: Before initial installation of the Dilution Probe Assembly, and after any probe head maintenance, the tests described in Sections 4.9 and 4.10 of this manual should be performed. The probe pre-test verifies that the Probe Assembly is leak free and has the proper flow rates.

A) Reinstall the probe head by sliding the probe head over the polished probe tip. The rear of the probe head is usually tilted upward during installation to allow clearance for the sample outlet fitting.

B) Reinstall all items removed during steps B and C of the Probe Head Removal Section:

1) Connect the eductor dilution air.

2) Connect the eductor exhaust tube.

3) Connect the eductor inlet tube.

4) Connect the calibration/purge tube.

5) Connect the sample outlet tube.

6) Connect the probe filter heater cartridge.

7) Connect the RTD on top of the heated filter, next to the eductor assembly.

8) Check all connections and confirm that the cartridge heater and thermistor are installed to maximum depth.

3.3.2 Air Supply

NOTE: Do **NOT** apply pressure to the Conditioning Assembly until Start-up, Section 3.4. This section is for air line connection, only.

The air supply must have a dew point of at least -40°C (-40°F). A low dew point will prevent condensation in the unheated sample line and reduce sample loss. The air supply should have a minimum pressure of 60 PSIG (400kPa) to ensure an adequate blow-back. The typical TFS Air Clean-up Assembly meets these requirements.

Connect a 1/2-inch O.D. minimum air supply line to the instrument air inlet of the Conditioning Assembly. The instrument air supply inlet is accessed through a 1/2-inch stainless steel compression tube fitting located at the bottom of the Conditioning Assembly.

3.3.3 Sample and Calibration Gas Lines

Connect the Teflon® sample and calibration gas lines to the appropriate 1/4-inch compression type tube fittings located at the bottom of the Conditioning Assembly. The maximum length for the sample and calibration lines varies with individual applications. Please refer to the specific installation drawings for each application.

3.3.4 Vent Line

A ¼ inch rubber grommet and Teflon® tube are supplied for the vent.

NOTE: ~~The sample vent/eductor exhaust should never be restricted or pressurized.~~

3.3.5 Power

A standard 120VAC, 15A service is required to operate the PRO903 Dilution Probe Conditioning Assembly. Service must be supplied using 12 AWG minimum. For long runs where voltage drops may occur, 10 AWG may be used.

Connect the power to Disconnect Switch DC1, TB-1 and the grounding screws (please refer to the site-specific wiring drawings). DC1 is a UL and CSA approved disconnect switch rated for 10 AWG wire, 20 Amps AC. A power cable entry to the Conditioning Assembly is supplied through a ¾ inch conduit hub.

3.3.6 Control and Data Lines

Connect signal lines using specified shielded cable for control lines for calibration, blow-back, and purge valves. A cable entry to the Conditioning Assembly is supplied through a ½-inch CGB. (Please refer to specific installation drawings for each application site.)

3.4 Dilution Probe Conditioning Assembly Start-up

A) The Dilution Probe Conditioning Assembly start-up procedure may be performed only after the installation procedure outlined, above, has been completed and all wiring and tubing connections have been rechecked for accurate hook-ups.

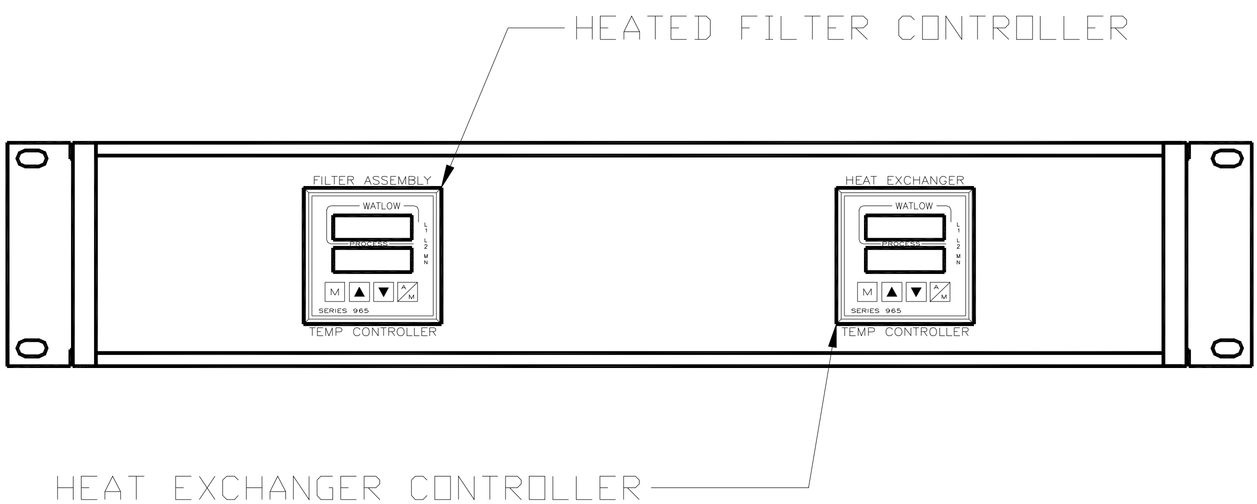

Figure 3.4 Probe Controller Front Panel

B) Heated Filter and Heat Exchanger temperature controller setup procedure.

1. Remove the Watlow controllers from the front panel and check the dip switches on the backs of the controllers: both switches should be in the "on" position.

2. Reinstall the temperature controllers and apply power to the remote probe controller assembly via the power switch located at the rear of the chassis.

3. Please refer to Table 3.4-1, below, for parameter set points for each controller. Enter the setup menu by pressing and holding the up and down arrows on the controller for three seconds. The controller will enter the setup menu when "LOC" is displayed on the lower window.

4. To proceed to the next parameter, press the M (mode) key.
NOTE: all outputs will be switched off while in the setup menu.

Parameter	Function	Heated Filter Settings	Heat Exchanger Settings
LOC	Lockout Security Level	0	0
In	Input Type	420	420
dEC	Decimal Point Placement	0	0.0
rL	Low Temperature Range	32	0
rH	High Temperature Range	626	176
Ot1	Output Type #1	Ht	Cl
HSC	Hysterisis Control	3.0	0.3
Ot2	Output Type #2	dEA	dEA
HSA	Alarm Hysterisis (Dead Band)	2	.2
LAt	Alarm Latching	NLA	NLA
SiL	Alarm Silencing	OFF	OFF
rP	Ramping (not used)	OFF	OFF
PL	Power Limiting	100	not used
dSP	Display Windows	NOr	NOr

Table 3.4-1 Setup Menu Parameters

5. Please refer to Table 3.4-2, below, for parameter set points for each controller. Enter the operation menu by pressing the M (mode) key. The controller is in the operation menu when "Pb1" is displayed on the lower window. To proceed to the next parameter, press the M (mode) key. These parameters will be automatically entered after the Auto-tune is complete.

Parameter	Function	Heated Filter Settings	Heat Exchanger Settings
Pb1	Power Band #1	6	15
rE1/dE1	Reset #1	.17	0.15
Ra1/dE1	Rate #1	.29	0.1
Ct1	Cycle Time #1	1.0	1.0
ALO	Low Alarm Setpoint	-10.0	-5.0
AHI	High Alarm Setpoint	+10.0	+5.0
CAL	Calibration Offset	0.0	0.0
Aut	AutoTune Function*	Do Not Autotune	Do Not Autotune

Table 3.4-2 Operation Setup Menu

* Auto Tune will be engaged when a value other than 0 is entered into the Aut Parameter. When the Auto Tune is complete, the value will automatically revert back to 0.

C) Go to the Dilution Probe Assembly and verify that the dilution air regulator has been turned off. This will keep moisture from contaminating the system until temperature set points are reached.

D) Apply power to the Dilution Probe Assembly by turning on the rotary power switch. Using a digital thermometer, check the temperature of the Heated Filter Assembly and the Heat Exchanger Assembly, via the thermocouple port drilled into each assembly. Make sure that both temperatures are approaching their set points. When both temperatures have stabilized, return to the Probe Controller Assembly for the next step.

E) At the controller, check that both temperature controllers show a temperature within 10°F of the set point. On the Heated Filter temperature controller, push the M (mode) key until "Aut" is on the display and use the "up" key to enter a "2." The controller will begin an autotune and the Heated Filter temperature will cycle up and down until the controller has set autotune parameters. ***Do not perform the autotune on the Heat Exchanger temperature controller.***

F) Using a digital thermometer, verify the Heat Exchanger temperature is 40-45°F.

G) Using a digital thermometer, verify the Heated Filter temperature is 275-295°F.

H) Verify that the probe enclosure temperature is 100°F.

I) Turn on the main air supply from the Air Clean-up Assembly and adjust the dilution air supply regulator (PR1) to 30 PSI (200kPa).

J) Complete the leak, flow and vacuum tests outlined in sections 4.8, 4.9 and 4.10.

K) Complete a purge cycle on the Dilution Probe Conditioning Assembly.

L) The Dilution Probe is now ready to be calibrated with the complete CEM system.

3.5 Absolute Pressure Transducer Checkout Procedure

A) Obtain the current Barometric pressure reading in inches of Hg.

B) At the Dilution Probe Assembly, locate the Stack Pressure Signal at VCM1 of the Valve Control Watchdog Module, terminals 26(-) and 27(+). Place an ammeter in series with this signal to measure 4-20 mADC. The pressure transducer range is 16-32" Hg.

C) Remove the calibration gas inlet tube at the Heated Filter Assembly to allow the pressure transducer to measure the current Barometric pressure. The 4-20 mADC signal should be equal to: Barometric pressure in inches Hg minus 12 equals output in mADC (Hg – 12 = mADC). Tolerance is +5.0%. There are no field repairs or alignment procedures for this component.

D) Reconnect the calibration gas tube to the Heated Filter Assembly.

4.0 MAINTENANCE

4.1 General

The following procedures are designed to allow the maintenance technician to accomplish all necessary maintenance procedures on the PRO903 Dilution Probe Conditioning Assembly. With the exception of changing the heated filter element, none of these procedures are to be considered as normal maintenance and should only be performed in the event of a calibration failure, other trouble shooting procedure, or after disassembly of the Heated Filter/Eductor Assembly.

4.2 Required Maintenance Equipment

To perform maintenance on the sample system, the following equipment is required.

A. Vacuum gauge 0-30 inches Hg (0-100kPa)
B. Flow meter 0-500 cc/minute (P/N 29020006 or equivalent)
C. Flow Meter 0-10 L/minute (P/N 29020009 or equivalent)
D. Temperature meter 0-260°C (0-500°F)
E. Tweezers (to remove quartz jet)
F. 2 ea. 1/4" tube cap (Teflon®)
G. 2 ea. 1/8" FPT pipe cap
H. Probe Adapter 3/8" pipe to 1/4" tube (P/N 07990000)
I. Vacuum Pump 20 inches Hg (70kPa) (P/N 26006022 or equivalent)
J. Standard Hand Tools
K. High Vacuum Silicone Grease (P/N 16000003 or equivalent)

4.3 Heated Filter Replacement

NOTE: The existing heated filter must be replaced with a new one each time the filter cap is removed (the filter is slightly crushed to seal). Once a crushed filter is removed, it will not seal properly and should not be used again.

A) Turn off the Dilution Air Regulator to prevent any contamination in the critical orifice while the filter cap is removed. Remove the three nuts that secure the heated filter cap.

B) Remove the main filter cap by pulling straight back on the filter cap tube fitting. The filter is snugly fit with an O-Ring seal.

C) Remove the filter from the mandrel of the heated filter cap.

D) Inspect the filter body and cap for particulate accumulation around the filter seats. Clean the filter body and seat by wiping with a soft cloth.

E) Lubricate the cap O-Ring with a light coating of silicone based high vacuum grease.

F) Install the **new** filter element onto the cap mandrel and insert the cap and filter into the filter body.

G) Align the screw holes in the cap with the screw holes in the body and press the cap into the filter body. Reinstall the nuts. Hand tighten the nuts, only.

4.4 Quartz Orifice Replacement

The quartz orifice may be changed by removing the eductor inlet tube. The orifice is sealed in the bore by an O-Ring and may be removed by grasping the orifice with tweezers and pulling straight back. If the O-Ring does not come out with the orifice, remove the O-Ring with the tweezers. Install a new orifice by placing the orifice O-Ring on the orifice and inserting the smaller end of the orifice into the orifice bore.

4.5 Probe Head Removal

A) Note the dilution air pressure setting, then turn off the power and air supplies.

B) Disconnect the air supply tubing to the eductor air jet.

C) Disconnect the sample tubing from the eductor exhaust.

D) Disconnect the purge/calibration tubing from the filter cap.

E) Disconnect the raw sample outlet tubing from the bottom of the filter body.

F) Loosen the filter body wing nut.

G) Remove the heater and RTD from the rear of the filter body.

H) Remove the Probe Head from the Probe Barrel.

I) Prior to reinstalling the Probe Head, coat the polished probe tip surface with a liberal amount of silicone-based high vacuum grease. This allows a proper O-ring seal of the Probe Head. Install the Probe Head in the reverse order of removal.

4.6 Orifice Holder Assembly Removal

A) Remove the Probe Head as described in section 4.5.

B) Remove the eductor assembly housing insulated cover.

C) Remove the four (4) spring screws and remove the flat washers and springs.

D) Remove the eductor assembly top cap.

E) Remove the eductor jet assembly and orifice holder assembly from the eductor assembly housing. Gently break the modules apart at the gasket.

F) Clean the sealing gasket by removing all hardened vacuum grease. Lubricate the gasket with a fresh, thin coat of silicone high vacuum grease. Do no let any grease get in the gasket opening.

G) Reassemble the eductor assembly in the reverse order of disassembly, being sure to align the block passages with the gasket opening.

H) The top plate springs measure ½-inch, uncompressed. Tighten the nuts until the spring height is approximately 3/8 of an inch.

I) Reinstall the Probe Head.

J) Return the air supply to the exact previous pressure.

4.7 Eductor Jet Body Removal

The eductor block may be removed as follows:

A) Remove the Probe Head as described in section 4.5.

B) Remove the eductor assembly housing insulated cover.

C) Remove the four (4) spring screws and remove the flat washers and springs.

D) Remove the eductor assembly top cap.

E) Remove the eductor jet assembly and the jet cartridge assembly from the eductor assembly housing. Gently break the modules apart at the gasket. The eductor jet assembly can now be repaired or replaced.

F) Clean the sealing gasket by removing all hardened vacuum grease. Lubricate the gasket with a fresh, thin coat of silicone high vacuum grease. Do no let any grease get in the gasket opening.

G) Reassemble the eductor assembly in the reverse order of disassembly, being sure to align the block passages with the gasket opening.

H) The top plate springs measure ½ inch, uncompressed. Tighten the nuts until the spring height is approximately 3/8 of an inch.

I) Reinstall the Probe Head.

J) Return the air supply to the exact previous pressure.

4.8 Probe Head Leak Test

Cap the eductor air inlet (dilution air) and the eductor exhaust (outlet) ports, then connect a hand held vacuum pump to the eductor sample inlet as shown in Figure 4.8. Pull a minimum vacuum of 20 inches Hg (70kPa) with the vacuum pump as shown on the vacuum gauge and record this value. The vacuum reading must not drop by more than 0.5 inches Hg (1.7kPa) in 1 minute.

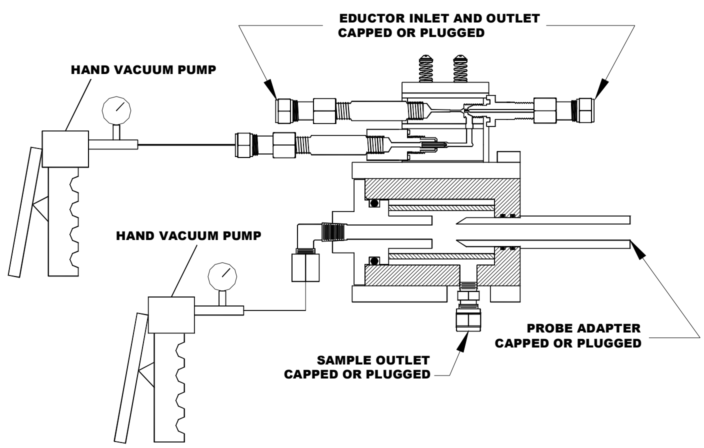

Figure 4.8 Probe Head Leak Test Configuration

Remove the hand held vacuum pump from the eductor sample inlet port and connect it to the purge/calibration inlet (heated filter cap). Install a probe adapter fitting into the sample probe barrel port as shown in Figure 4.8. Pull a minimum vacuum of 20 inches Hg (70kPa) with the vacuum pump as shown on the vacuum gauge and record this value. The vacuum reading must not drop by more than 0.5 inches Hg (1.7kPa) in 1 minute.

4.9 Probe Head Flow Test

The Dilution Probe may be supplied with various jets to accomplish different dilution ratios. Please refer to the site-specific system flow diagram to obtain the proper flow rates.

Connect a mass flow meter in-line to the eductor exhaust (outlet) port (eductor outlet flowmeter as shown in Figure 4.9). When 30 psi instrument air is supplied to the eductor (dilution) air inlet port, the meter flow rate should be approximately the same value as the value recorded on the system flow diagram.

Repeat the flow test with a flow meter connected to the eductor sample inlet port (dry sample flowmeter in figure 4.9). When 30 psi instrument air is supplied to the eductor (dilution) air inlet port, the meter flow rate at the sample inlet port should be approximately the same value as the value recorded on the system flow diagram.

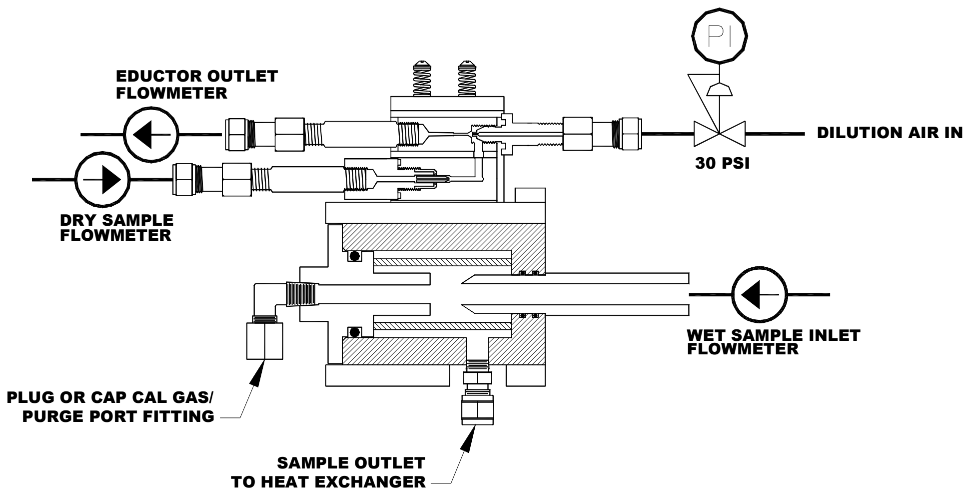

Figure 4.9 Probe Head Flow Test Configuration

4.10 Eductor Vacuum Test

Connect the hand held vacuum pump to the eductor inlet port as shown in Figure 4.10, below. The hand held vacuum pump is used for its vacuum gauge only. With the instrument air pressure of 30 PSIG (200kPa) supplied to the eductor air jet, the eductor must pull a minimum of 17 inches Hg vacuum.

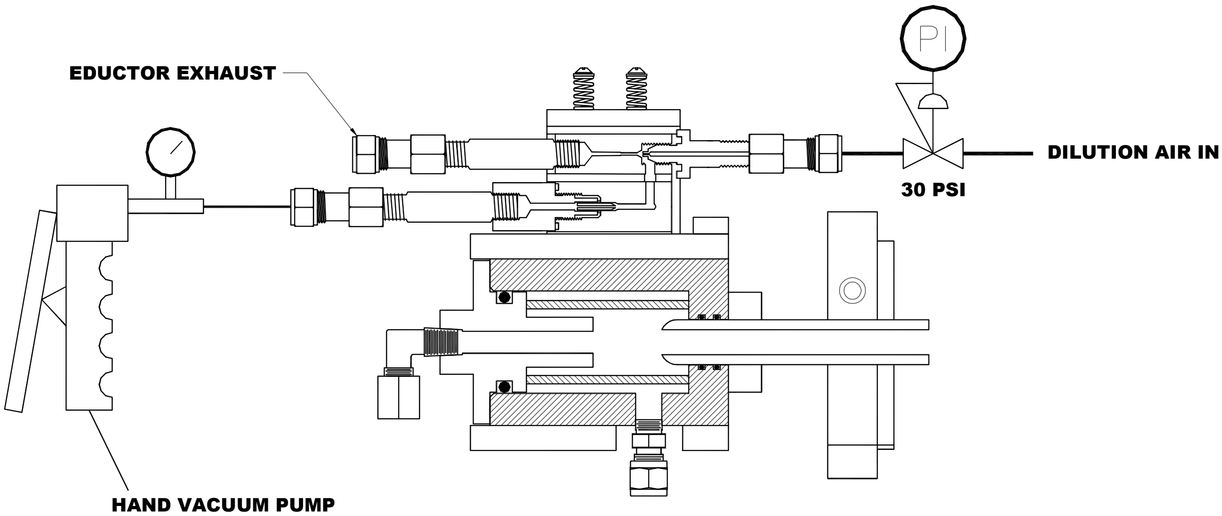

Figure 4.10 Eductor Vacuum Test Configuration

4.11 Trouble Shooting

4.11.1 Zero Drift - Full System

Zero drift is independent of the dilution system, as any dilution of a zero gas will still cause a zero indication on the analyzer. Analyzer zero drift may be caused, however, by trace levels of the measured gas in the dilution air supply. Either obtain the dilution air from a different source or install suitable air cleanup devices to remove the gas of interest. Check the analyzer location for large temperature changes or other changes in the analyzer utilities. Please see the system manual for zero drift calculations.

4.11.2 Span Drift - Full System

Span drift may be caused by many different variables throughout the monitoring system. Most problems with the sampling system will be indicated by a failure to pass the daily span calibration. Failure to pass the daily calibration is subdivided into several different problem areas that would cause a high or low indication on daily calibration. For each possible problem, a corrective action is listed. Please see the system manual for span drift calculations.

4.11.3 Low Sample Flow Rate

Possible Problem - Leak in sample line between filter body and orifice holder.

Corrective Action: check heated filter sample outlet, eductor inlet, Heat Exchanger inlet and outlet, and sample line tee compression fittings.

Possible Problem - *Plugged Orifice.*

Corrective Action: Change Orifice

Possible Problem - *Leak around filter cap.*

Corrective Action: Clean O-Ring and apply high vacuum grease. Replace O-Ring.

Possible Problem - *Leak at probe connection to filter body.*

Corrective Action: Clean probe tip and O-Rings area. Apply silicone grease to probe and O-Rings. Replace O-Rings.

Possible Problem - *Leak between orifice holder and eductor body.*

Corrective Action: Tighten compression springs to specification (Please see Section 4.6, step H). Clean gasket and apply high vacuum grease.

Possible Problem - *Low sample vacuum.*

Corrective Action: Check probe assembly for leaks. Check eductor exhaust line for restriction.

Possible Problem - *Leak in external components connected to blow-back/calibration port.*

Corrective Action: Check external fittings for leaks. Check external valves for port to port leaks.

4.11.4 High Sample Flow Rate

Possible Problem - *Leak around orifice.*

Corrective Action: Either replace:
1. Orifice O-Ring or
2. Exchange the orifice holder assembly

4.11.5 Low Flow Rate at the Eductor Exhaust

Possible Problem - *Eductor air jet plugged.*

Corrective Action: Replace air jet.

<u>*Possible Problem*</u> - *Restricted eductor exhaust tubing.*

Corrective Action: Check internal and external exhaust vent tubing for restrictions.

<u>*Possible Problem*</u> - *Pressure Regulator not adjusted correctly or defective.*

Corrective Action: Adjust or replace regulator.

4.11.6 High Flow Rate at the Eductor Exhaust

<u>*Possible Problem*</u> - *Regulator pressure set too high.*

Corrective Action: Reduce Regulator Pressure.

<u>*Possible Problem*</u> - *Leak around sample orifice.*

Corrective Action: Replace Orifice O-Ring (quartz orifices) or orifice holder (stainless steel jets).

<u>*Possible Problem*</u> - *Leak between orifice holder and eductor body.*

Corrective Action: Clean and lubricate gasket with high vacuum grease or replace gasket.

4.11.7 Low Eductor Vacuum

<u>*Possible Problem*</u> - *Leak between orifice holder and eductor body.*

Corrective Action: Clean, lubricate and tighten compression springs to specification (please see Section 4.7, step H) or replace gasket.

<u>*Possible Problem*</u> - *Eductor exhaust restricted.*

Corrective Action: Check internal and external exhaust vent tubing for restrictions.

<u>*Possible Problem*</u> - *Defective Eductor Air Jet.*

Corrective Action: Replace Jet.

4.11.8 Low Span Reading

Possible Problem - *Dirty Main Filter element.*

Corrective Action: Replace filter element.

Possible Problem - *Sample jet plugged.*

Corrective Action: Replace jet.

Possible Problem - *Leak at filter body cap.*

Corrective Action: Clean or replace filter cap O-Ring. Check purge/calibration gas inlet filter.

Possible Problem - *Leak at probe/filter connections.*

Corrective Action: Clean probe and O-Ring area. Apply silicone grease. Replace O-Rings.

Possible Problem - *Leak at orifice holder or eductor gaskets.*

Corrective Action: Clean or replace gaskets. Check Spring Setting (Please see Section 4.7, step H).

Possible Problem - *Eductor air pressure too high.*

Corrective Action: Adjust regulator.

Possible Problem - *Defective Regulator.*

Corrective Action: Replace Regulator.

4.11.9 High Span Reading

Possible Problem - *Leak around sample jet.*

Corrective Action: Replace orifice O-Ring on the orifice holder assembly.

Possible Problem - *Eductor air pressure set too low.*

Corrective Action: Adjust regulator.

Possible Problem - *Plugged eductor air jet.*

Corrective Action: Replace jet.

5.0 RETURNING ASSEMBLIES FOR REPAIR

Should it become necessary to return any assembly, sub-assembly, or component for repair or replacement, contact the factory prior to shipment for specific information such as: return authorization number, shipping instructions, price, time to repair, etc. Also include pertinent facts describing the nature of the problem. Ship all components to the following address:

TEI
P.O. BOX 2470, 45 FIR STREET
WALDRON, AR 72958 U.S.A.

5.1 Obtaining Replacement Parts

The following information must be included in all purchase orders for parts:

A. TFS Model and S/N of major assembly
B. Part Number (found in parts tables)
C. Description of part

5.2 Spare Parts List, PRO903

CHEMICAL, HEAT SINK	16000007
CHEMICAL, SILICONE GREASE	16000003
CONTROLLER ASSEMBLY, WATCHDOG/VALVE	22000009
CONTROLLER ASSEMBLY, HEATED FILTER	22000010
CONTROLLER, TEMP., 965	22110019
EDUCTOR, ASSY, %L/MIN. (SYSTEM SPECIFIC)	********
FILTER, .1 MICRON 2.5" STD	26002018
FILTER, 1 MIC NYLON	26002001
FUSE, 1 AMP DELAY MDL	43001011
FUSE, 2 AMP DELAY MDL	43008023
FUSE, 5 AMP DELAY MDL	43005025
GASKET, EDUCTOR	25501002
HEAT EXCHANGER ASSEMBLY, COMPLETE	26000551
HEATER ASSEMBLY, CARTDRIDGE, 150 WATT	53010036
LAMP, 60W 120V	24600020
O-RINGS, VITON	25503015
O-RING, EDUCTOR JET	25503011
O-RING, FILTER BODY	25503012
O-RING, PROBE	25503021
HOLDER ASSEMBLY, QUARTZ (SITE SPECIFIC)	********
ORIFICE, QUARTZ (SYSTEM SPECIFIC)	********

PCA, CONTROLLER 900 SERIES	17010074
RTD ASSEMBLY, SURFACE MOUNT, 900 SERIES	53040007
TRANSDUCER, ASSY, PRESSURE, 16-32" HG	55010000
VALVE ASSEMBLY, 2-WAY	45500006
VALVE ASSEMBLY, 3-WAY	45500008

******** Site specific: check system drawings for dilution ratios and flow rates.

5.3 Recommended Tools

PROBE ADAPTER, TEFLON®	07990000
CHEMICAL, HEAT SINK	16000007
CHEMICAL, SILICONE GREASE	16000003
PUMP, VACUUM, HAND HELD	26006022
FLOWMETER, SIERRA, 5 L/MIN	29020005
FLOWMETER, SIERRA, 500 CC/MIN	29020006

Printed in the U.S.A.

Appendix A
Warranty

Seller warrants that the Products will operate or perform substantially in conformance with Seller's published specifications and be free from defects in material and workmanship, when subjected to normal, proper and intended usage by properly trained personnel, for the period of time set forth in the product documentation, published specifications or package inserts. If a period of time is not specified in Seller's product documentation, published specifications or package inserts, the warranty period shall be one (1) year from the date of shipment to Buyer for equipment and ninety (90) days for all other products (the "Warranty Period"). Seller agrees during the Warranty Period, to repair or replace, at Seller's option, defective Products so as to cause the same to operate in substantial conformance with said published specifications; provided that (a) Buyer shall promptly notify Seller in writing upon the discovery of any defect, which notice shall include the product model and serial number (if applicable) and details of the warranty claim; (b) after Seller's review, Seller will provide Buyer with service data and/or a Return Material Authorization ("RMA"), which may include biohazard decontamination procedures and other product-specific handling instructions; and (c) then, if applicable, Buyer may return the defective Products to Seller with all costs prepaid by Buyer. Replacement parts may be new or refurbished, at the election of Seller. All replaced parts shall become the property of Seller. Shipment to Buyer of repaired or replacement Products shall be made in accordance with the Delivery provisions of the Seller's Terms and Conditions of Sale. Consumables, including but not limited to lamps, fuses, batteries, bulbs and other such expendable items, are expressly excluded from the warranty under this warranty.

Notwithstanding the foregoing, Products supplied by Seller that are obtained by Seller from an original manufacturer or third party supplier are not warranted by Seller, but Seller agrees to assign to Buyer any warranty rights in such Product that Seller may have from the original manufacturer or third party supplier, to the extent such assignment is allowed by such original manufacturer or third party supplier.

In no event shall Seller have any obligation to make repairs, replacements or corrections required, in whole or in part, as the result of (i) normal wear and tear, (ii) accident, disaster or event of force majeure, (iii) misuse, fault or negligence of or by Buyer, (iv) use of the Products in a manner for which they were not designed, (v) causes external to the Products such as, but not limited to, power failure or electrical power surges, (vi) improper storage and handling of the Products or (vii) use of the Products in combination with equipment or software not supplied by Seller. If Seller determines that Products for which Buyer has requested warranty services are not covered by the warranty hereunder, Buyer shall pay or reimburse Seller for all costs of investigating and responding to such request at Seller's then prevailing time and materials rates. If Seller provides repair services or replacement parts that are not covered by the warranty provided in this warranty, Buyer shall pay Seller therefor at Seller's then prevailing time and materials rates. ANY INSTALLATION, MAINTENANCE, REPAIR, SERVICE, RELOCATION OR ALTERATION TO OR OF, OR OTHER TAMPERING WITH, THE PRODUCTS PERFORMED BY ANY PERSON OR ENTITY OTHER THAN SELLER WITHOUT SELLER'S PRIOR WRITTEN APPROVAL, OR ANY USE OF REPLACEMENT PARTS NOT SUPPLIED BY SELLER, SHALL IMMEDIATELY VOID AND CANCEL ALL WARRANTIES WITH RESPECT TO THE AFFECTED PRODUCTS.

THE OBLIGATIONS CREATED BY THIS WARRANTY STATEMENT TO REPAIR OR REPLACE A DEFECTIVE PRODUCT SHALL BE THE SOLE REMEDY OF BUYER IN THE EVENT OF A DEFECTIVE PRODUCT. EXCEPT AS EXPRESSLY PROVIDED IN THIS WARRANTY STATEMENT, SELLER DISCLAIMS ALL OTHER WARRANTIES, WHETHER EXPRESS OR IMPLIED, ORAL OR WRITTEN, WITH RESPECT TO THE PRODUCTS, INCLUDING WITHOUT LIMITATION ALL IMPLIED WARRANTIES OF MERCHANTABILITY OR FITNESS FOR ANY PARTICULAR PURPOSE. SELLER DOES NOT WARRANT THAT THE PRODUCTS ARE ERROR-FREE OR WILL ACCOMPLISH ANY PARTICULAR RESULT.