Vent Master™

Process Analyzer Vent-Header Pressure Control System

Temperature • Flow • Pressure

Value Proposition:

After a process sample stream is analyzed, it must be disposed of in a manner consistent with environmental regulations. Today, as in the past, it has been common practice to simply vent the sample stream to the atmosphere. As environmental regulations become more stringent, it is becoming undesirable, if not illegal, to admit these samples to the atmosphere.

For an analyzer to operate correctly, it must be calibrated and operated under the same conditions. These critical conditions are temperature, flow and pressure, with the pressure of the measurement cell being the most critical. Venting analyzer effluent to atmosphere is not only convenient, but it also provides a very stable reference pressure for the analyzer measurement cell. In other words, the measurement cell “floats” on atmospheric pressure.

Analyzer outlet sample streams are traditionally collected into a closed vent header. This vent header either flows to atmosphere or back to the process. When atmospheric venting is not allowed, the most common disposal point is the plant flare where the analyte sample stream is burned. However, the flare header is subject to pressure variations as high as 20 psig or more as process upsets create backpressure. When venting an analyzer into the flare collection system, the measurement cell “floats” on these varying pressures. If this condition is left unchecked these pressure fluctuations will result in significant analyzer measurement errors.

The primary function of the Parker Vent Master™ is to isolate the analyzer from fluctuating outlet pressures by controlling the pressure of the collection header (commonly referred to as the Vent Header) and pumping the effluent sample gases into the fluctuating return system.

Image courtesy of ABB

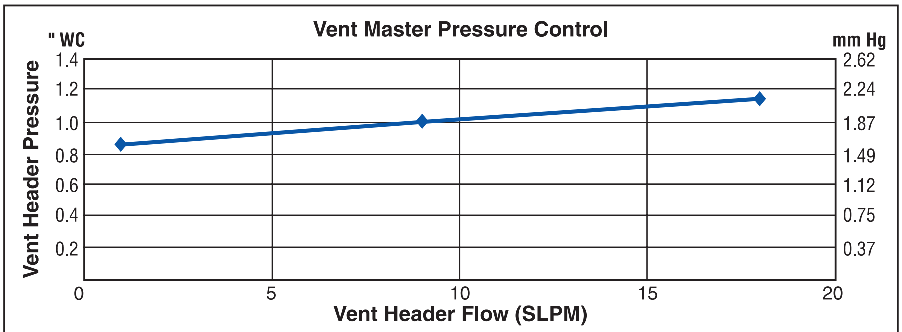
Vent Master™

Functional Options:

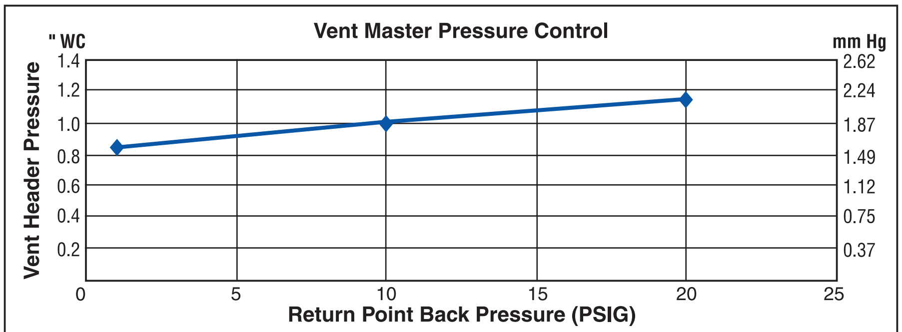
The Parker Vent Master™ can be configured to perform in several different applications as outlined in the following nomenclature summary.

- The Eductor model (EDR) is the most common and is used when disposing analyzer effluent gasses to a flare system. The -EDR model requires a bulk nitrogen source to provide the necessary motive force for the eductor.
- The Eductor Natural Gas model (EDRNB) is very similar to the -EDR but it incorporates non-bleed pneumatic circuitry that enables the use of fuel gas as the motive force for the eductor.
- The pump (PMP) model is most commonly used when returning analyzer effluent to the process, or any other point with a return pressure above 20 psig. In this case a positive displacement pump (provided by others) is utilized.
- The model with no pump or eductor (NPE) is used when an external plant vacuum system is available.

All configurations of the Parker Vent Master™ provide exceptional pressure stability in the analyzer effluent vent header regardless of upstream flow and downstream pressure fluctuations as detailed below:



" WC = Inches of Water Column (1 PSI = 27.68 inches of water)



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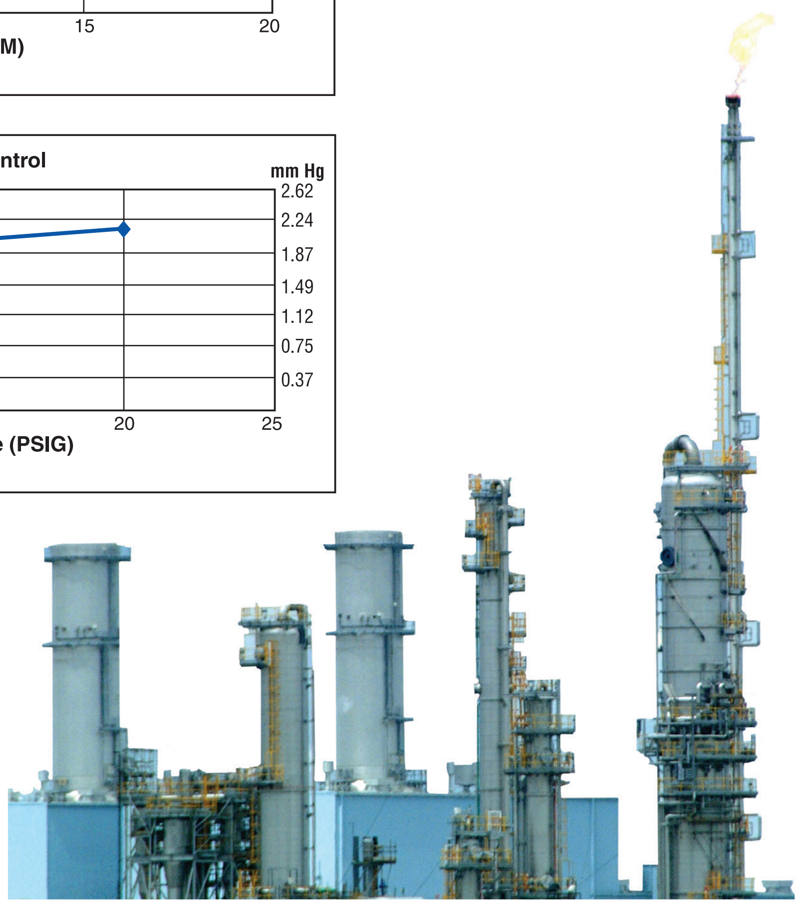
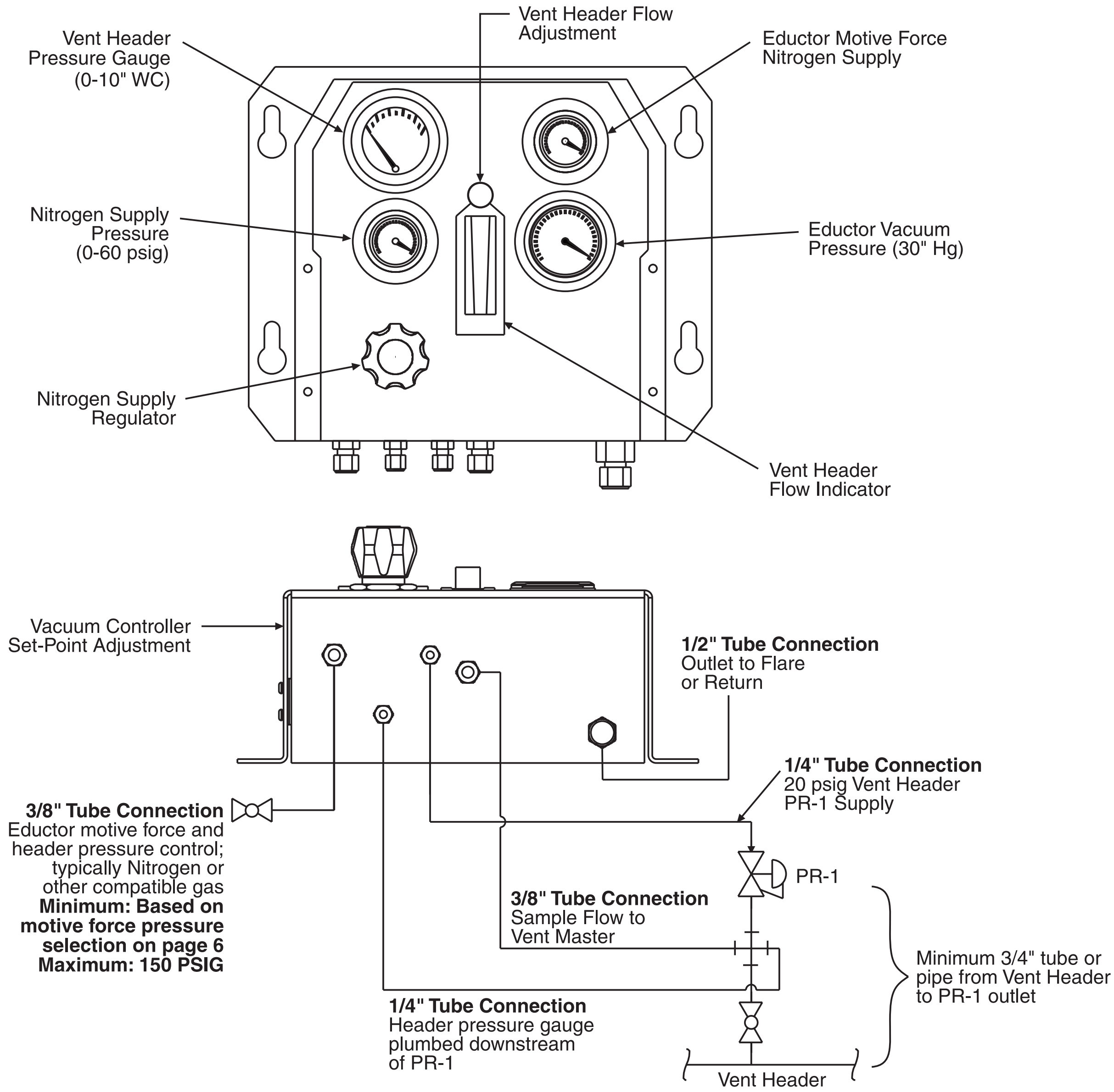


Pressure Control Systems

Vent Master™

Parker Vent Master™ Eductor (-EDR) Model Theory of Operation:

This system is comprised of regulators, gauges, a rotameter, a controller and an eductor mounted in a small enclosure for ease of operation and installation. A low-pressure regulator (PR-1) with a large sensitive diaphragm is also included with the system but is mounted directly onto the vent header as shown on the schematic below and layout drawing on page 7. The eductor flow capacity dictates the Vent Master's maximum analyzer effluent flow capacity. Parker Vent Master™ EDR models have a wide range of analyte flow, return point back pressure and motive force capabilities.



Pressure Control Systems

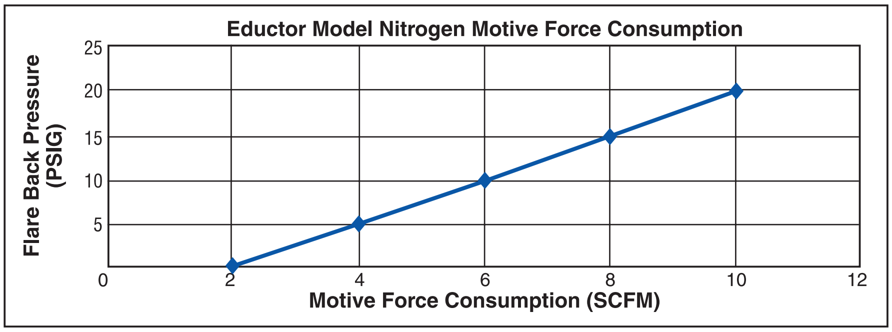
Vent Master™

Parker Vent Master™ Eductor Model Theory of Operation (Continued):

PR-1 is the vent header pressure controller. Its function is to constantly flow a Nitrogen makeup gas into the vent header, sufficient to maintain a constant pressure. While each analyzer will vent effluent gas into the vent header by varying amounts, PR-1 will sense the header pressure and provide Nitrogen to makeup the difference necessary to maintain a stable +1” WC pressure. Simultaneously, the Parker Vent Master™ eductor will pump a constant analyzer effluent and Nitrogen makeup mixture from the Vent Header.

For example, if the Vent Header Flow Adjustment (FI-1) is set at 14 SLPM and the analyzers are venting a total of 12 SLPM into the vent header, PR-1 will supply 2 SLPM of Nitrogen. The flow capacity limiting component in the Parker Vent Master™ is the eductor. The Parker Vent Master™ is available with three different eductor capacities as outlined on the performance curves on page 6. In all cases, test results show that the Vent Header pressure will be maintained to within .3" WC pressure variation over the flow capacity range of each eductor. The Parker Vent Master™ incorporates a Nitrogen Economizer Circuit which throttles the eductor’s motive force flow necessary to maintain a constant 6" Hg vacuum. This circuit conserves Nitrogen use and reduces the normal motive pressure eductor supply to approximately 20 psig, with an eductor return point back pressure of 1 psig. As the eductor’s back pressure increases (caused by increasing flare header pressures) the vacuum created by the eductor will be reduced.

The Economizer Circuit vacuum controller monitors the eductor’s vacuum and automatically adjusts the motive force flow to the eductor accordingly to maintain a constant differential pressure necessary to facilitate a constant flow rate from the Vent Header. The motive force Nitrogen flow rate can vary from 3 to 9 SCFM depending upon the return point back pressure of the eductor as outlined in the Nitrogen Motive Force Consumption chart below.



Note: The standard PR-1 incorporates an internal relief valve on its diaphragm. The relief valve will only open when the Vent Header pressure exceeds 7” WC. The threaded vent port on the dome of the PR-1 regulator must be vented to a safe area and MUST be maintained at atmospheric pressure. ANY pressure change in the regulators dome connection will be reflected in the Vent Header. Consult factory for a PR-1 without a relief valve.

Nitrogen is the normal makeup and motive force gas used to drive the eductor because it is inert. In cases where Nitrogen is not desirable, Natural Gas can also be used to drive the eductor into a flare system or any other gas that is compatible with the process. In this case, the -EDRNB should be specified.

Vent Master™

Parker Vent Master™ Eductor Motive Force / Return Point Back Pressure / Flow Curves:

The -EDR version of the Vent Master is available with three different eductor capacities. Proper eductor sizing is based on three critical system variables:

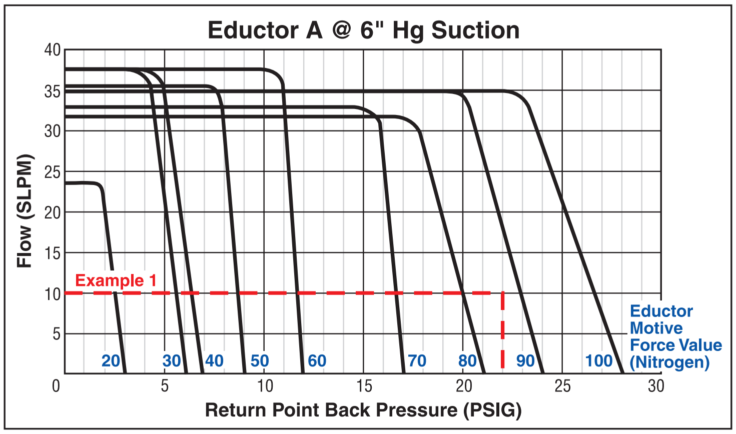
- Motive force pressure availability
- Maximum analyte flow from the Vent Header
- Maximum return point back pressure

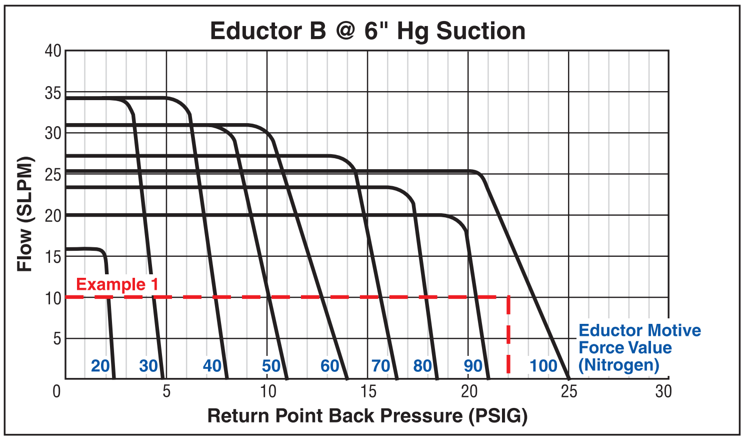
Use the graphs at the right to determine the proper eductor size for an application. When the flow and return point back pressure are plotted as shown in the lines labeled "Example 1" the entire area below the plotted line must fall within the area of the line representing the available motive force pressure.

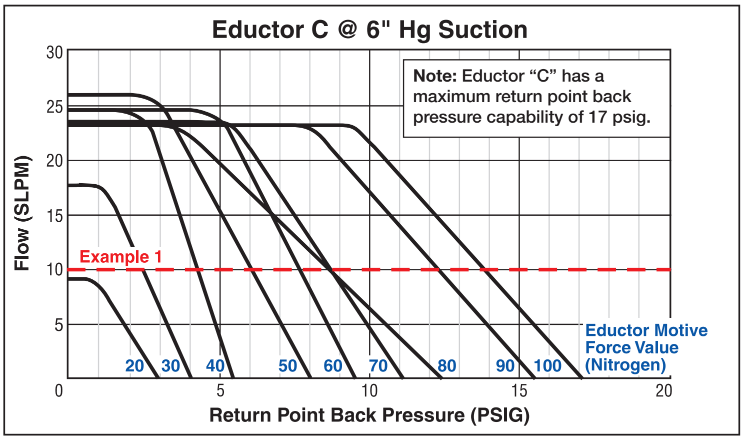
Example 1: An analyzer shelter has 8 different continuous analyzers each flowing 1 SLPM; allowing for a Nitrogen makeup cushion of 2 SLPM, the total flow is 10 SLPM. The return point is the flare header that typically runs at a pressure of 1-2 psig, but process upsets can spike this pressure as high as 22 psig. A bulk Nitrogen source with 90 psig is available for the motive force.

The red line in the graphs at right reflect the maximum flow and return point back pressure described above. In this application, the "A" eductor should be selected because it is the only graph which shows the entire dashed red line within (to the left of) the 90 psig eductor motive force value. Both the "B" and "C" eductors cannot pump against a back pressure of 22 psig at a 10 SLPM flow rate on the 90 psig motive force curve.

Example 2: A shelter's Vent Header has a total analyte volume of 33 SLPM and the return is going back to the process that runs from 35-45 psig. In this case, none of the eductors have the capacity for the application and, the Parker Vent Master™ would be configured for a mechanical pump.



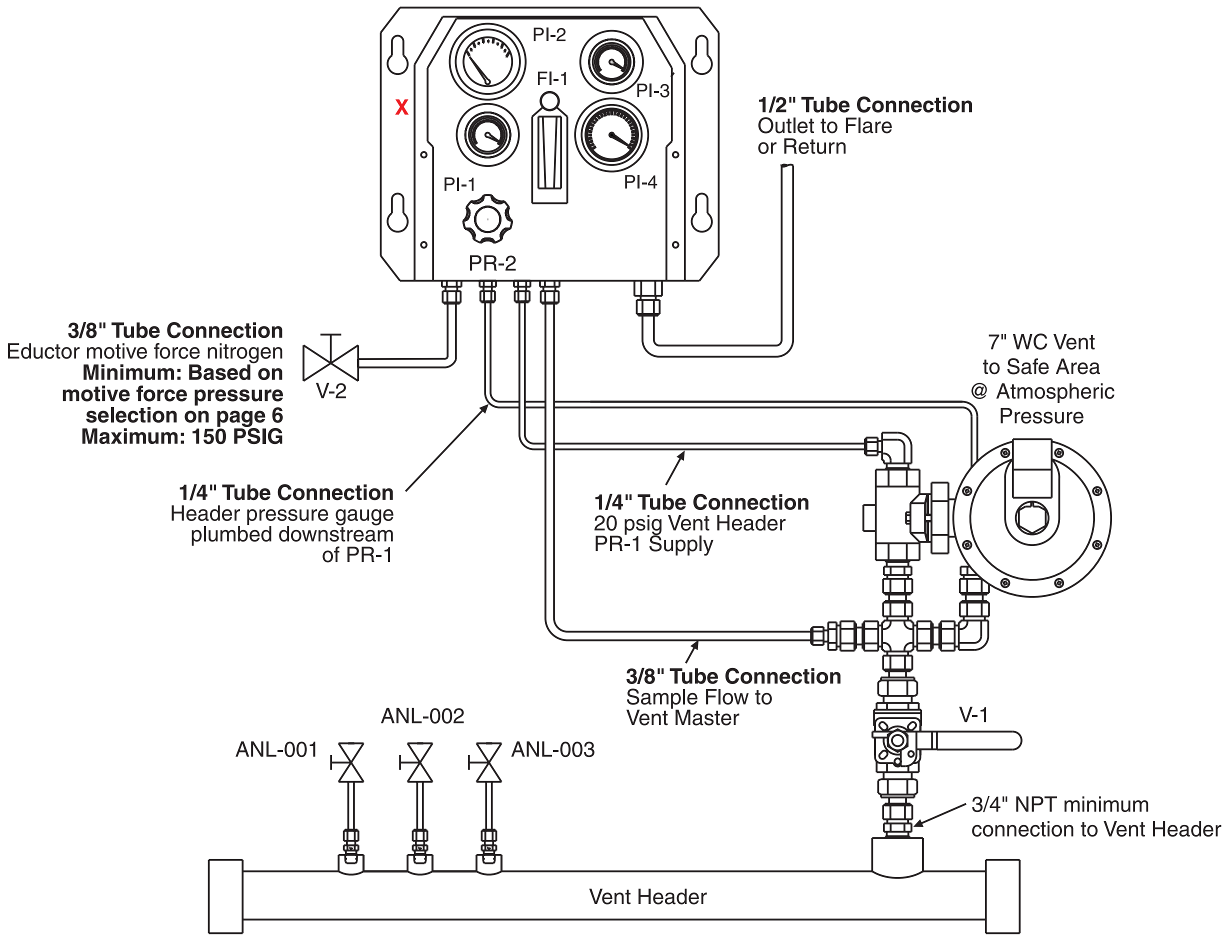




Vent Master™

Parker Vent Master™ Nitrogen (-EDR) Model Installation and Startup Procedures:

1. Ensure that all connections are made as per the drawing below. It is very important to maintain a minimum pressure drop from the Vent Header to the outlet of PR-1. A straight run of 3/4" tube or pipe is recommended.
2. Close V-1.
3. Ensure that the eductor outlet to the flare is not blocked. Blocking this flow will cause PR-1 to relieve to its vent and could cause damage to the system.
4. Open V-2 to initiate Nitrogen flow.
5. Adjust PR-2 to read 20 psig on PI-1.
6. PI-4 should read 6" Hg vacuum. If adjustment is required, remove the small cover on the upper left side of the case (X marks the spot below) with a 1/8" Allen Wrench, then adjust the set point until the vacuum is reading 6" Hg vacuum. Reinstall the cover. Adjustment should be made carefully. Full rotation of adjusting screw is not required. Vacuum is set at the factory so any adjustments should be minimal.
7. Adjust the FI-1 rotameter needle valve to at least 2 SLPM higher than the MAXIMUM flow from the analyzers, keeping in mind abnormal flow rates such as calibration gas introduction. Example: If your analyzers contribute 10 SLPM of flow to the vent header, adjust the rotameter to 12 SLPM or higher.
8. At this time PI-2 should read around 1" WC. The set point of PR-1 is fixed and cannot be field adjusted.
9. Open V-1.
10. The Parker Vent Master™ is now in service and will maintain the header at approximately 1" WC ±.15". As the flare header pressure increases PI-3 (motive force pressure) will increase. PI-3 will fluctuate up and down with the flare header pressure.

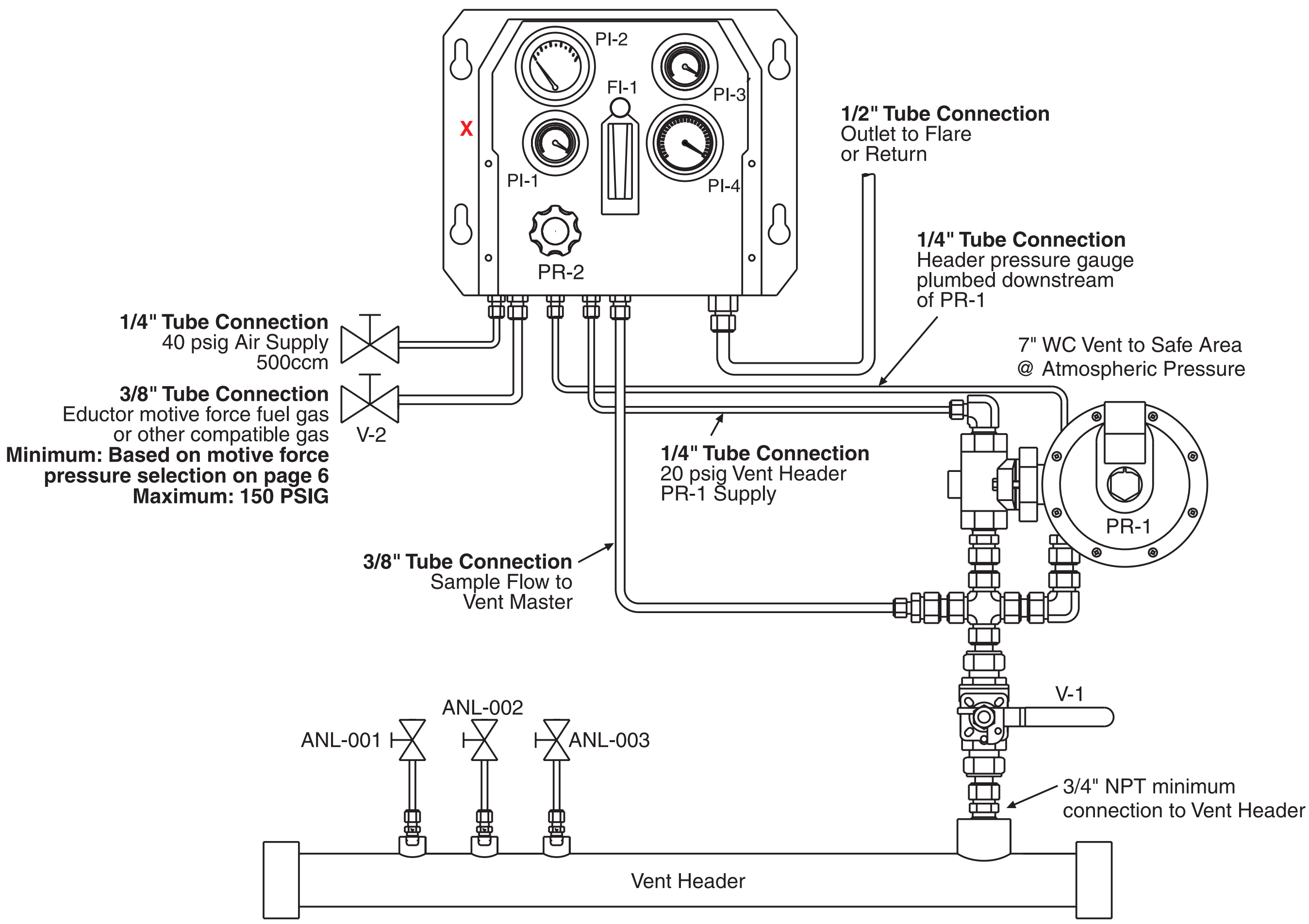


Pressure Control Systems

Vent Master™

Parker Vent Master™ Natural Gas (-EDRNB) Model Installation and Startup Procedures:

1. Ensure that all connections are made as per the drawing below. It is very important to maintain a minimum pressure drop from the Vent Header to the outlet of PR-1. A straight run of 3/4" tube or pipe is recommended.
2. Close V-1.
3. Ensure that the eductor outlet to the flare is not blocked. Blocking this flow will cause PR-1 to relieve to its vent and could cause damage to the system.
4. Turn on the 40 psig air supply, then open V-2 to initiate Fuel Gas flow.
5. PI-4 should read 6" Hg vacuum. If adjustment is necessary, remote the small cover on the upper left side of the case (X marks the spot below) with a 1/8" Allen Wrench, then adjust the set point until the vacuum is reading 6" Hg. Reinstall the cover. Adjustment should be made carefully. Full rotation of adjusting screw is not required. Vacuum is set at the factory so any adjustments should be minimal.
6. Adjust the FI-1 rotameter needle valve to at least 2 SLPM higher than the MAXIMUM flow from the analyzers, keeping in mind abnormal flow rates such as calibration gas introduction. Example: If your analyzers contribute 10 SLPM of flow to the vent header, adjust the FI-1 rotameter to 12 SLPM or higher.
7. At this time PI-2 should read around 1" WC. The set point of PR-1 is fixed and cannot be field adjusted.
8. Open V-1.
9. The Parker Vent Master™ is now in service and will maintain the header at approximately 1" WC ±.15". As the flare header pressure increases, PI-3 (motive force pressure) will increase. PI-3 will fluctuate up and down with the flare header pressure.



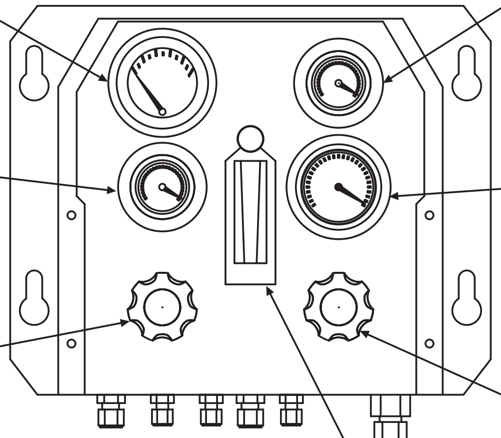
Pressure Control Systems

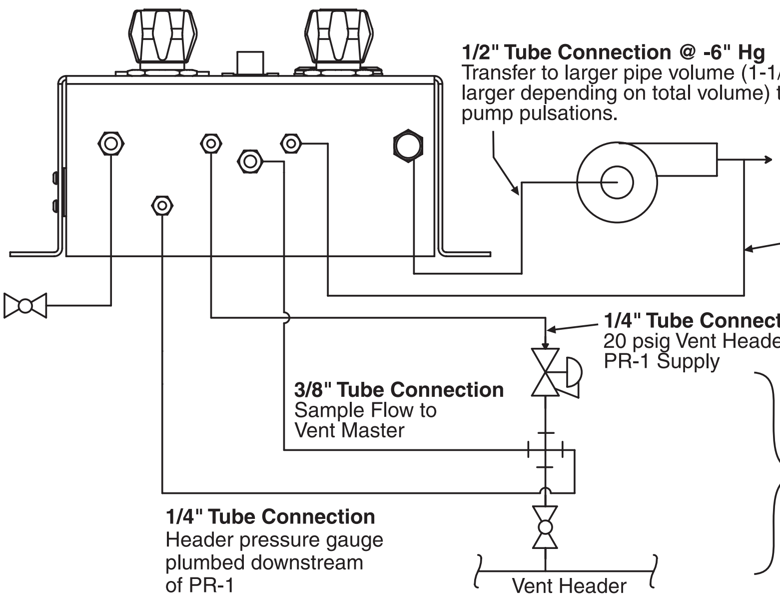
Vent Master™

Parker Vent Master™ Pump (-PMP) Model Theory of Operation:

In applications where the flow rate or back pressure conditions exceed the capabilities of the available eductors, or if introducing a motive gas is not practical, an alternate pumping method must be employed. This method usually employs a centrifugal or positive displacement pump (provided by others). The use of a mechanical pump has the advantage of being able to pump into much higher backpressures and not introduce motive gases into the system. The big disadvantage of course, is that they are mechanical and require considerable maintenance for reliable operation.

When a mechanical pump is used instead of an eductor, the economizer circuit is not required. Instead a vacuum regulator is used to control the suction pressure of the pump by introducing a gas, usually Nitrogen (or other gas compatible with the return point), sufficient to control the suction pressure at 6" Hg vacuum. This will control the differential pressure across the rotameter's throttling valve, which will provide a constant flow from the Vent Header. This method will provide extremely stable flow and pressure control of the Vent Header, at flow rates up to 200 SLPM.





Vent Master™

Parker Vent Master™ Pump (-PMP) Model Installation and Startup Procedures:

Specifying a Pump: Vent Master™ -PMP applications require a mechanical pump provided by others. In order to properly specify a positive displacement pump, the manufacturer will need to know the following:

(1) the inlet (suction) pressure which is a constant -6" Hg

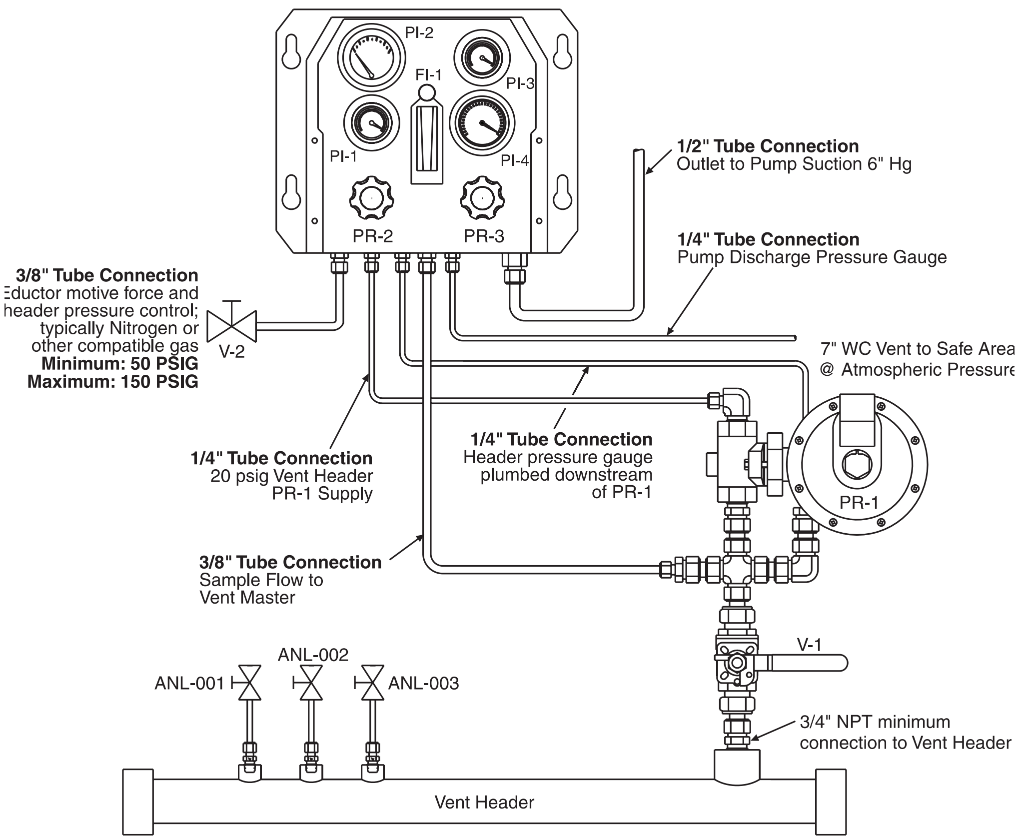
(2) the maximum analyte volumn to be pumped

(3) the maximum back pressure at the return point

(4) hazardous area classification, voltage and other electrical requirements

Air Dimensions, Incorporated (www.airdimensions.com) can assist with diaphragm pump specifications.

1. Ensure that all connections are made as per the drawing below. It is very important to maintain a minimum pressure drop from the Vent Header to the outlet of PR-1. A straight run of 3/4" tube or pipe is recommended.
2. Close V-1.
3. Open V-2 to initiate Nitrogen flow.
4. Adjust PR-2 to read 20 psig on PI-1.
5. Turn on the pump.
6. Adjust PR-3 to read 6" Hg vacuum on PI-4.
7. Adjust the FI-1 rotameter needle valve to at least 2 SLPM higher than to MAXIMUM flow from the analyzers, keeping in mind abnormal flow rates such as calibration gas introduction. Example: If your analyzers will con tribute 10 SLPM of flow to the vent header, adjust the rotameter to 12 SLPM or higher.
8. At this time the PI-2 should read around 1" water. This is the fixed set point of PR-1.
9. Open V-1.
10. The Parker Vent Master™ is now in service. It will maintain the header at approximately 1" WC ±.15".

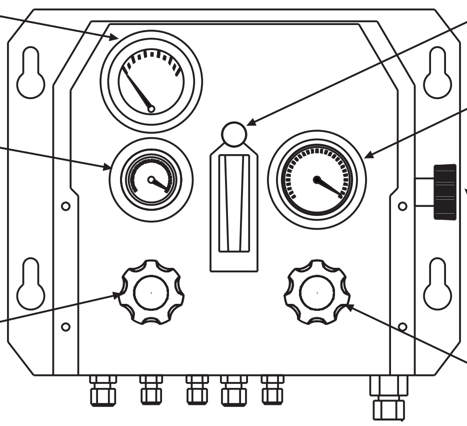


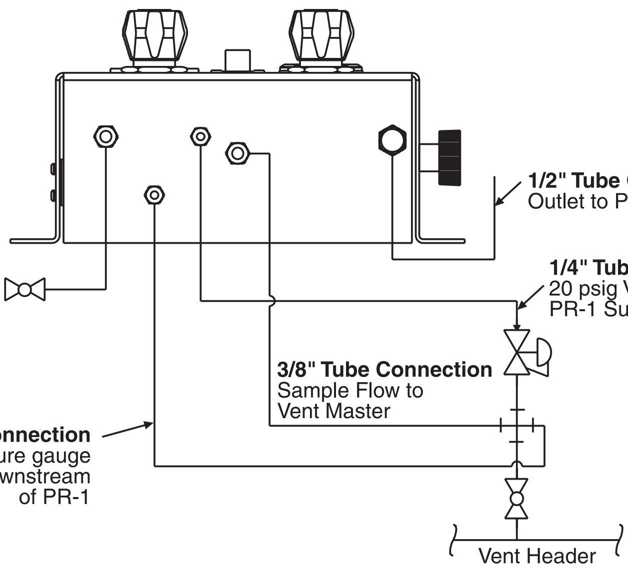
Vent Master™

Parker Vent Master™ No Pump or Eductor (-NPE) Model Theory of Operation:

The Parker Vent Master™ requires a lower pressure on the outlet of the rotameters throttling valve of at least -2.5 psig in order to have enough differential pressure to produce 18 SLPM of flow. This lower outlet pressure is provided by either using the standard economizer circuit with the eductor, the mechanical pump, or by an available lower pressure in the process. Using this available lower pressure is considered the best way because it requires no pumps or motive gases. The Parker Vent Master™ system uses a vacuum isolation valve in this circuit (V-1).

This isolation valve acts as a load valve, limiting the amount of vacuum exposed to the outlet of the rotameter's throttling valve. A vacuum regulator is also employed in this circuit. The load valve limits the amount of gas needed, from the vacuum regulator, to control the vacuum on the rotameters outlet valve. The vacuum regulator capacity is limited and would not be able to counter the external vacuum source therefore the load limiting valve is used to limit the total flow into the external vacuum. With the external vacuum limited, with this valve (V-1), the vacuum regulator can now control the vacuum on the rotameters outlet-throttling valve.

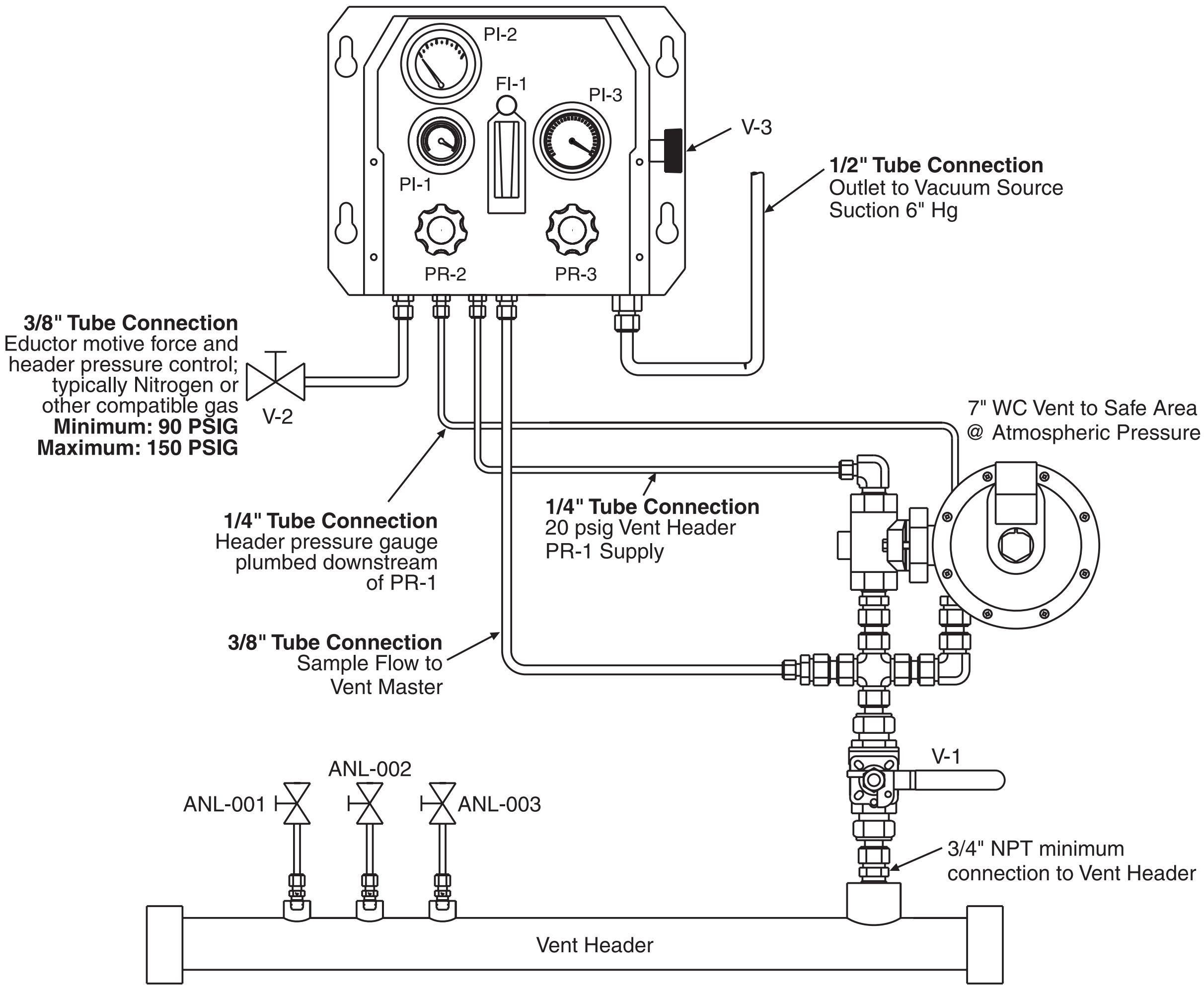




Vent Master™

Parker Vent Master™ No Pump or Eductor (-NPE) Model Installation and Startup Procedures:

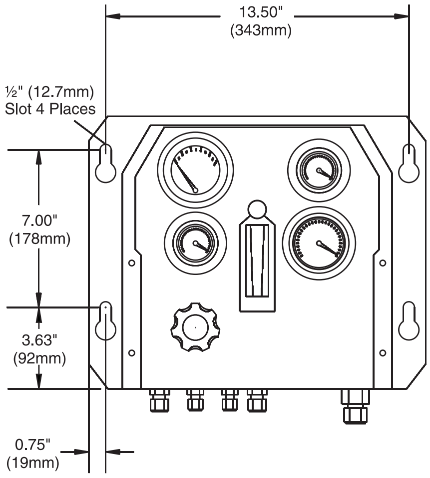
1. Ensure that all connections are made as per the drawing below. It is very important to maintain a minimum pressure drop from the Vent Header to the outlet of PR-1. A straight run of 3/4" tube or pipe is recommended.
2. Close V-1.
3. Fully open FI-1 (turn counter clockwise).
4. Close V-3 completely, clockwise, and then crack it open two turns.
5. Open V-2 to initiate Nitrogen flow.
6. Adjust PR-2 to read 20 psig on PI-1.
7. Adjust PR-3 to read 6" Hg vacuum on PI-4.
8. Adjust V-3, open or close, until rotameter flow is greater than analyzer flow into the header, keeping in mind abnormal flow rates such as calibration gas. Example: If your analyzers will contribute 10 SLPM of flow to the vent header, adjust the rotameter to 12 SLPM or higher.
9. At this time PI-2 should read around 1" water. This is the fixed set point of PR-1.
10. Open V-1.
11. The Parker Vent Master™ is now in service and will maintain the header at approximately 1" WC ±.15".

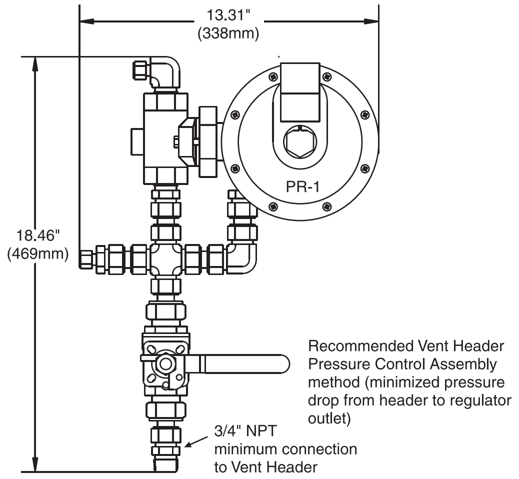


Pressure Control Systems

Vent Master™

Dimensions:





How to Order:

The correct part number is easily derived from the following example and ordering chart. The seven product characteristics required are coded as shown in the chart.

Example 1, below, describes an Eductor A model with a 23 SLPM glass tube rotameter with metric CPI® tube connections on both the Vent Master control box and PR-1 subassembly.

Example 2, below, describes a Pump model with a 100 SLPM armored rotameter with imperial tube connections on the Vent Master control box and PR-1 shipped without connections.

Examples:

1:	**VM**	**-**	**EDR**	**-**	**A**	**-**	**23**	**-**		**-**	**TFA**	**-**	**ZM**
2:	**VM**	**-**	**PMP**	**-**		**-**	**100**	**-**	**ARM**				

Vent Master	–	Model	–	Eductor Selection	–	Rotameter Range	–	Rotameter Options	–	PR-1 Options	–	Tube Connections

Vent Master	Model	Eductor Selection*	Rotameter Range (SLPM)**	Rotameter Options	PR-1 Options	Tube Connections
VM	**EDR** **EDRNB**	**A** **B** **C**	0 to... 3, 8, 15, 23 & 30	**Blank** Glass Tube with Outlet Needle Valve **ARM†** Armored with Outlet Needle Valve	**Blank** Regulator Only **TFA** PR-1 with Tube Fitting Assembly (shown above)	**Z** Imperial CPI™ **ZM** Metric CPI™ **A** Imperial A-LOK® **AM** Metric A-LOK®
	PMP	**Blank**	0 to... 3, 8, 15, 23, 30, 40, 50, 100, 150, 200 (subject to fluid density)			
	NPE					

* See page 7 for eductor sizing.
** The rotameter range is determined by adding 2 SLPM to your MAXIMUM analyzer flow, keeping in mind abnormal flows such as calibration gas introduction, then rounding up to the next highest range available from the selection chart above.
† Armored rotameters are normally used only in applications where QC 3.1B certificates are required. The maximum pressure applied to the rotameter is -6" Hg.

Specifications:

Temperature Range: -20°F to 140°F (-29°C to 50°C)
Wetted Materials of Construction: 316SS and Parker Parofluor o-rings (Highly Fluorinated Fluorocarbon Rubber)

3.1B Certificate of Conformance available

Vent Master™

Conversions:

Pressure Conversion Table: (Units used in this manual)

Units	psi	kPa	kg/cm2	cm of H2O	feet of H2O	inches of Hg	mm of HG	inches of H2O	ounces per sq. inch	Atm (atmospheres)	bar	mbar	Mpa
psi	1	6.89476	0.07031	70.3069	2.30672	2.03602	51.7149	27.6807	16	0.068046	0.6895	68.9476	0.00689
kPa	0.14504	1	0.0102	10.1975	0.33456	0.2953	7.50061	4.01472	2.3206	0.00966924	0.01	10	0.001
kg/cm2	14.2233	98.0669	1	1000.03	32.8093	28.959	735.559	393	227.573	0.9678416	0.98066	1013.25	0.09806
cm of H2O	0.01422	0.09806	0.001	1	0.03281	0.02896	0.73554	0.3937	0.22757	0.00096781	0.0098	0.9806	0.00098
feet of H2O	0.43352	2.96896	0.03048	30.48	1	0.88265	22.4192	12	6.93624	0.2949896	0.02969	29.689	0.00298
inches of Hg	0.49115	3.386389	0.03453	34.5325	1.13296	1	25.4	13.5955	7.85847	0.0334211	0.03386	33.8639	0.00386
mm of Hg	0.01934	0.13332	0.00136	1.35955	0.0446	0.03937	1	0.53526	0.30939	0.00131579	0.00133	1.33322	0.00013
inches of H2O	0.03613	0.24908	0.00254	2.54	0.0333	0.07355	1.86827	1	0.57802	0.00245825	0.00249	2.49089	0.00025
ounces per sq. inch	0.0625	0.43092	0.00439	4.39431	0.14417	0.12725	3.23218	1.73004	1	0.00425288	0.00431	4.309	0.00043
Atm (atmospheres)	14.696	101.325	1.03323	1033.26	33.8995	29.9213	760	406.794	235.136	1	1.01325	1013.25	0.1013
bar	14.5038	100	1.01972	1019.75	33.4833	29.53	750.063	401.86	232.064	0.986923	1	1000	0.1
mbar	0.0145	0.1	300102	1.019	0.00346	0.02953	0.75006	0.40146	0.23206	0.00099	0.001	1	0.0001
Mpa	145.038	1000	10.197	10197.5	334.56	295.299	7500.61	4014.74	2320.6	9.669	10	10000	1

Volume Conversion Table: (Units used in this manual)

Units	Liters	cc (cubic centimeters)	ml (milliliters)	Ft^3 (cubic feet)	Inch^3 (cubic inches)	Gallon
Liters	1	1000	1000	0.03531467	61.02374	0.2641721
cc (cubic centimeters)	1000	1	1	3.53147-5	0.06102374	0.000264172
ml (milliliters)	1000	1	1	3.53147-5	0.06102374	0.000264172
Ft^3 (cubic feet)	28.31685	28,316.85	28,316.85	1	1,728.00	7.480519
Inch^3 (cubic inches)	0.01638706	16.38706	16.38706	0.000578704	1	0.004329004
Gallon	3.785412	3,785.41	3,785.41	0.1336806	231	1

Vent Master™

Safety Instructions:

1. Be sure all connections are made properly.
2. On Eductor (EDR) models, make sure that the eductor outlet to the flare is not blocked. Blocking this flow will cause PR-1 to relieve to its vent and could cause damage to the system.
3. The standard PR-1 regulator incorporates an internal relief valve on its diaphragm. The relief valve will only open when the Vent Header pressure exceeds 7" WC. The threaded vent port on the top of the dome of PR-1 must be vented to a safe area and MUST be maintained at atmospheric pressure. ANY pressure change in the regulator's dome connection will be reflected in the Vent Header. The orientation of the dome vent connection should be horizontal or facing downward to prevent liquids from accumulating.

Maintenance Instructions:

The Parker Vent Master™ is a mechanical system, but the only moving parts are the minor movements of the diaphragms in the regulators. Therefore, the Parker Vent Master™ is virtually maintenance free.

Note: The standard PR-1 incorporates a carbon steel regulator body. Its wetted components come in contact with only the Nitrogen stream, not any of the analyzer stream components. If PR-1 is to be located in a corrosive environment, contact the factory for additional options.