"THE NEXT GENERATION"





F70PR Series Pilot-Operated Pressure Relief Valves

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The policy of FLOW SAFE and its authorized assemblers is a commitment to value through:

- Environmentally compatible products
- Cost-efficient design with minimal parts
- Quality products readily available
- Flexibility to meet unique customer needs
- "No-hassle" service

INTRODUCTION

Today's natural gas and process industries require leak-tight valves to reduce emissions, save product, and minimize horsepower requirements.

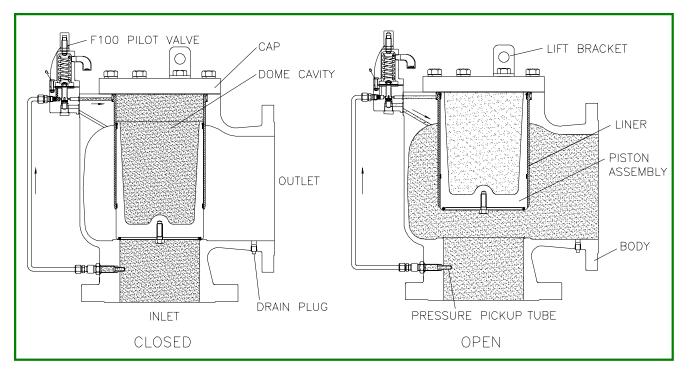
The **F70PR** Series "High Performance Pilot Operated pressure relief valves accomplish bubble-tight seating with accurate and consistent operational characteristics.

F70PR design features include:

- Modulating valve action (less product loss)
- Elastomeric seat and seals
- Repeatable bubble-tight seating
- Rugged, simple, and efficient design
- Superior flow capacities (independently) verified)
- 10 "wc to 285 psig pressure range
- -65 to 400 °F service temperature range
- Easy and economical installation
- Inline maintenance capability
- Pilot exhaust to main valve (standard)
- Discharge drain plug (standard)
- Lift brackets 2x3 and larger (standard)
- Low upset ration (piston area / seat area)
- DOT (49CFR192.199) compliance

F70PR SERIES

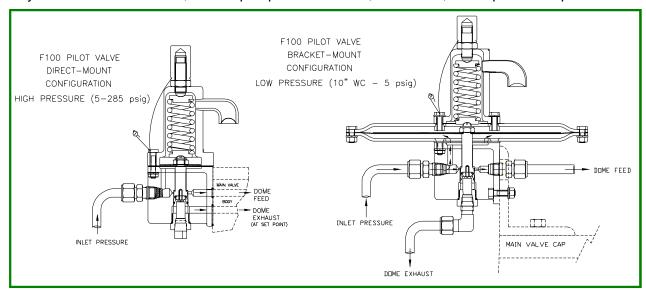
OPERATION



System pressure is routed from the valve inlet, through the modulating pilot valve, to the dome cavity of the main valve. At the designated set pressure, the pilot valve reduces the dome pressure proportional to demand at set pressure, and allows the piston to lift. Once system pressure is relieved, the pilot valve closes, allowing the dome to repressurize and the main valve piston to close.

When the piston is closed, dome pressure acts on an area at the top piston seal that is greater than the seat area, creating a net downward force to keep the piston tightly seated.

The **F70PR** uses an elastomeric seat on the piston to achieve bubble-tight seating. A dynamic piston seal prevents any leakage from the dome to the discharge. Wear rings on the piston prevent any metal-to-metal contact, and help to provide smooth, consistent, and repeatable operation.



APPLICATIONS

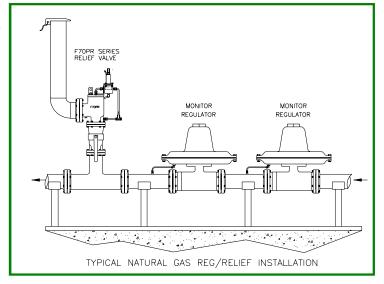
Natural Gas

The **F70PR** pressure relief valve provides overpressure safety protection for natural gas distribution or transmission applications, with the ability to handle large volumes and provide consistent, leaktight shutoff before and after a system upset.

The **F70PR** is designed to be repeatedly cycled at full pressure throughout its acceptable range of temperatures. It is ideal for systems that require overpressure protection, and utilizes modulating action to improve process efficiency and reduce product loss. The **F70PR**'s F100 Series pilot valve is bubble-tight to the set point upon opening, and reseats by 5% below set point, allowing the user to operate close to the nameplate set pressure. A maximum of 5% overpressure is required to fully open the main valve.

The **F70PR** is ideal for city gate, end of line, single regulator-relief and meter station protection. It is also the safest and most economical choice when using it in conjunction with a monitor regulator system for <u>full capacity</u> protection.

- Regulator operating pressure is close to MAOP
- A high cycling rate exists
- A long service life is required
- Minimal product loss is important
- Reduced installation and maintenance time is desirable
- DOT compliance is required



In all applications, the end user should consider preventing the freezing of liquids within the valve which may, under certain conditions, cause erratic performance or valve failure.

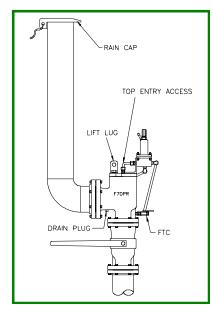
COMPARE THE VALUE!

Value of ownership is offered by utilizing the **F70PR**. Easy installation and inline maintenance is offered by the right angle body style design.

High flow rates provide, in many cases, one inlet size smaller than equivalent capacity pilot-operated regulator/relief valves.

The Flow Safe F70PR features:

- √ Simple design
- √ Reliable operation
- √ Easy Installation
- √ Easy, inline serviceability
- √ Superior flow capacities
- √ Easy field testing
- ✓ ESD (emergency shutdown) capability available with use of dome unloader option — See Page 11







APPLICATIONS

Process Industries

The **F70PR** pressure relief valve is a superior choice to protect industrial process applications at lower (non-Code) set pressures because of the valve's heavy-duty, low-profile body design.

The **F70PR**'s ability to flow high volumes of gas or liquid allows for a smaller valve size than traditional relief valves to get the job done. Smaller valves are not only less expensive but also require smaller piping and isolation valving, and associated connections, both on the inlet and on the outlet.

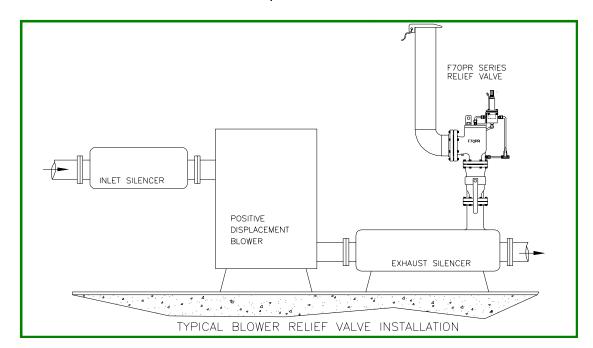
Remote pressure pickup, unloading, and field testing are available options for the **F70PR** Series that allow the operator greater versatility in the operation and servicing of this valve. See Page 11 for more details.

Positive Displacement Blowers — Relief and Unloading

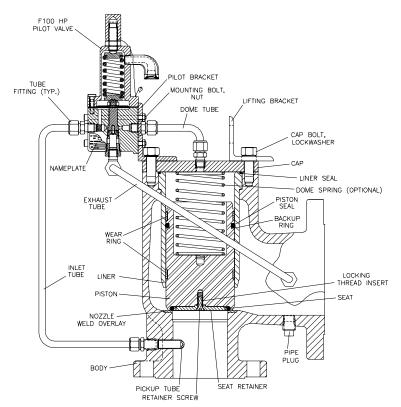
The design technology of the **F70PR** offers, for the first time, a solution for this very demanding, high-cycle, high-vibration/pulsation service. Due to the robust piston design, the **F70PR** can handle the inherent vibrations and pulsations of these blower systems. The welded-in stainless steel seating surface, piston wear rings, and the high L / D piston construction allow the valve the ability to operate reliably for an extended period of time.

The installation of a solenoid valve to the dome of the **F70PR** main valve allows unloading by being able to open the valve at any point below set pressure. Upon startup, to reduce downstream load, the **F70PR** provides atmospheric reference. When the blower stage is run, the **F70PR** reverts back to the relief mode with the solenoid valve closed.

By unloading upon startup, less load is applied to motors — offering protection, extending motor life and, in some cases, reducing the required motor horsepower. Expensive butterfly valves and high-maintenance actuators can be avoided when replaced with the **F70PR** relief and unloader.

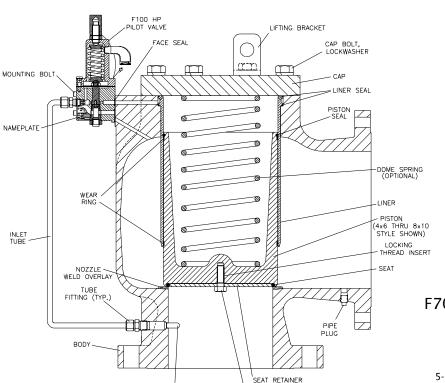


F70PR HIGH PRESSURE ASSEMBLY

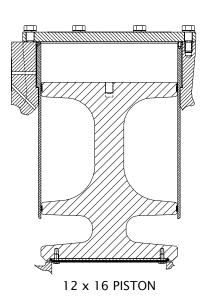


F70PR HIGH PRESSURE ASSEMBLY 2 x 3 AND 3 x 4 SIZES

PRESSURE RANGE
5-285 psig with F100 High Pressure Pilot Valve



RETAINER BOLT



F70PR HIGH PRESSURE ASSEMBLY 4 x 6 THRU 12 x 16 SIZES

PRESSURE RANGE

5-285 psig with F100 High Pressure Pilot Valve 2-4.9 psig with F100 Low Pressure Pilot Valve

6



PICKUP TUBE

F70PR HIGH PRESSURE ASSEMBLY

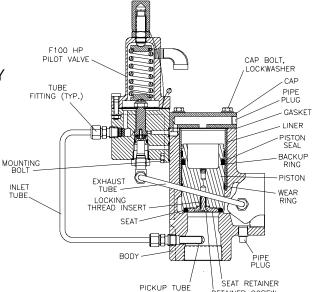
	Materials of Construction				
Part Name	Standard Trim	Stainless Steel (S1) Trim			
Backup Ring	PTFE	PTFE			
Body	A216 WCB ¹	A216 WCB ¹			
Cap	A36 or SA-516 Gr. 70	A36 or SA-516 Gr. 70			
Cap Bolt	SAE Gr. 5	SAE Gr. 5			
Dome Spring (Optional) ²	302/304 SS	302/304 SS			
Face Seal	Elastomer 3	Elastomer ³			
F100 HP Pilot Valve	Aluminum – 6061 / 316 SS trim 4	Aluminum – 6061 / 316 SS trim ⁴			
Gasket	Elastomer 3	Elastomer ³			
Lifting, Pilot Brackets	A36	A36			
Liner	Carbon steel (plated) ⁵	316 SS or A743 CF8M			
Liner Seal	Elastomer ³	Elastomer ³			
Locking Thread Insert	304 SS	304 SS			
Lockwasher	SS	SS			
Mounting Bolts, Nuts	304 or 316 SS	304 or 316 SS			
Nameplate	SS or Aluminum	SS or Aluminum			
Nozzle Weld Overlay	309 SS	309 SS			
Pickup Tube	316 SS	316 SS			
Pipe Plug	CS	CS			
Piston	Aluminum – 356.0 cast or 6061	316 SS or A351 CF8M			
Piston Seal	Elastomer ³	Elastomer ³			
Retainer Screw / Bolt	316 SS	316 SS			
Seat	Elastomer ³	Elastomer ³			
Seat Retainer	Aluminum – 6061	316 SS			
Tube Fittings	316 SS	316 SS			
Tubing	316 SS	316 SS			
Wear Ring	Graphite-filled PTFE	Graphite-filled PTFE			

^{1 1-1/2} x 2 body is ASTM B26 - 356.0 cast aluminum

F70PR HIGH PRESSURE ASSEMBLY 1-1/2 x 2 SIZE

PRESSURE RANGE

5-285 psig with F100 High Pressure Pilot Valve



RETAINER SCREW

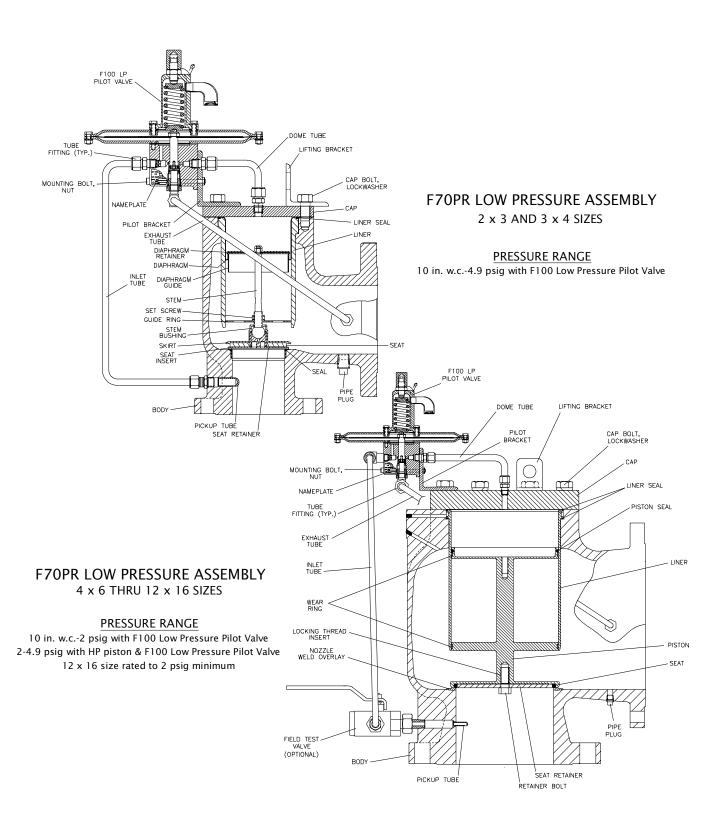
² Dome spring not available in 12 x 16 size

⁴ All 316 SS F100 pilot valve available as option

^{5 316} SS or CF8M liner is standard in 1-1/2 x 2 and 4 x 6 thru 12 x 16 sizes

³ Buna-N standard; Viton, EPR, other materials available

F70PR LOW PRESSURE ASSEMBLY



F70PR LOW PRESSURE ASSEMBLY

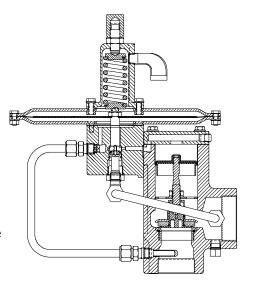
	Materials of Construction
Part Name	Standard Trim ¹
Body	A216 WCB ²
Cap	A36 or SA-516 Gr. 70
Cap Bolt	SAE Gr. 5
Diaphragm Guide, Retainer	Aluminum – 6061
Diaphragm	Buna-N
F100 LP Pilot Valve	Aluminum – 6061 / 316 SS trim ³
Guide Ring	Aluminum – 6061
Lifting, Pilot Brackets	A36
Liner	Carbon steel (plated) ⁴
Liner Seal	Elastomer ⁵
Locking Thread Insert	304 SS
Lockwasher	SS
Mounting Bolts, Nuts	304 or 316 SS
Nameplate	SS or Aluminum
Nozzle Weld Overlay	309 SS
Pickup Tube	316 SS
Pipe Plug	CS
Piston	Aluminum – 6061
Piston Seal	Elastomer ⁵
Retainer Bolt	316 SS _
Seal	Elastomer ⁵
Seat	Neoprene
Seat Insert	316 SS
Seat Retainer	Aluminum – 6061
Set Screw	302 SS
Skirt	Aluminum – 6061
Stem	Aluminum – 6061
Stem Bushing	PEEK
Tube Fittings	316 SS
Tubing	316 SS
Wear Ring	Graphite-filled PTFE

Low-pressure piston available in aluminum only

F70PR LOW PRESSURE ASSEMBLY 1-1/2 x 2 SIZE

PRESSURE RANGE

10 in. w.c.-4.9 psig with F100 Low Pressure Pilot Valve



² 1-1/2 x 2 body is ASTM B26 - 356.0 cast aluminum

³ All 316 SS F100 pilot valve available as option
⁴ A743 CF8M liner may be used in 4x6 and larger valves
⁵ Buna-N standard; Viton, EPR, other materials available

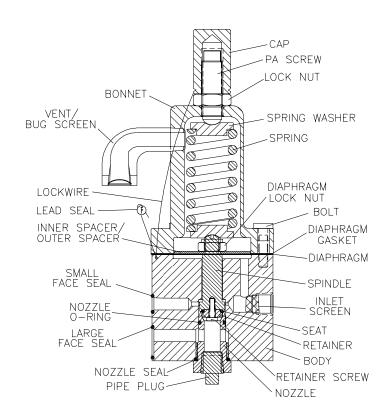
F100 PILOT VALVES

	Matariala af	0 1 1		
	Materials of Construction			
Part Name	Standard Trim	Stainless Steel (S1) Trim		
Body Bolt Bonnet Cap Diaphragm Diaph. Gasket Diaph. Housing Diaph. Lock Nut Face Seals Gasket Inner / Outer Spacers Inlet Screen Lead Seal Lock Nut Lockwire Nozzle Nozzle O-ring Nozzle Seal PA Screw Pipe Plug Retainer Retainer Screw Seat SH Cap Screw Spindle Spring Spring Washer Support Plate Vent /				

¹ PTFE available to 150 psig

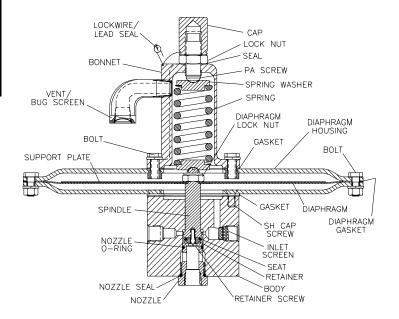
F100 PILOT VALVE LOW PRESSURE

10 in.w.c. - 4.9 psig



F100 PILOT VALVE

5 - 285 psig





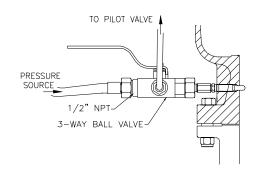
² Buna-N standard; Viton, EPR, other materials available

ACCESSORIES AND OPTIONS

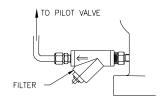
F70PR SERIES

<u>Field Test Connection (P/N Code T)</u>: allows the user to verify set pressure with the valve in service, without valve removal. An external pressure source is attached to the FTC to direct pressure to the pilot valve, while blocking off inlet pressure. Checks can include pilot set pressure alone, and also main piston operation if sufficient inlet pressure is present.

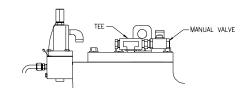
In addition, a remote sense line can be routed from the vessel or system to the FTC for installations where inlet pressure losses with the valve flowing would exceed 3% of the set point.



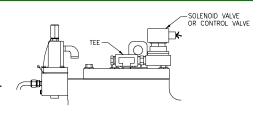
<u>Inlet Supply Filter (F)</u>: should be used for dirty applications to clean the supply gas to the pilot valve. The filter includes a purge connection.



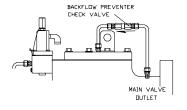
Manual Blowdown Valve (M): allows for main valve lift independent of pilot by using a manual valve to exhaust the dome cavity.



Remotely Operated Blowdown Valve (S): allows for main valve lift independent of pilot by using an electrically operated solenoid valve or pneumatic valve to exhaust the dome cavity. The automatic valve can be specified as normally open (SO) or normally closed (SC). This valve can function as part of a natural gas compression ESD (emergency shutdown) system.



<u>Backflow Preventer (P)</u>: prevents backflow into the system, when the inlet is at a vacuum condition or when outlet pressure exceeds inlet pressure. The mode of possible backflow should be specified when ordering.



<u>Closed Dome Tee (D)</u>: as shown above with blowdown valve diagrams, allows for future mounting of valve, pressure gage, or other instrumentation.

<u>Diverter Assembly (V)</u>: provides for switching between two redundant F70PR's to permit maintenance.



<u>SIZING</u> F70PR SERIES

Described below are criteria and equations used to calculate the flow capacities of **F70PR** Series relief valves on gas or vapor. Equations are based on API 520 Part I. Capacities for air and natural gas at various set pressures are tabulated on Page 13 for easy reference.

<u>Critical vs. Subcritical (Subsonic) Flow</u>: As a gas is expanded across a nozzle, the mass flow rate will increase as downstream pressure decreases until a limiting velocity (speed of sound) is reached in the nozzle. When this *critical* flow condition is reached, downstream pressure can increase until it equals the critical flow pressure [P_{cf} , Equation (1)] without affecting the flow rate. Below approximately 12-13 psig, flow is *subcritical*, where the ratio of backpressure to inlet pressure exceeds the critical pressure ratio, P_{cf} / P_1 .

First, use Equation (1) to determine whether flow is critical or subcritical. If backpressure P_2 is less than or equal to P_{cf} , flow is critical. If P_2 is greater than P_{cf} , flow is subcritical.

(1)
$$P_{cf} = P_1[2/(k+1)]^{k(k-1)}$$

If flow is **subcritical**, required orifice area is determined from Equation (2). If orifice area is known, capacity can be determined from Equation (3).

(2) A =
$$[V/(4645 F_2 K_d K_c)] \{MTZ/[P_1(P_1 - P_2)]\}^{1/2}$$

(3) V =
$$4645 \text{ A } F_2 K_d K_c [P_1(P_1 - P_2) / \text{MTZ}]^{1/2}$$

If flow is **critical**, required orifice area is determined from Equation (4). If orifice area is known, capacity can be determined from Equation (5).

(4) A =
$$V (MTZ)^{1/2} / (6.32 C P_1 K_d K_c)$$

(5) V =
$$6.32 \text{ A C P}_1 \text{ K}_d \text{ K}_c / (\text{MTZ})^{1/2}$$

 P_{cf} = Critical flow pressure (psia)

P = Set pressure (psig)
P₁ = Inlet pressure, including accumulation (psia)

P_a = Inlet pressure, including accumulation (psig)

 P_2 = Backpressure (psia)

 $k = Specific heat ratio (C_p / C_v)$

= Orifice area (in²)

V = Flow rate (scfm) @ 60°F, 14.7 psia

K_d = Discharge coefficient (see table, below left)

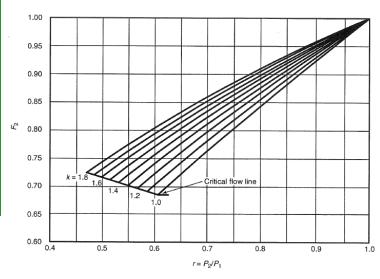
K_c = Rupture disk correction factor 1.0 with no disk 0.9 with disk in combination

C = Gas coefficient based on k

M = Molecular weight

T = Relieving temperature (°F +460) Z = Compressibility factor for gas F₂ = Subcritical flow coefficient, from figure below

Pressure Range, Pa / Siz	ze K _d
10 in. w.c 5 psig (all si	zes) 0.698
5 - 15 psig (1-1/2x2, 2x3, 3x4)	0.0084P _a + 0.656
5 - 15 psig (all others)	$0.0202P_a + 0.597$
15 - 30 psig (1-1/2x2)	$0.00453P_a + 0.714$
15 - 30 psig (2x3, 3x4)	$0.00253P_a + 0.744$
15 - 285 psig (all others)	
30 - 285 psig (1-1/2x2)	0.850
30 - 285 psig (2x3, 3x4)	0.820



12 April 2009 update

AIR MW = 29, k = 1.40, C = 356

SCFH @ 5% overpressure, 60 °F

Valve Size	1-1/2 x 2	2 x 3	3 x 4	4 x 6	6 x 8	8 x 10	12 x 16
Cv ¹ =	46	79	174	269	614	1076	2635
A (in ²) =	1.770	3.365	7.402	11.430	26.06	45.66	111.87
Set Pressure							
10" wc	6610	12570	27650	44700	97350	170570	
15" wc	8090	15380	33850	52270	119170	208810	
20" wc	9340	17760	39070	60330	137550	241000	
25" wc	10440	19840	43660	67420	153710	269330	
1 psig	10980	20880	45940	70950	161770	283440	
5 psig	24390	46370	102010	158190	360680	631950	1547300
10 psig	36230	68880	151510	254370	579960	1016100	2488000
15 psig	46520	88290	194210	344340	785090	1375500	3370200
20 psig	56200	105260	231560	403710	920450	1612700	3951300
30 psig	76400	140130	308250	522430	1191100	2086900	5113300
40 psig	93760	171980	378310	641170	1461800	2561300	6275500
50 psig	111130	203830	448370	759910	1732500	3035600	7437600
60 psig	128500	235680	518430	878650	2003300	3509900	8599700
80 psig	163240	299380	658560	1116000	2544600	4458600	10924000
100 psig	197970	363080	798670	1353500	3086100	5407300	13248300
120 psig	232700	426770	938790	1591000	3627500	6356000	15572500
140 psig	267430	490470	1078900	1828500	4169000	7304600	17896900
160 psig	302160	554180	1219000	2066000	4710500	8253300	20221100
180 psig	336890	617880	1359100	2303400	5251800	9201900	22545400
200 psig	371620	681580	1499200	2540900	5793300	10150600	24869600
220 psig	406350	745280	1639300	2778300	6334700	11099200	27194000
240 psig	441090	808980	1779400	3015800	6876200	12047800	29518200
260 psig	475820	872670	1919600	3253400	7417600	12996500	31842500
285 psig	519240	952280	2094700	3550200	8094400	14182400	34747900

¹Cv reference data valid for 30 psig and above; K_d factors are in accordance with Page 12

NATURAL GAS MW = 19, k = 1.27, C = 344

= subcritical flow condition

Valve Size	1-1/2 x 2	2 x 3	3 x 4	4 x 6	6 x 8	8 x 10	12 x 16
Cv ¹ =	46	79	174	269	614	1076	2635
A (in ²) =	1.770	3.365	7.402	11.430	26.06	45.66	111.87
Set Pressure							
10" wc	8150	15500	34110	52670	120100	210440	
15" wc	9970	18970	41730	64440	146930	257440	
20" wc	11510	21880	48130	74330	169470	296930	
25" wc	12850	24430	53750	83000	189250	331600	
1 psig	13520	25700	56550	87320	199100	348850	
5 psig	29630	56340	123930	192180	438170	767720	1879700
10 psig	43440	82600	181690	305040	695480	1218500	2983700
15 psig	55540	105400	231850	411070	937240	1642100	4023300
20 psig	67090	125660	276430	481950	1098800	1925200	4717000
30 psig	91200	167290	367990	623690	1422000	2491400	6104400
40 psig	111940	205310	451630	765450	1745100	3057700	7491700
50 psig	132670	243330	535270	907190	2068300	3623900	8879100
60 psig	153400	281360	618910	1048800	2391400	4190300	10266500
80 psig	194870	357400	786180	1332300	3037900	5322700	13041200
100 psig	236330	433450	953450	1615800	3684300	6455200	15815900
120 psig	277790	509490	1120600	1899400	4330600	7587700	18590700
140 psig	319250	585530	1287900	2182900	4977000	8720300	21365400
160 psig	360720	661580	1455100	2466400	5623300	9852800	24140100
180 psig	402180	737620	1622500	2749900	6269700	10985300	26914900
200 psig	443640	813670	1789800	3033300	6916000	12117800	29689600
220 psig	485110	889720	1957100	3316800	7562500	13250300	32464400
240 psig	526570	965690	2124300	3600300	8208900	14382800	35239100
260 psig	568030	1041700	2291600	3883900	8855200	15515400	38013800
285 psig	619860	1136800	2500700	4238300	9663100	16931000	41482200

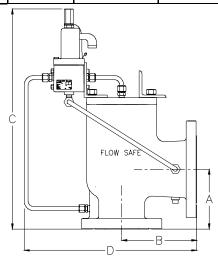
SPECIFICATIONS

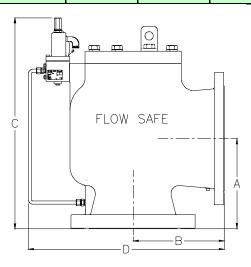
Set pressure range, Low Pressure (LP)	10 in. w.c. to 4.9 psig			
Set pressure range, High Pressure (HP)	5 psig to 285 psig (ANSI 150)			
Process temperature range (continuous)	-65 °F to 400 °F (Viton elastomer)			
Main valve body material	A216 WCB (B26-356.0 aluminum for 1-1/2x2)			
Main valve trim material	6061 aluminum / 316 SS optional			
Pilot valve body material	6061 aluminum			
Pilot valve trim material	316 or 304 SS			
Seat and seal material	Elastomer (see table below)			
Tubing, fitting material	316 SS			

	Continuous Process	Temperature (°F)	Pressure Range (psig)		
Seat Material	Min.	Max.	Min.	Max.	
Buna-N	-30	275	2	285	
Viton®	-30	400	2	285	
Ethylene propylene (EPR)	-65	325	2	285	
Kalrez®	0	500	2	285	
Neoprene	-20	200	10 in. w.c.	5	

Viton and Kalrez are registered trademarks of DuPont Performance Elastomers

Valve Weight		alve Weight Connections		Maximum Dimensions (in)			
Size	(lbs)	Inlet	Outlet	Α	В	С	D
1-1/2 x 2	15	1-1/2" FNPT	2" FNPT	2.75	3.00	13.5	12.0
2 x 3	60	2"-150#RF	3"-150#RF	4.56	5.30	18.5	17.5
3 x 4	85	3"-150#RF	4"-150#RF	5.70	7.00	21.5	18.5
4 x 6	170	4"-150#RF	6"-150#RF	7.75	8.25	22.5	19.0
6 x 8	270	6"-150#RF	8"-150#RF	9.44	9.50	27.5	22.0
8 x 10	460	8"-150#RF	10"-150#RF	10.88	11.00	31.5	24.5
12 x 16	1100	12"-150#RF	16"-150#RF	11.92	15.56	39.0	32.5





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ORDERING / PART NUMBERING

F70PR SERIES

To properly order and process an **F70PR** Series relief valve, please specify the following:

- 1. Quantity required, required ship date(s), as agreed upon quotation
- 2. Inlet and outlet connection sizes, ratings
- 3. Flow Safe part number (See below)
- 4. Material requirements: main valve, trim, pilot valve, seats and seals
- 5. Operating conditions: set pressure, fluid & state, relieving temperature
- 6. Optional accessories (See Page 11)
- 7. Any special requirements
- 8. Required documentation
- 9. Valve tagging requirements
- 10. Any special packaging & shipping instructions

PART NUMBERING <u>2 - 1000 - 12BFT</u> **OPTIONS** VALVE TYPE 02 - F70 (main valve)subass'y B - Bracket mount (standard on 03 - F100 pilot valve subass'y 2x3, 3x4, and all LP) 12 - F70PR assembly D - Closed dome tee F - Inlet filter M - Manual blowdown P - Backflow preventer ASSEMBLY TYPE T - Field test connection 10 - F70PR assembly SO - Solenoid valve (NO) 11 - F70 (main valve) subass'y SC - Solenoid valve (NC) 91 - F100 pilot valve assembly V - Diverter valve S1 - SS piston, retainer S2 - SS piston, retainer, liner SP - Special VALVE SIZE 03 - 1-1/2 x 2 $05 - 6 \times 8$ MATERIAL TYPE 06 - 8 x 10 00 - 2 x 3 2 - Carbon steel 01 - 3 x 4 08 - 12 x 16 3 - Stainless steel (pilot only) 04 - 4 x 6 94 - F100 pilot valve 5 - Aluminum $(1-1/2 \times 2 \text{ or pilot only})$

PILOT VALVE TYPE

- 0 Low pressure
- 1 High pressure

<u>EXAMPLES</u>: Conditions: Operating press. = 42 psig; Set press. = 50 psig (5% overpressure)

Medium: Natural gas; Capacity required = 500,000 scfh

Accessories: Filter

Order: P/N 12-1001-12BF, F70PR HP, 3 x 4, Set @ 50 psig

Conditions: Operating press. = 15 in. w.c.; Set press. = 20 in. w.c. (5% O.P.)

Medium: Natural gas; Capacity required = 65,000 scfh

Accessories: Field test connection, filter

Order: P/N 12-1004-02BFT, F70PR LP, 4 x 6, Set @ 20 in. w.c.

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