Parker Vent Master™

Process Analyzer Vent-Header Pressure Control System

Catalog 4142-VM

October 2008

aerospace
climate control
electromechanical
filtration
fluid & gas handling
hydraulics
pneumatics
process control
sealing & shielding

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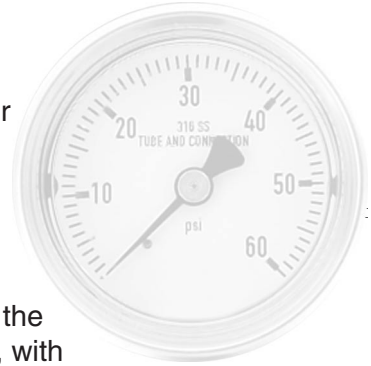
Introduction



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

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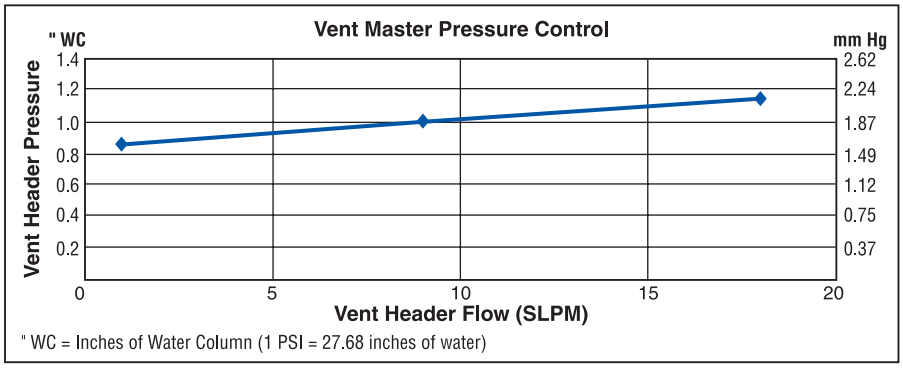
Functional Options

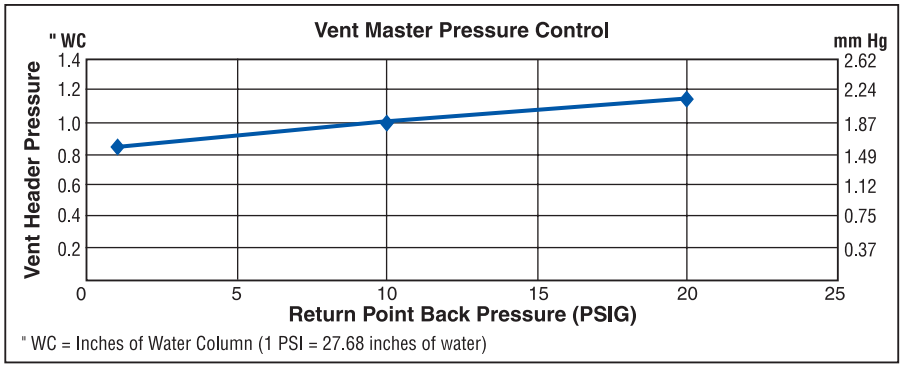
The Parker Vent Master™ can be configured to perform in several different applications as outlined in the following nomenclature summary.

- 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.

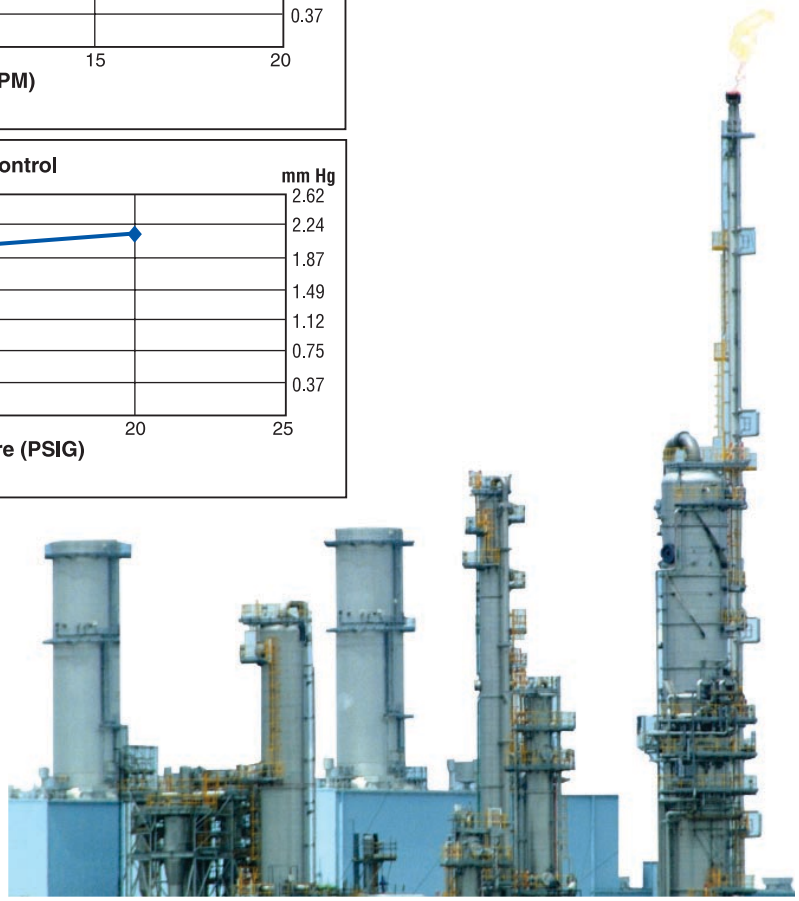
All configurations of the Parker Vent Master™ provide exceptional pressure stability in the analyzer effluent vent header regardless of upstream flow and downstream pressure fluctuations as detailed below:



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



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



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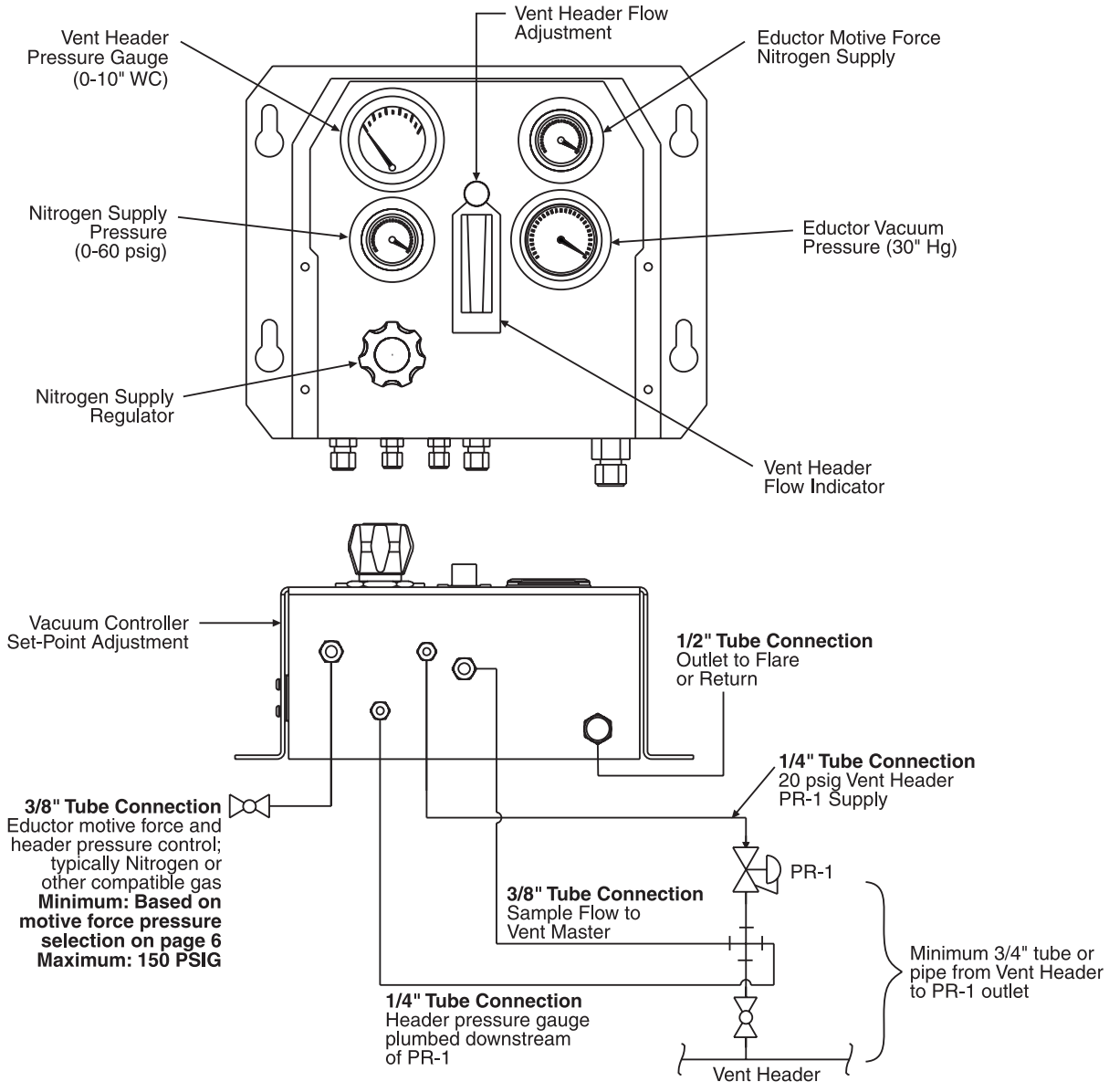
Parker Vent Master™ Eductor (-EDR) Model Theory of Operation

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.



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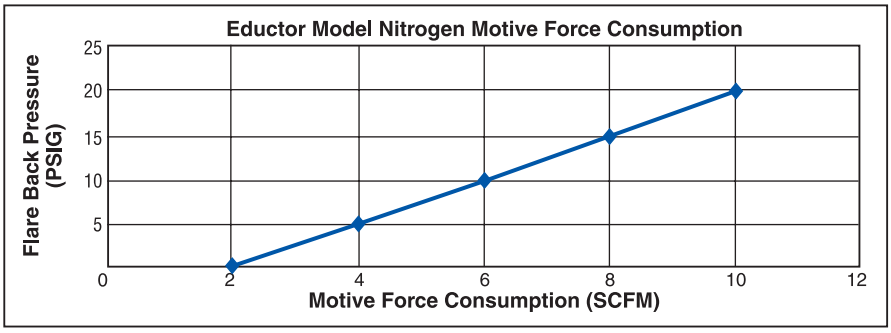
Parker Vent Master™ Eductor Model Theory of Operation (Continued)

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.

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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:

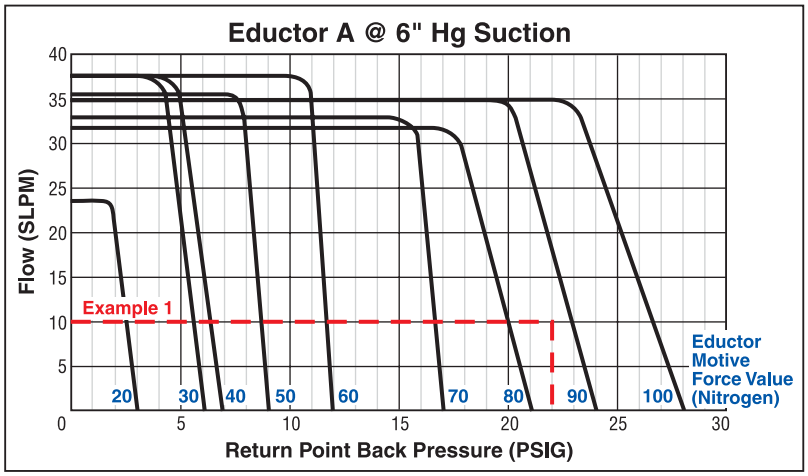
- Motive force pressure availability
- Maximum analyte flow from the Vent Header
- Maximum return point back pressure

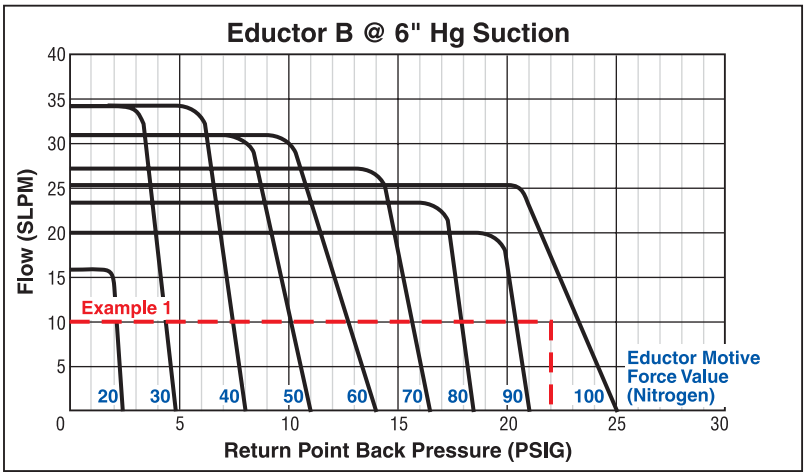
Use the graphs at the right to determine the proper eductor size for an application. When the flow and return point back pressure are plotted as shown in the lines labeled “Example 1” the entire area below the plotted line must fall within the area of the line representing the available motive force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

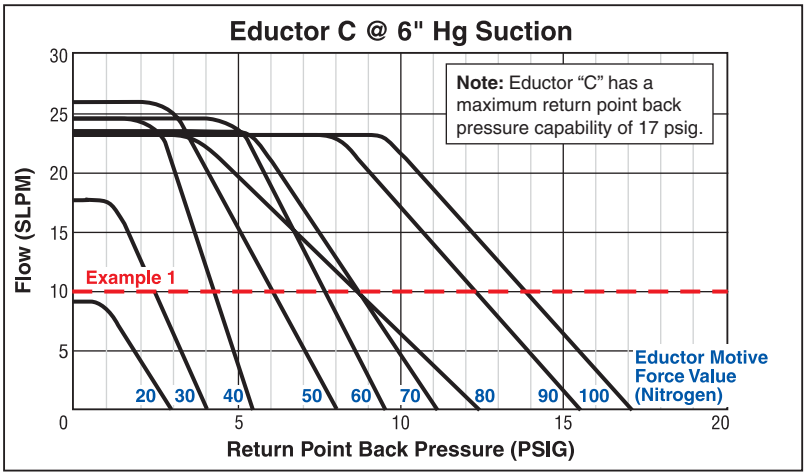
Example 1: An analyzer shelter has 8 different continuous analyzers each flowing 1 SLPM; allowing for a Nitrogen makeup cushion of 2 SLPM, the total flow is 10 SLPM. The return point is the flare header that typically runs at a pressure of 1-2 psig, but process upsets can spike this pressure as high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







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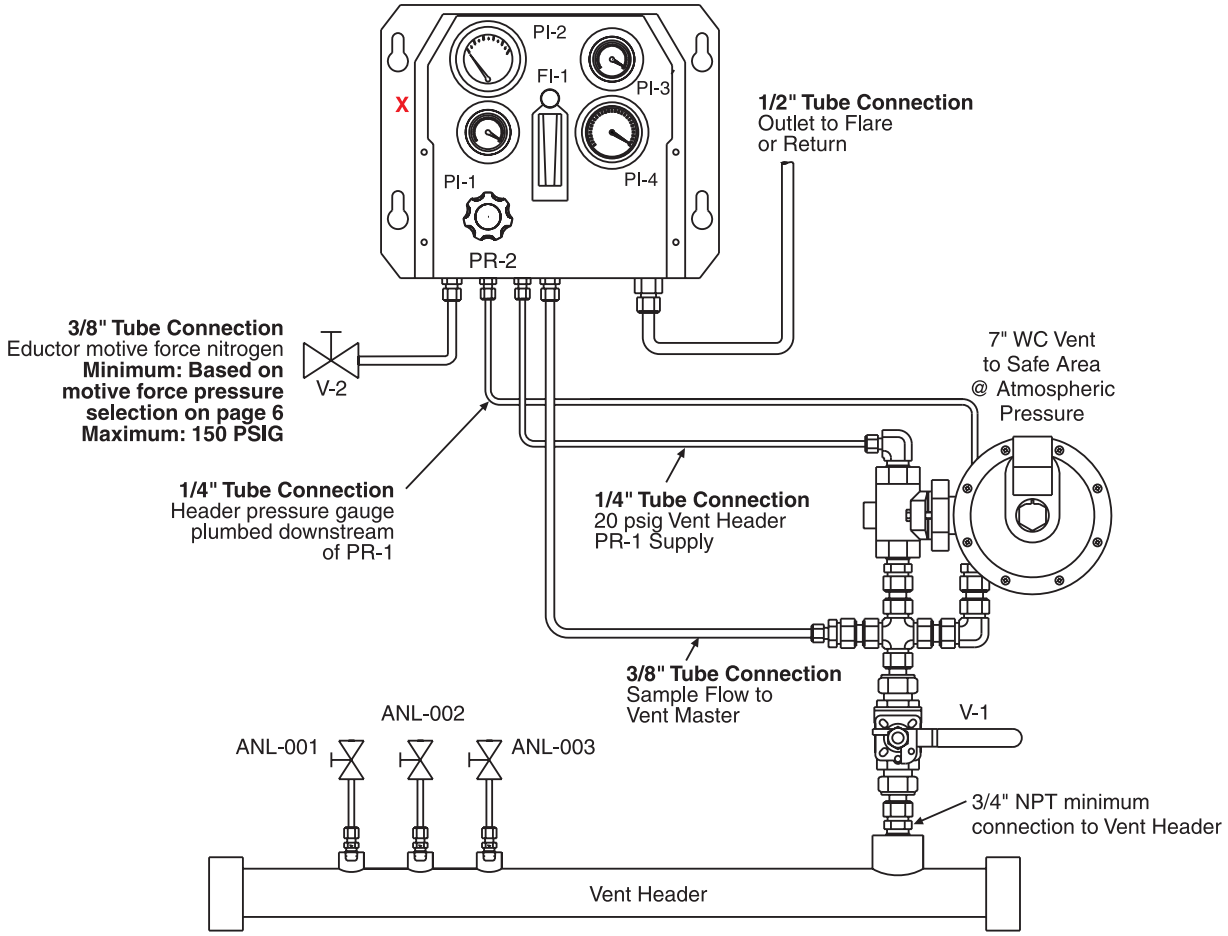
Parker Vent Master™ Nitrogen (-EDR) Model Installation and Startup Procedures

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.
7. Adjust the FI-1 rotameter needle valve to at least 2 SLPM higher than the maximum flow from the analyzers. 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.



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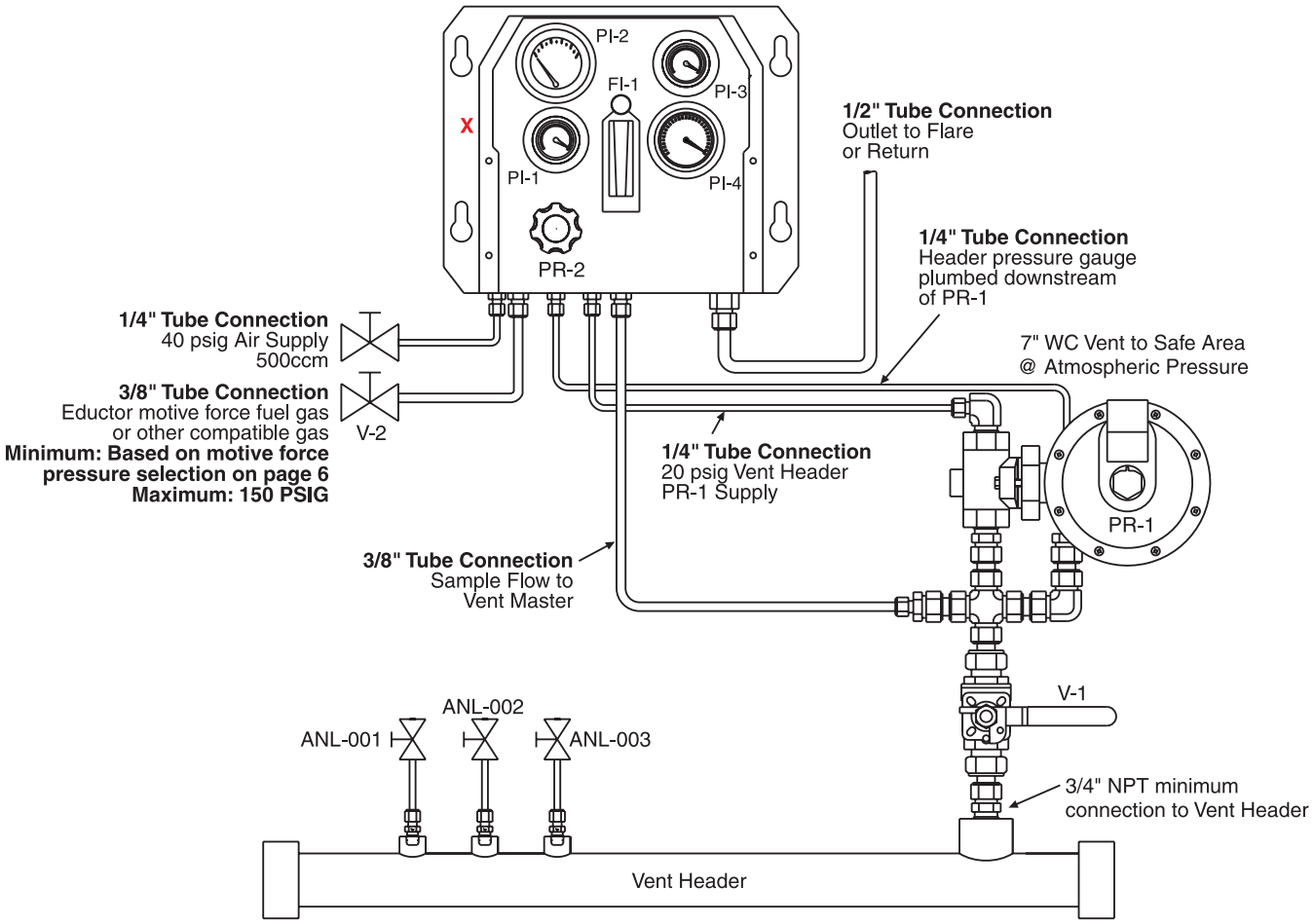
Parker Vent Master™ Eductor Natural Gas (-EDRNB) Model Installation and Startup Procedures

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.
6. Adjust the FI-1 rotameter needle valve to at least 2 SLPM higher than the maximum flow from the analyzers. 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.



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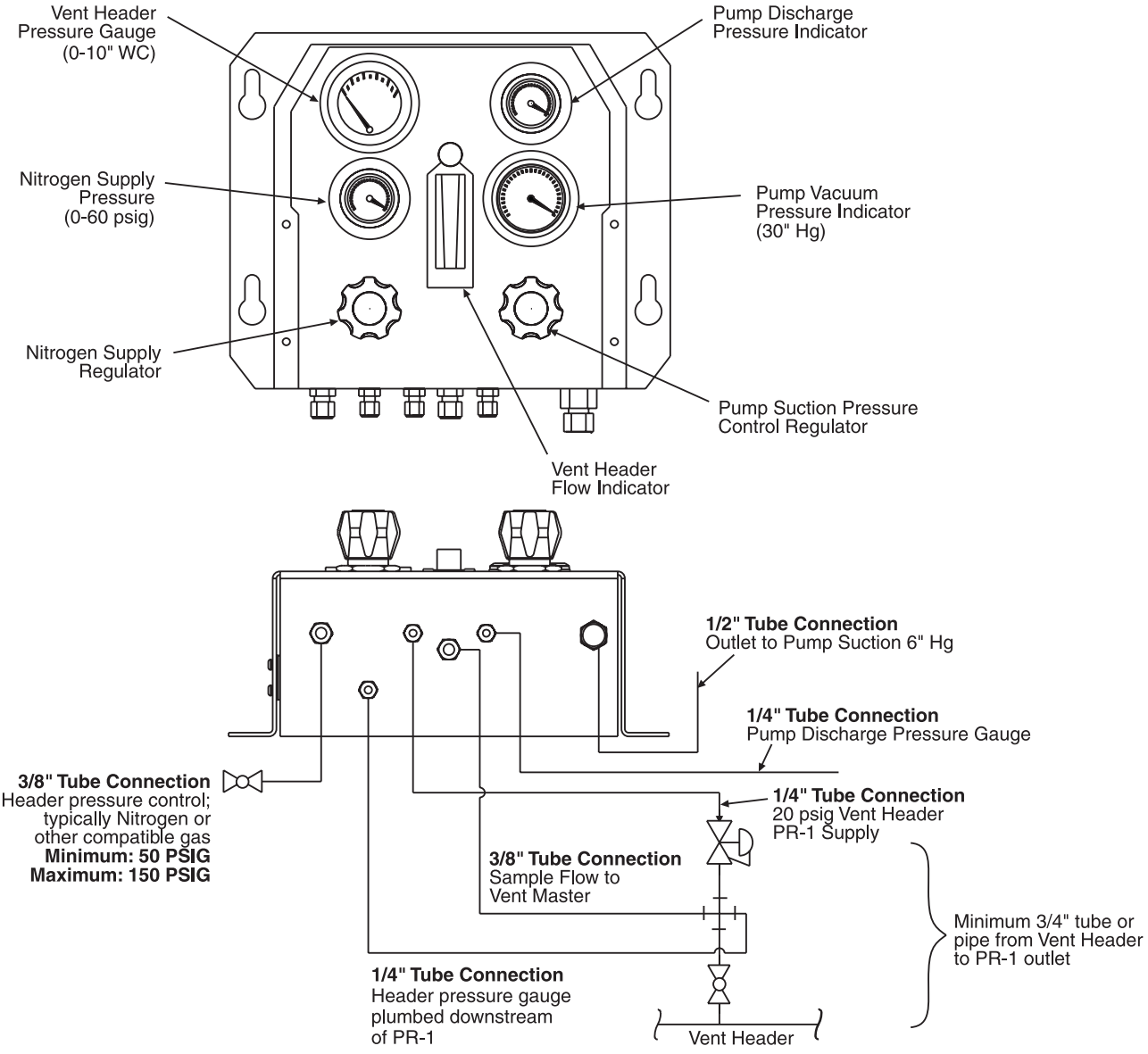
Parker Vent Master™ Pump (-PMP) Model Theory of Operation

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.



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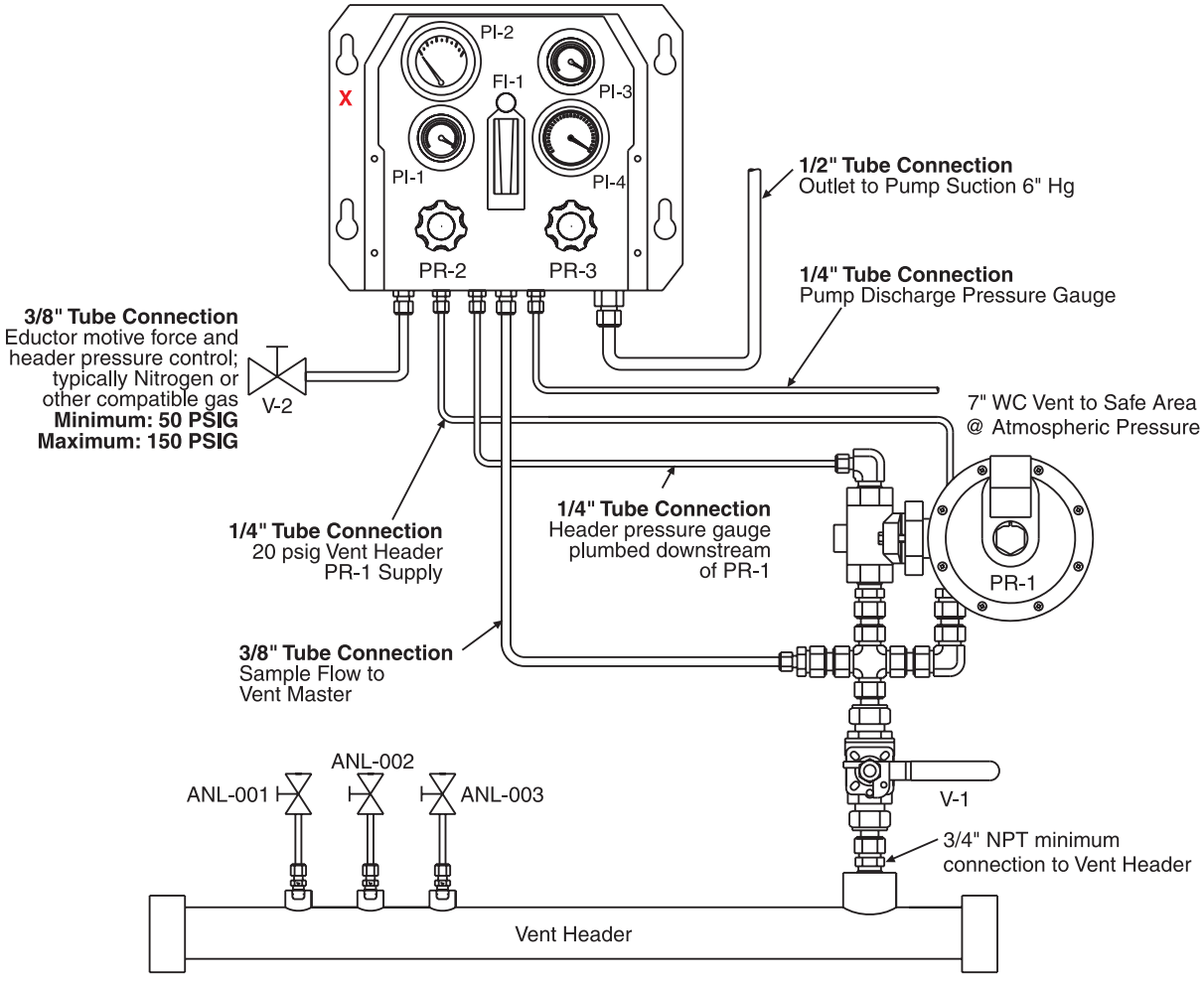
Parker Vent Master™ Pump (-PMP) Model Installation and Startup Procedures

1. Ensure that all connections are made as per the above drawing. 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. **Example:** If your analyzers will contribute 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.



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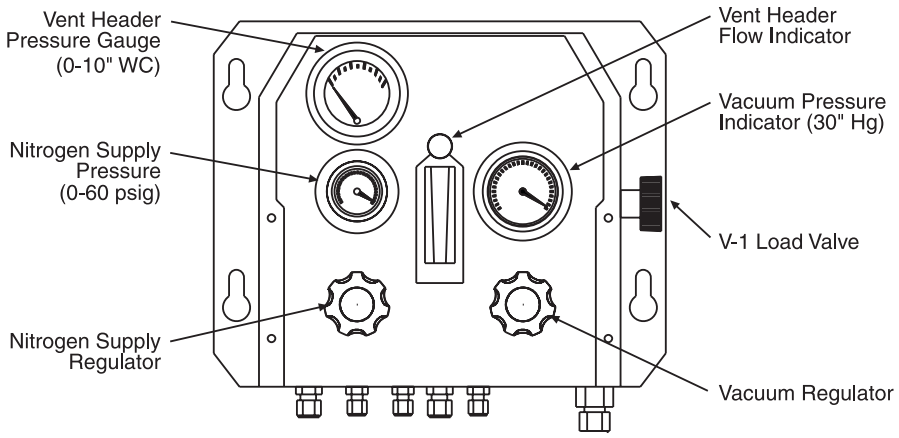
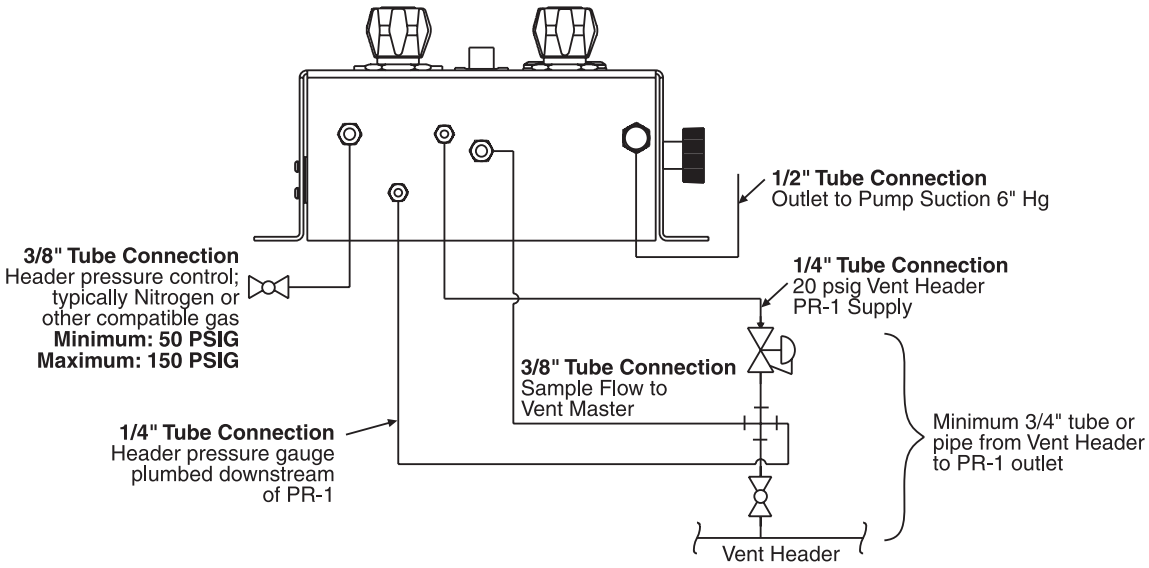
Parker Vent Master™ No Pump or Eductor (-NPE) Model Theory of Operation

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.





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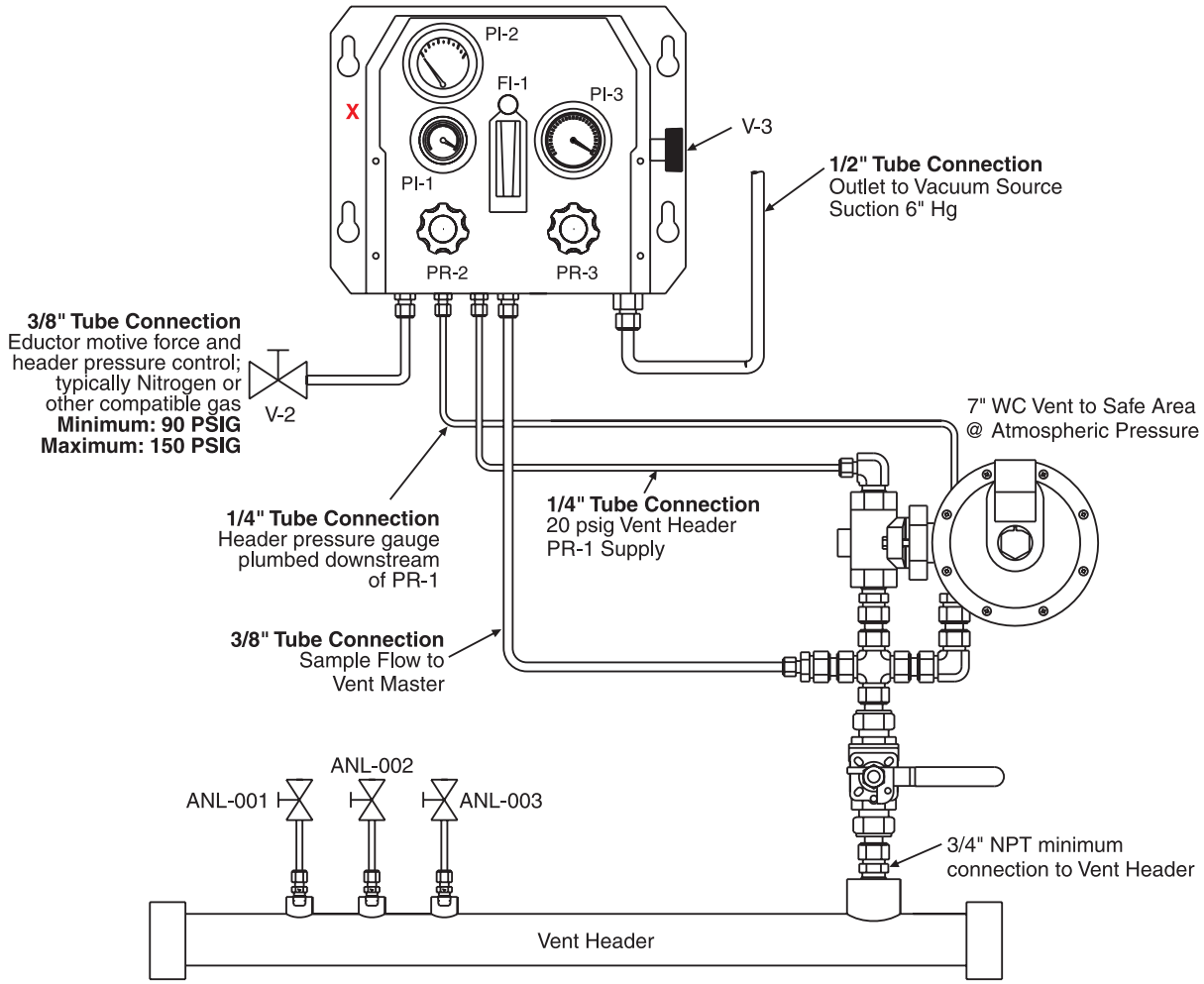
Parker Vent Master™ No Pump or Eductor (-NPE) Model Installation and Startup Procedures

1. Ensure that all connections are made as per the above drawing. 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. **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".



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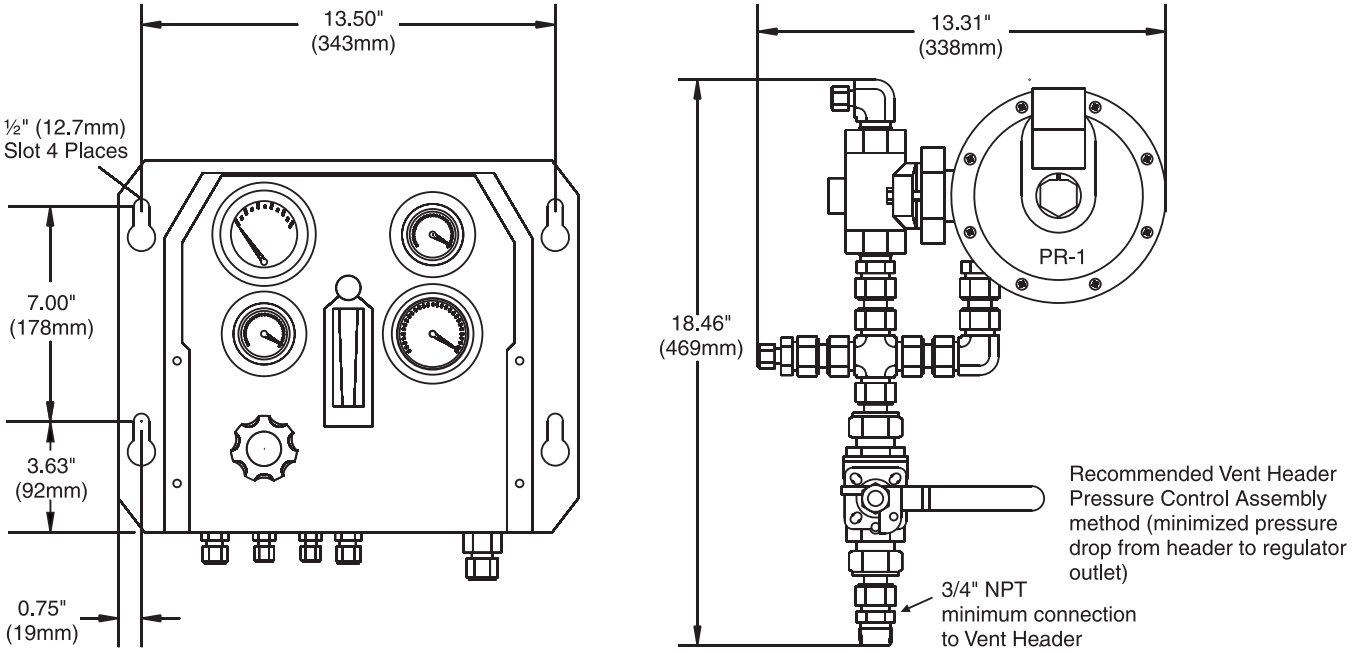
Dimensions



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 (SLPM)**	Rotameter Options	PR-1 Options	Tube Connections
VM	EDR EDRNB	A B C	0 to... 3, 8, 15, 23, 30 & 40	**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 NPE	Blank	0 to... 50, 100, 150, 200			

* See page 7 for eductor sizing.

** The rotameter range is determined by adding 2 SLPM to your total analyzer flow rate, then rounding up to the next highest range available from the selection chart above.

Specifications

Temperature Range: -20°F to 140°F (-29°C to 60°C)

Wetted Materials of Construction: 316SS and Parker Parofluor o-rings (Highly Fluorinated Fluorocarbon Rubber)

Hastelloy C-276 and PTFE Parker Vent Master™ designs available. Hastelloy is the registered trademark of Haynes International, Inc.

ATEX Certificate of Conformance available

3.1B Certificate of Conformance available

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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

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Instrumentation Products Division
Jacksonville, AL USA
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Safety & Maintenance Instructions

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.

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Jacksonville, AL USA
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4. Warranty: Seller warrants that items sold hereunder shall be free from defects in material or workmanship. **THIS WARRANTY COMPRISES THE SOLE AND ENTIRE WARRANTY PERTAINING TO ITEMS PROVIDED HEREUNDER. SELLER MAKES NO OTHER WARRANTY, GUARANTEE, OR REPRESENTATION OF ANY KIND WHATSOEVER. ALL OTHER WARRANTIES, INCLUDING BUT NOT LIMITED TO, MERCHANTABILITY AND FITNESS FOR PURPOSE, WHETHER EXPRESS, IMPLIED, OR ARISING BY OPERATION OF LAW, TRADE USAGE, OR COURSE OF DEALING ARE HEREBY DISCLAIMED.**

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6. Changes, Reschedules and Cancellations: Buyer may request to modify the designs or specifications for the items sold hereunder as well as the quantities and delivery dates thereof, or may request to cancel all or part of this order, however, no such requested modification or cancellation shall become part of the contract between Buyer and Seller unless accepted by Seller in a written amendment to this Agreement. Acceptance of any such requested modification or cancellation shall be at Seller's discretion, and shall be upon such terms and conditions as Seller may require.

7. Special Tooling: A tooling charge may be imposed for any special tooling, including without limitation, dies, fixtures, molds and patterns, acquired to manufacture items sold pursuant to this contract. Such special tooling shall be and remain Seller's property notwithstanding payment of any charges by Buyer. In no event will Buyer acquire any interest in apparatus belonging to Seller which is utilized in the manufacture of the items sold hereunder, even if such apparatus has been specially converted or adapted for such manufacture and not withstanding any charges paid by Buyer. Unless otherwise agreed, Seller shall have the right to alter, discard or otherwise dispose of any special tooling or other property in its sole discretion at any time.

8. Buyer's Property: Any designs, tools, patterns, materials, drawings, confidential information or equipment furnished by Buyer or any other items which become Buyer's property, may be considered obsolete and may be destroyed by Seller after two (2) consecutive years have elapsed without Buyer placing an order for the items which are manufactured using such property, Seller shall not be responsible for any loss or damage to such property while it is in Seller's possession or control.

9. Taxes: Unless otherwise indicated on the face hereof, all prices and charges are exclusive of excise, sales, use, property, occupational or like taxes which may be imposed by any taxing authority upon the manufacture, sale or delivery of the items sold hereunder. If any such taxes must be paid by Seller or if Seller is liable for the collection of such tax, the amount thereof shall be in addition to the amounts for the items sold. Buyer agrees to pay all such taxes or to reimburse Seller therefore upon receipt of its invoice. If Buyer claims exemption from any sales, use or other tax imposed by any taxing authority, Buyer shall save Seller harmless from and against any such tax, together with any interest or penalties thereon which may be assessed if the items are held to be taxable.

10. Indemnity For Infringement of Intellectual Property Rights: Seller shall have no liability for infringement of any patents, trademarks, copyrights, trade dress, trade secrets or similar rights except as provided in this Part 10. Seller will defend and indemnify Buyer against allegations of infringement of U.S. Patents, U.S. Trademarks, copyrights, trade dress and trade secrets (hereinafter 'Intellectual Property Rights'). Seller will defend at its expense and will pay the cost of any settlement or damages awarded in an action brought against Buyer based on an allegation that an item sold pursuant to this contract infringes the Intellectual Property Rights of a third party. Seller's obligation to defend and indemnify Buyer is contingent on Buyer notifying Seller within ten (10) days after Buyer becomes aware of such allegations of infringement, and Seller having sole control over the defense of any allegations or actions including all negotiations for settlement or compromise. If an item sold hereunder is subject to a claim that it infringes the Intellectual Property Rights of a third party, Seller may, at its sole expense and option, procure for Buyer the right to continue using said item, replace or modify said item so as to make it noninfringing, or offer to accept return of said item and return the purchase price less a reasonable allowance for depreciation. Notwithstanding the foregoing, Seller shall have no liability for claims of infringement based on information provided by Buyer, or directed to items delivered hereunder for which the designs are specified in whole or part by Buyer, or infringements resulting from the modification, combination or use in a system of any item sold hereunder. The foregoing provisions of this Part 10 shall constitute Seller's sole and exclusive liability and Buyer's sole and exclusive remedy for infringement of Intellectual Property Rights.

If a claim is based on information provided by Buyer or if the design for an item delivered hereunder is specified in whole or in part by Buyer, Buyer shall defend and indemnify Seller for all costs, expenses or judgments resulting from any claim that such item infringes any patent, trademark, copyright, trade dress, trade secret or any similar right.

11. Force Majeure: Seller does not assume the risk of and shall not be liable for delay or failure to perform any of Seller's obligations by reason of circumstances beyond the reasonable control of Seller (hereinafter 'Events of Force Majeure'). Events of Force Majeure shall include without limitation, accidents, acts of God, strikes or labor disputes, acts, laws, rules or regulations of any government or government agency, fires, floods, delays or failures in delivery of carriers or suppliers, shortages of materials and any other cause beyond Seller's control.

12. Entire Agreement/Governing Law: The terms and conditions set forth herein, together with any amendments, modifications and any different terms or conditions expressly accepted by Seller in writing, shall constitute the entire Agreement concerning the items sold, and there are no oral or other representations or agreements which pertain thereto. This Agreement shall be governed in all respects by the law of the State of Ohio. No actions arising out of the sale of the items sold hereunder or this Agreement may be brought by either party more than two (2) years after the cause of action accrues.

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Parker's Motion & Control Technologies

At Parker, we're guided by a relentless drive to help our customers become more productive and achieve higher levels of profitability by engineering the best systems for their requirements. It means looking at customer applications from many angles to find new ways to create value. Whatever the motion and control technology need, Parker has the experience, breadth of product and global reach to consistently deliver. No company knows more about motion and control technology than Parker. For further info call 1-800-C-Parker.

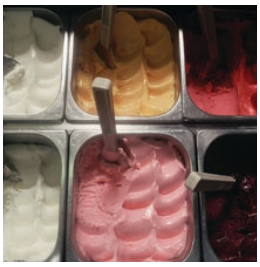
AEROSPACE

Key Markets

- Aircraft engines
- Business & general aviation
- Commercial transports
- Land-based weapons systems
- Military aircraft
- Missiles & launch vehicles
- Regional transports
- Unmanned aerial vehicles

Key Products

- Flight control systems & components
- Fluid conveyance systems
- Fluid metering delivery & atomization devices
- Fuel systems & components
- Hydraulic systems & components
- Inert nitrogen generating systems
- Pneumatic systems & components
- Wheels & brakes



CLIMATE CONTROL

Key Markets

- Agriculture
- Air conditioning
- Food, beverage & dairy
- Life sciences & medical
- Precision cooling
- Processing
- Transportation

Key Products

- CO^2 controls
- Electronic controllers
- Filter driers
- Hand shut-off valves
- Hose & fittings
- Pressure regulating valves
- Refrigerant distributors
- Safety relief valves
- Solenoid valves
- Thermostatic expansion valves

ELECTROMECHANICAL

Key Markets

- Aerospace
- Factory automation
- Life science & medical
- Machine tools
- Packaging machinery
- Paper machinery
- Plastics machinery & converting
- Primary metals
- Semiconductor & electronics
- Textile
- Wire & cable

Key Products

- AC/DC drives & systems
- Electric actuators, gantry robots & slides
- Electrohydrostatic actuation systems
- Electromechanical actuation systems
- Human machine interface
- Linear motors
- Stepper motors, servo motors, drives & controls
- Structural extrusions

FILTRATION

Key Markets

- Food & beverage
- Industrial machinery
- Life sciences
- Marine
- Mobile equipment
- Oil & gas
- Power generation
- Process
- Transportation

Key Products

- Analytical gas generators
- Compressed air & gas filters
- Condition monitoring
- Engine air, fuel & oil filtration & systems
- Hydraulic, lubrication & coolant filters
- Process, chemical, water & microfiltration filters
- Nitrogen, hydrogen & zero air generators

FLUID & GAS HANDLING

Key Markets

- Aerospace
- Agriculture
- Bulk chemical handling
- Construction machinery
- Food & beverage
- Fuel & gas delivery
- Industrial machinery
- Mobile
- Oil & gas
- Transportation
- Welding

Key Products

- Brass fittings & valves
- Diagnostic equipment
- Fluid conveyance systems
- Industrial hose
- PTFE & PFA hose, tubing & plastic fittings
- Rubber & thermoplastic hose & couplings
- Tube fittings & adapters
- Quick disconnects

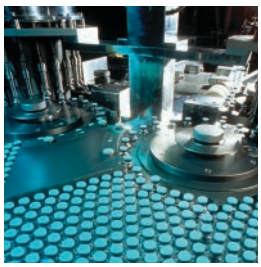
HYDRAULICS

Key Markets

- Aerospace
- Aerial lift
- Agriculture
- Construction machinery
- Forestry
- Industrial machinery
- Mining
- Oil & gas
- Power generation & energy
- Truck hydraulics

Key Products

- Diagnostic equipment
- Hydraulic cylinders & accumulators
- Hydraulic motors & pumps
- Hydraulic systems
- Hydraulic valves & controls
- Power take-offs
- Rubber & thermoplastic hose & couplings
- Tube fittings & adapters
- Quick disconnects



PNEUMATICS

Key Markets

- Aerospace
- Conveyor & material handling
- Factory automation
- Life science & medical
- Machine tools
- Packaging machinery
- Transportation & automotive

Key Products

- Air preparation
- Brass fittings & valves
- Manifolds
- Pneumatic accessories
- Pneumatic actuators & grippers
- Pneumatic valves & controls
- Quick disconnects
- Rotary actuators
- Rubber & thermoplastic hose & couplings
- Structural extrusions
- Thermoplastic tubing & fittings
- Vacuum generators, cups & sensors

PROCESS CONTROL

Key Markets

- **Chemical & refining**
- **Food, beverage & dairy**
- **Medical & dental**
- **Microelectronics**
- **Oil & gas**
- **Power generation**

Key Products

- **Analytical sample conditioning products & systems**
- **Fluoropolymer chemical delivery fittings, valves & pumps**
- **High purity gas delivery fittings, valves & regulators**
- **Instrumentation fittings, valves & regulators**
- **Medium pressure fittings & valves**
- **Process control manifolds**

SEALING & SHIELDING

Key Markets

- Aerospace
- Chemical processing
- Consumer
- Energy, oil & gas
- Fluid power
- General industrial
- Information technology
- Life sciences
- Military
- Semiconductor
- Telecommunications
- Transportation

Key Products

- Dynamic seals
- Elastomeric o-rings
- EMI shielding
- Extruded & precision-cut, fabricated elastomeric seals
- Homogeneous & inserted elastomeric shapes
- High temperature metal seals
- Metal & plastic retained composite seals
- Thermal management

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