Valve Sizing

Table B - Steam Super Heat Correction Factor, K_{sh}

Set Pressure psig	[barg]	Saturated Steam Temp. °F	[°C]	Total Steam Temperature °F [°C] 580 [305]	600 [316]	620 [326]	640 [338]	660 [349]	680 [360]	700 [371]	720 [382]	740 [393]	760 [405]	780 [416]	800 [427]	900 [482]	1000 [537]	1100 [593]
15	[1.03]	250	[121]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
20	[1.38]	259	[126]	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.81	.78	.75	.72
40	[2.40]	287	[142]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
60	[4.14]	308	[153]	.89	.88	.87	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
80	[5.52]	324	[162]	.89	.89	.88	.87	.86	.85	.84	.84	.83	.82	.82	.81	.78	.75	.72
100	[6.90]	338	[170]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
120	[8.27]	350	[177]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
140	[9.65]	361	[183]	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.82	.81	.78	.75	.72
160	[11.0]	371	[188]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
180	[12.4]	380	[193]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.81	.78	.75	.72
200	[13.8]	388	[198]	.90	.89	.88	.87	.86	.86	.85	.84	.83	.83	.82	.81	.78	.75	.72
220	[15.2]	395	[201]	.91	.90	.89	.88	.87	.86	.85	.84	.8	.83	.82	.81	.78	.75	.72
240	[16.6]	403	[206]	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.81	.78	.75	.72
260	[17.9]	409	[209]	.91	.90	.89	.88	.87	.86	.85	.85	.84	.83	.82	.81	.78	.75	.72
280	[19.3]	416	[213]	.91	.90	.91	.88	.87	.86	.85	.85	.84	.83	.82	.82	.78	.75	.72
300	[20.7]	422	[217]	.91	.90	.89	.88	.87	.86	.86	.85	.84	.83	.82	.82	.78	.75	.72
350	[24.1]	436	[224]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.83	.82	.78	.76	.72
400	[27.6]	448	[231]	.92	.91	.90	.89	.88	.87	.86	.85	.84	.84	.83	.82	.79	.76	.72
450	[31.0]	460	[238]	.93	.92	.91	.89	.88	.87	.86	.86	.85	.84	.83	.82	.79	.76	.72
500	[34.5]	470	[243]	.93	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
550	[37.9]	480	[249]	.94	.92	.91	.90	.89	.88	.87	.86	.85	.84	.83	.82	.79	.76	.73
600	[41.4]	489	[254]	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.84	.83	.79	.76	.73
650	[44.8]	497	[258]	.95	.94	.92	.91	.90	.89	.87	.86	.86	.85	.84	.83	.79	.76	.73
700	[48.3]	506	[263]	.96	.94	.93	.91	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
750	[51.7]	513	[267]	.96	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.83	.79	.76	.73
800	[55.2]	520	[271]	.97	.95	.94	.92	.91	.90	.88	.87	.86	.85	.84	.84	.80	.76	.73
850	[58.6]	527	[275]	.98	.96	.94	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.76	.73
900	[62.1]	533	[278]	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.84	.80	.77	.73
950	[65.5]	540	[282]	.99	.97	.95	.94	.92	.91	.89	.88	.87	.86	.85	.84	.80	.77	.73
1000	[69.0]	546	[286]	.99	.98	.96	.94	.93	.91	.90	.89	.87	.86	.85	.84	.80	.77	.73
1050	[72.4]	552	[289]	1.00	.99	.97	.95	.93	.92	.90	.89	.88	.87	.86	.85	.80	.77	.73
1100	[75.9]	558	[292]	1.00	.99	.98	.95	.94	.92	.91	.89	.88	.87	.86	.85	.81	.77	.73
1150	[79.3]	563	[295]	1.00	.99	.98	.96	.94	.92	.91	.90	.88	.87	.86	.85	.81	.77	.73
1200	[82.7]	569	[298]	1.00	.99	.98	.97	.95	.93	.91	.90	.89	.87	.86	.85	.81	.77	.73

Note

Revised capacity for "Super Heat Steam:" multiply capacity of Valve x Factor noted above.

Valve Sizing

Table C - Air and Gas Temperature Correction Factors

Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc	Temperature °F	Tc
0	1.062	90	0.972	260	0.849	440	0.760
10	1.051	100	0.964	280	0.838	460	0.752
20	1.041	120	0.947	300	0.828	480	0.744
30	1.030	140	0.931	320	0.817	500	0.737
40	1.020	160	0.916	340	0.806	550	0.718
50	1.009	180	0.902	360	0.796	600	0.701
60	1.000	200	0.888	380	0.787	650	0.685
70	0.991	220	0.874	400	0.778	700	0.669
80	0.981	240	0.862	420	0.769	750	0.656

For temperatures other than 60°F at valve inlet, multiply standard SCFM by Tc.

Table D - Gas and Liquid Relative Density Correction Factors

Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc	Specific Gravity	Dc
0.07	3.770	0.60	1.290	1.05	0.975	1.70	0.768
0.08	3.530	0.65	1.240	1.10	0.955	1.80	0.745
0.09	3.333	0.70	1.195	1.15	0.933	1.90	0.725
0.10	3.160	0.75	1.155	1.20	0.913	2.00	0.707
0.20	2.240	0.80	1.117	1.25	0.895	2.50	0.633
0.30	1.825	0.85	1.085	1.30	0.877	3.00	0.577
0.40	1.580	0.90	1.055	1.40	0.845	3.50	0.535
0.50	1.414	0.95	1.025	1.50	0.817	4.00	0.500
0.55	1.350	1.00	1.000	1.60	0.791	4.50	0.471

For a specific gravity other than air or water (=1.0), multiply CFM or GPM by Dc.

Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Acetone	58.08	1.12	329
Acetylene (Ethyne)	26.04	1.26	343
Air	28.97	1.40	356
Ammonia, Anhydrous	17.03	1.31	348
Argon	39.95	1.67	378
Benzene (Benzol or Benzole)	78.11	1.12	329
Boron Trifluoride	67.82	1.20	337
Butadiene-1,3 (Divinyl)	54.09	1.12	329
Butane-n (Normal Butane)	58.12	1.09	326
Butylene (1-Butene)	56.11	1.11	328
Carbon Dioxide	44.01	1.29	346
Carbon Disulfide (C. Bisulfide)	76.13	1.21	33
Carbon Monoxide	28.01	1.40	356
Carbon Tetrachloride	153.82	1.11	328
Chlorine	70.91	1.36	353
Chloromethane (Methyl Chloride)	50.49	1.28	345
Cyclohexane	84.16	1.09	326
Cyclopropane (Trimethylene)	42.08	1.11	328
Decane-n	142.29	1.04	320
Diethylene Glycol (DEG)	106.17	1.07	323
Dimethyl Ether (Methyl Ether)	46.07	1.11	328
Dowtherm A	165.00	1.05	321
Dowtherm E	147.00	1.00	315
Ethane	30.07	1.19	336
Ethyl Alcohol (Ethanol)	46.07	1.13	330
Ethylene (Ethene)	28.05	1.24	341
Ethylene Glycol	62.07	1.09	326
Ethylene Oxide	44.05	1.21	338
Fluorocarbons:			
12, Dichlorodifluoromethane	120.93	1.14	331
13, Chlorotrifluoromethane	104.47	1.17	334
13B1, Bromotrifluoromethane	148.93	1.14	331
22, Chlorodifluoromethane	86.48	1.18	335
115, Chloropentafluoroethane	154.48	1.08	324
Glycerine (Glycerin or Glycerol)	92.10	1.06	322
Helium	4.00	1.67	378
Heptane	100.21	1.05	321

Valve Sizing

Physical Properties

Gas or Vapor	M Molecular Weight	k Specific Heat Ratio	C Gas Constant
Hexane	86.18	1.06	322
Hydrogen	2.02	1.41	357
Hydrogen Chloride, Anhydrous	36.46	1.41	357
Hydrogen Sulfide	34.08	1.32	349
Isobutane (2-Methylpropane)	58.12	1.10	327
Isoprene (2-Methyl-1, 3 Butadiene)	68.12	1.09	326
Isopropyl Alcohol (Isopropanol)	60.10	1.09	326
Krypton	83.80	1.71	380
Methane	16.04	1.31	348
Methyl Alcohol (Methanol)	32.04	1.20	337
Methylamines, Anhydrous			
Monomethylamine (Methylamine)	31.06	1.02	317
Dimethylamine	45.08	1.15	332
Trimethylamine	59.11	1.18	335
Methyl Mercapton (Methanethiol)	48.11	1.20	337
Naphthalene (Napthaline)	128.17	1.07	323
Natural Gas (specific gravity = 0.60)	17.40	1.27	344
Neon	20.18	1.64	375
Nitrogen	28.01	1.40	356
Nitrous Oxide	44.01	1.30	347
Octane	114.23	1.05	321
Oxygen	32.00	1.40	356
Pentane	72.15	1.07	323
Propadiene (Allene)	40.07	1.69	379
Propane	44.10	1.13	330
Propylene (Propene)	42.08	1.15	332
Propylene Oxide	58.08	1.13	330
Styrene	104.15	1.07	323
Sulfur Dioxide	64.06	1.28	345
Sulfur Hexafluoride	146.05	1.09	326
Steam	18.02	1.31	348
Toluene (Toluol or Methylbenzene)	92.14	1.09	326
Triethylene Glycol (TEG)	150.18	1.04	320
Vinyl Chloride Monomer (VCM)	62.50	1.19	336
Xenon	131.30	1.65	376
Xylene (p-Xylene)	106.17	1.07	323

Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Acetaldehyde	0.779	68	20
Acetic Acid	1.051	68	20
Acetone	0.792	68	20
Ammonia, Anhydrous	0.666	68	20
Automotive Crankcase and Gear Oils:			
SAE-5W Through SAE 150	0.88-0.94	60	15.6
Beer	1.01	60	15.6
Benzene (Benzol)	0.880	68	20
Boron Trifluoride	1.57	-148	-100
Butadiene - 1, 3	0.622	68	20
Butane-n (Normal Butane)	0.579	68	20
Butylene (1-Butene)	0.600	68	20
Carbon Dioxide	1.03	-4	-20
Carbon Disulfide (C. Bisulfide)	1.27	68	20
Carbon Tetrachloride	1.60	68	20
Chlorine	1.42	68	20
Chloromethane (Methyl Chloride)	0.921	68	20
Crude Oils:			
32.6 Deg API	0.862	60	15.6
35.6 Deg API	0.847	60	15.6
40 Deg API	0.825	60	15.6
48 Deg API	0.79	60	15.6
Cyclohexane	0.780	68	20
Cyclopropane (Trimethylene)	0.621	68	20
Decane-n	0.731	68	20
Diesel Fuel Oils	0.82-0.95	60	15.6
Diethylene Glycol (DEG)	1.12	68	20
Dimethyl Ether (Methyl Ether)	0.663	68	20
Dowtherm A	0.998	68	20
Dowtherm E	1.087	68	20
Ethane	0.336	68	20
Ethyl Alcohol (Ethanol)	0.79	68	20
Ethylene (Ethene)	0.569	-155	-104
Ethylene Glycol	1.115	68	20
Ethylene Oxide	0.901	68	20

Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Fluorocarbons:			
R12, Dichlorodifluoromethane	1.34	68	20
R13, Chlorotrifluoromethane	0.916	68	20
R13B1, Bromotrifluoromethane	1.58	68	20
R22, Chlorodifluoromethane	1.21	68	20
R115, Chloropentafluoromethane	1.31	68	20
Fuel Oils, Nos. 1, 2, 3, 5 and 6	0.82-0.95	60	15.6
Gasolines	0.68-0.74	60	15.6
Glycerine (Glycerin or Glycerol)	1.26	68	20
Heptane	0.685	68	20
Hexane	0.660	68	20
Hydrochloric Acid	1.64	60	15.6
Hydrogen Sulfide	0.78	68	20
Isobutane (2-Methylpropane)	0.558	68	20
Isoprene (2-Methyl - 1, 3-Butadiene)	0.682	68	20
Isopropyl Alcohol (Isopropanol)	0.786	68	20
Jet Fuel (average)	0.82	60	15.6
Kerosene	0.78-0.82	60	15.6
Methyl Alcohol (Methanol)	0.792	68	20
Methylamines, Anhydrous:			
Monomethylamine (Methylamine)	0.663	68	20
Dimethylamine	0.656	68	20
Trimethylamine	0.634	68	20
Methyl Mercapton (Methanethiol)	0.870	68	20
Nitric Acid	1.50	60	15.6
Nitrous Oxide	1.23	-127	-88.5
Octane	0.703	68	20
Pentane	0.627	68	20
Propadiene (Allene)	0.659	-30	-34.4
Propane	0.501	68	20
Propylene (Propene)	0.514	68	20
Propylene Oxide	0.830	68	20
Styrene	0.908	68	20
Sulfur Dioxide	1.43	68	20

Valve Sizing

Physical Properties

Liquid	G Specific Gravity Water = 1	°F	°C
Sulfur Hexafluoride	1.37	68	20
Sulfuric Acid:			
95–100%	1.839	68	20
60%	1.50	68	20
20%	1.14	68	20
Toluene (Toluol or Methylbenzene)	0.868	68	20
Triethylene Glycol (TEG)	1.126	68	20
Vinyl Chloride Monomer (VCM)	0.985	-4	-20
Water, fresh	1.00	68	20
Water, sea	1.03	68	20
Xylene (p-Xylene)	0.862	68	20

Sizing - Determining K_v and K_w

U.S. Units

$$R = \frac{V_L\,(2{,}800\ G)}{\mu\sqrt{A}}$$

or

$$R = \frac{12{,}700\ V_L}{U\sqrt{A}}$$

Metric Units

$$R = \frac{31{,}313\ V_L\ G}{\mu\sqrt{A}}$$

Determining K_v

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

V_L = Flow rate at the flowing temperature, in U.S. gpm [m³/hr]

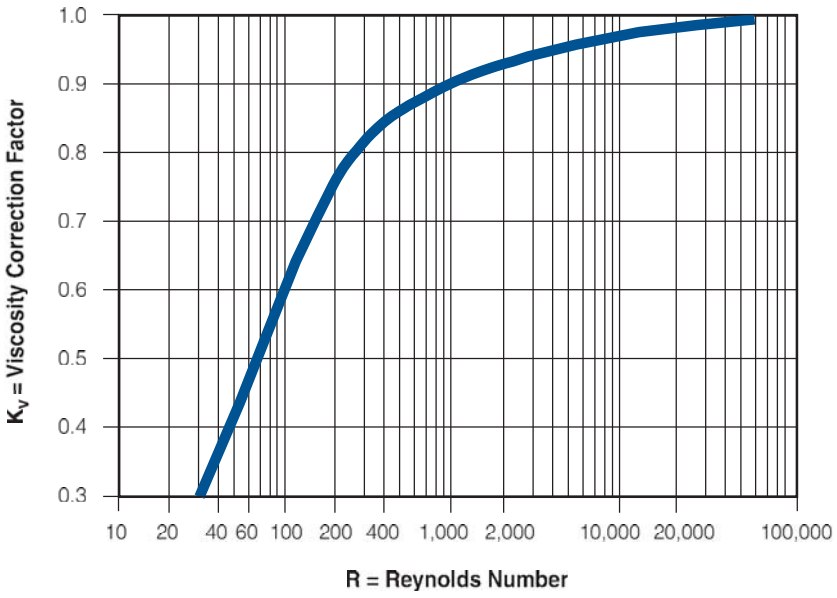
G = Specific gravity of liquid at flowing temperature referred to water = 1.00 at 70°F [21°C]

μ = Absolute viscosity at the flowing temperature, in centipoises

A = Effective discharge area, in square inches [cm²] (from manufacturer's standard orifice areas)

U = Viscosity at the flowing temperature, in Saybolt Universal seconds

After the value of R is determined, the factor K_V is obtained from the graph. Factor K_V is applied to correct the "preliminary required discharge area." If the corrected area exceeds the "chosen standard orifice area," the calculations should be repeated using the next larger standard orifice size.



Conversion Factors

Absolute Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	poise	Centipoise	$\frac{gm}{cm-sec}$	$\frac{lb}{ft-sec}$
poise	—	100	1	0.0672
centipoise	0.01	—	0.01	0.000672
$\frac{gm}{cm-sec}$	1	100	—	0.0672
$\frac{lb}{ft-sec}$	14.88	1488	14.88	—

Notes

1. Kinematic viscosity x specific gravity = absolute viscosity.
2. Centistokes x specific gravity = centipoise.
3. Saybolt Second Universal (SSU) x 0.216 x specific gravity = centipoise.

Kinematic Viscosity

Given	To find desired value, multiply "Given" value by factor below			
	stoke	Centistoke	$\frac{cm^2}{sec}$	$\frac{ft^2}{sec}$
stoke	—	100	1	0.001076
centistoke	0.01	—	0.01	1.076 x 10-5
$\frac{cm2}{sec}$	1	100	—	0.001076
$\frac{ft2}{sec}$	929.0	92900	929.0	—

Liquid Flow Conversions

Given	To find desired value, multiply "Given" value by factor below				
	l/hr	gpm - US	gpm - Imp	barrels/day	m^3/hr
l/hr (litres/hour)	—	0.00440	0.003666	0.1510	0.0010
gpm (US gallons per minute)	227.1	—	0.8327	34.29	0.2271
gpm (Imperial gallons per minute)	272.8	1.201	—	41.18	0.2728
barrels/day (petroleum - 42 US gallons)	6.624	0.02917	0.02429	—	0.006624
$m^3$3/hr (cubic meters per hour)	1000	4.403	3.666	151.0	—
m^3/s (cubic meters per second)	3.6×10^6	0.02917	0.02429	—	0.006624
kg/hr (kilograms per hour)	$\frac{1}{G}$	$\frac{1}{227.1G}$	$\frac{1}{272.8G}$	$\frac{0.151}{G}$	$\frac{1}{1000G}$
lb/hr (pounds per hour)	$\frac{1}{2.205G}$	$\frac{1}{500.8G}$	$\frac{1}{601.5G}$	$\frac{1}{14.61G}$	$\frac{1}{2205G}$

Note

1. G = Specific gravity of liquid at its relieving temperature compared to that of water at 68°F [20°C], where $G_{water} = 1.00$.

Conversion Factors

Notes

1. M = Molecular weight of vapor or gas.
2. Volumetric flow (per time unit of hour or minute as shown) in standard cubic feet per minute at 14.7 psia [1.013 bara], 60°F [16°C].
3. Weight flow in pounds per hour.
4. Weight flow in kilograms per hour.
5. Volumetric flow (per time unit of hour or minute as shown) at 1.013 bara 32°F [0°C]. This represents the commercial standard, known as the Normal Temperature and Pressure (NTP).

   Conversions from one volumetric flow rate to another or to weight flow (and vice versa) may only be done when the volumetric flow is expressed in the standard conditions shown above. If flows are expressed at temperature or pressure bases that differ from those listed above, they must first be converted to the standard base.

Gas Flow Conversions

Given	To find desired value, multiply "Given" value by factor below					
	SCFM	SCFH	lb/hr	[kg/hr]	[Nm³/hr]	[Nm³/min]
scfm[2]	—	60	$\frac{M}{6.32}$	$\frac{M}{13.93}$	1.608	0.0268
scfh[2]	0.01677	—	$\frac{M}{379.2}$	$\frac{M}{836.1}$	0.0268	0.000447
lb/hr[3] or #/hr[3]	$\frac{6.32}{M}$	$\frac{379.2}{M}$	—	0.4536	$\frac{10.17}{M}$	$\frac{0.1695}{M}$
kg/hr[4]	$\frac{13.93}{M}$	$\frac{836.1}{M}$	2.205	—	$\frac{22.40}{M}$	$\frac{0.3733}{M}$
Nm³/hr[5]	0.6216	37.30	$\frac{M}{10.17}$	$\frac{M}{22.40}$	—	0.01667
Nm³/min[5]	37.30	2238	5.901 M	2.676 M	60	—

If flow is expressed in actual volume, such as cfm (cubic feet per minute) or acfm (actual cfm) as is often done for compressors, where the flow is described as displacement or swept volume, the flow may be converted to scfm as follows (or from flow expressed in m³/hr to Nm³/hr).

Inch-Pound Units

$$SCFM = \begin{pmatrix} cfm \\ or \\ acfm \end{pmatrix} x \frac{14.7 + p}{14.7} \times \frac{520}{460 + t}$$

Where:

p = gauge pressure of gas or vapor in psig

t = temperature of gas or vapor in °F

Metric Units

$$Nm^3/hr = m^3hr = x \frac{1.013 + p}{1.013} \times \frac{273}{273 + t}$$

Where:

p = gauge pressure of gas or vapor in barg

t = temperature of gas or vapor in °C

Notes

1. Also expressed as kp/cm² and kgf/cm².
2. Normal Temperature and Pressure (NTP) Conditions are, at sea level, equal to 1.013 bara or 1.033 kg/cm² (kilograms force per square centimeter absolute) at a base temperature of 32°F [0°C]. This differs slightly from Metric Standard Conditions (MSC), which uses 1.013 bara 60°F [15°C] for the base temperature.
3. Inch-Pound Standard Conditions are, at sea level, equal to 14.7 psia (pounds force per square inch absolute), rounded up from 14.696 psia, and at a base temperature of 60°F [16°C].

Pressure Conversion

Given	To find desired value, multiply "Given" value by factor below			
	kPa	psig	kg/cm²	barg
kPa (kilopascal)	—	0.1450	0.0102	0.0100
psig (pounds/in²)[3]	6.895	—	0.0703	0.06895
kg/cm²[1][1](kilograms/cm²)	98.07	14.22	—	0.9807
barg	100.00	14.50	1.020	—

Area Conversion

Given	To find desired value, multiply "Given" value by factor below			
	in²	ft²	mm²	cm²
in²	—	0.006944	645.16	6.4516
cm²	0.155	1.076×10^{-3}	100	—
ft²	144	—	92900	929
mm²	0.00155	1.076×10^{-5}	—	0.01

Temperature Conversion

Degrees Celsius (°C)	Degrees Fahrenheit (°F)
C + 273.15 = K (Kelvin)	F + 459.67 = R (Rankine)
(C x 1.8) + 32 = F (Fahrenheit)	(F - 32) x 0.556 = C (Celsius)

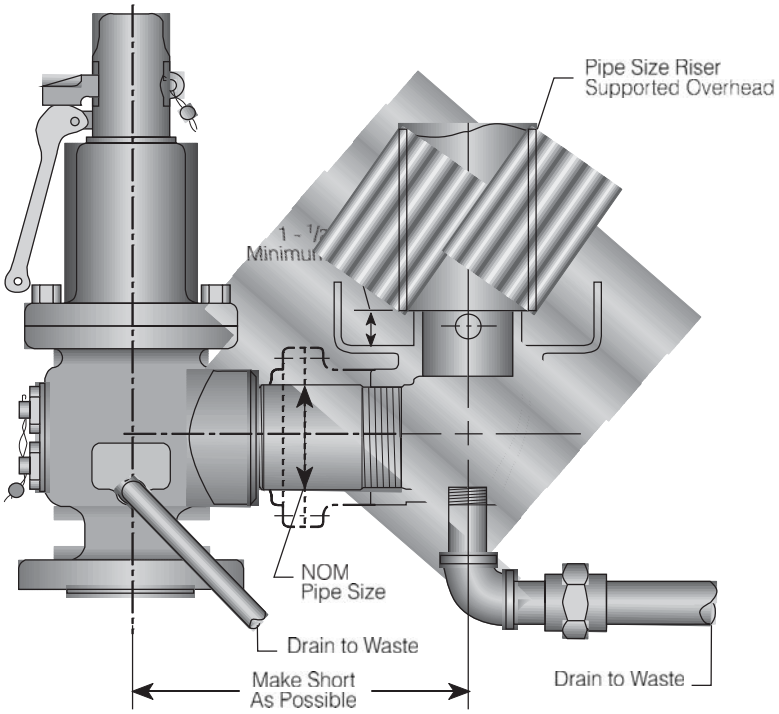
Installation

1. Before installing a new safety/relief valve, we recommend that a pipe tap be used to assure clean-cut and uniform threads in the vessel opening and to allow for normal hand engagement followed by a half to one turn by wrench.
2. Install the valve in a vertical position so that discharge piping and code required drains can be properly piped to prevent build-up of back pressure and accumulation of foreign material around the valve seat area.
3. Avoid over-tightening as this can distort safety/relief valve seats. One need only remember that as the vessel and valve are heated, the expansion involved will grasp the valve more firmly.
4. When installing flange connected valves, use new gaskets and draw the mounting bolts down evenly.
5. Do not use the valve outlet or cap as a lever for installation. Use only flat jawed wrenches on the flats provided.
6. Avoid excessive "popping" of the safety/relief valve as even one opening can provide a means for leakage. Safety/relief valves should be operated only often enough to assure that they are in good working order.
7. Avoid wire, cable, or chain pulls for attachment to levers that do not allow a vertical pull. The weight of these devices should not be directed to the safety/relief valve.
8. Avoid having the operating pressure too near the safety/relief valve set pressure. A very minimum differential of 5 psig or 10 percent (whichever is greater) is recommended. An even greater differential is desirable, when possible, to assure better seat tightness and valve longevity. Safety/relief valves in high-temperature hot water and organic fluid service are more susceptible to damage and leakage than safety valves for steam. It is recommended that the maximum allowable working pressure of the boiler and the safety/relief valve setting be selected substantially higher than the operating pressure. A differential of 30-40 percent is recommended.
9. Avoid discharge piping where its weight is carried by the safety/relief valve. Even though supported separately, changes in temperature alone can cause piping strain. We recommend that drip pan elbows or flexible connections be used wherever possible (see Type A, B, C Installation, page 29).
10. Apply a moderate amount of pipe compound to male threads only, leaving the first thread clean. Compound applied to female threads or used to excess can find its way into the valve, causing leakage.

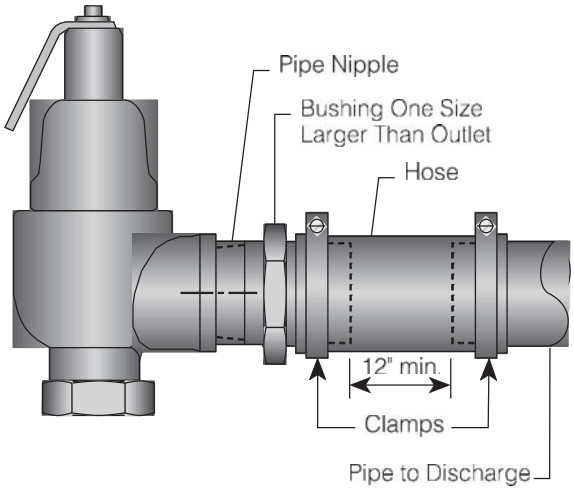
Installation

Recommended Discharge Installation

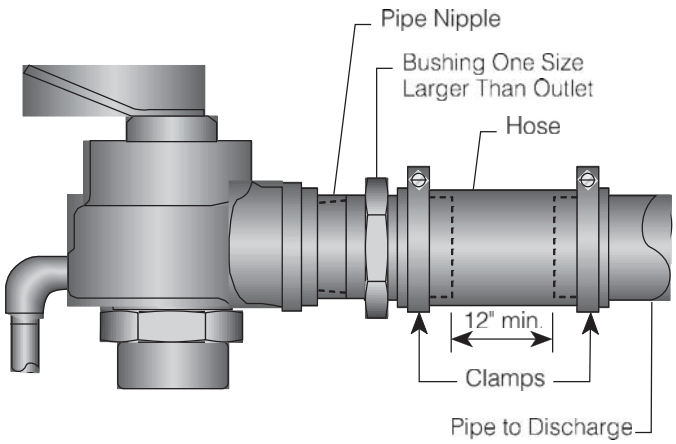
Type "A" Installation



Type "B" Installation



Type "C" Installation



Maintenance

1. Develop a regular program of visual inspection, looking for clogged drains and discharge pipe, dirt build-up in and around the valve seat and broken or missing parts.
2. Test the valve every two to six months (depending on valves' age and condition) preferably by raising the system pressure to the valves set pressure or operating the hand lever (see #3 in Operation).
3. Do not paint, oil, or otherwise cover any interior or working parts of any safety valve. They do not require any lubrication or protective coating to work properly.

When safety/relief valves require repair, service adjustments, or set pressure changes, work shall be accomplished by the manufacturer, or holders of "V," "UV," and/or "VR" stamps.

Guarantee

Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by buyer or user, accident, corrosion, chemical attack, or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle) immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced hereunder shall continue to be warranted for the remainder of the unexpired warranty period, if any. Any repair or replacement of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Black Mountain, North Carolina and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement goods or parts to buyer to repair defective goods, buyer agrees to install sold replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle) shall in no event be liable for any labor or material costs of buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality tests or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle) The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only, unless expressly stated as warranties. Except for the limited express warranty set forth in this section, Tyco Valves & Controls LP, Black Mountain (Kunkle) expressly disclaims all warranties, express and implied, oral and written, including, without limitation, any warranties regarding services rendered ancillary hereto, and the implied warranties of merchantability and fitness for a particular purpose, whether arising from statute, common law, civil code, custom or otherwise. Tyco Valves & Controls LP, Black Mountain's (Kunkle) warranty obligations and buyer's remedies for breach of warranty, except as to title, are solely and exclusively as stated in this section. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle), either before or after execution of this document, shall be made except in writing by the President, Vice President, or Director, Sales and Marketing of Tyco Valves & Controls LP, Black Mountain (Kunkle).

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1. Offer or Acceptance. If this document constitutes an offer to sell by Seller (sometimes referred to as 'Tyco Valves & Controls LP, Black Mountain (Kunkle)'), Seller's offer is expressly subject to Buyer's acceptance of all the terms and conditions contained herein and no other, unless otherwise mutually agreed to by both Seller and Buyer in a writing signed by both parties, and any response by Buyer which constitutes additional or different terms shall not operate as an acceptance if such acceptance would vary, delete or add to the terms and conditions contained herein. If this document constitutes an acceptance by Seller of Buyer's offer to buy the goods or services specified on the face hereof, such acceptance is expressly subject to all the terms and conditions contained herein and no others, unless otherwise mutually agreed to by both Seller and Buyer in a writing signed by both parties. Any of Buyer's proposed terms and conditions which are in addition to or different from those contained herein are hereby objected to and shall be of no effect. Buyer will in any event be deemed to have assented to all terms and conditions contained herein if any part of the goods sold hereunder are accepted.
2. Shipping Dates. The shipping dates, if any, set forth herein are approximate and are not guaranteed. Seller shall not be liable for any loss or damage for delay, non-delivery or other impairment of performance due to the actions or inactions of government, military authority, or Buyer, or by any reason of "force major," which shall be deemed to mean all other causes whatsoever not reasonably within the control of Seller, including, but not limited to, acts of God, war, riot, sabotage, fires, floods, strikes, lockouts or other industrial disturbances, delays of carriers, and inability to secure materials, fuel labor, transportation or manufacturing facilities at Seller's expected prices. Any delay resulting from any such cause shall extend shipping dates correspondingly. Seller shall in no event be liable for any special, incidental or consequential damages arising from delay irrespective of the reason thereof, and receipt by Buyer shall constitute acceptance of delivery and waiver of any claims due to delay. Should delivery be delayed due to Buyer's actions or inactions, or should delivery be delayed at the request of Buyer, the selling price of the goods shall automatically escalate at the rate of two percent [2%] per month for the duration of the delay or in an amount equal to Seller's increased cost, whichever is greater.
3. Drawings. If drawings are submitted herewith they are submitted only to show the general style, arrangement and approximate dimensions of the goods offered. No work is to be based on drawings unless the drawings are certified. Dimensional drawings certified by Seller will be furnished if agreed. In no event will manufacturing or proprietary drawings be supplied.
4. Risk of Loss. Buyer bears the risk of loss for damage to or destruction of the goods from and after the time same said goods are delivered either to the carrier for shipment to Buyer or to the Buyer, whichever occurs first, and regardless of whether or not Buyer may have the right to reject or revoke acceptance of said goods.
5. Shipment. If delivery specified is F.O.B. Seller's plant with freight allowed, Buyer shall pay to Seller, in addition to the purchase price, any and all transportation charges (including insurance).
6. Taxes. In addition to any prices specified herein, Buyer shall pay the gross amount of any present or future sales, use, excise, value-added, or other tax (whether federal, state, local or foreign) applicable to the price, sale, possession, or delivery of any goods or services furnished hereunder or to the use thereof by Buyer, or Buyer shall furnish Seller with a tax-exemption certificate acceptable to the levying taxing authority.
7. Payments. Buyer shall make payment in full for all goods ordered hereunder prior to shipment to Buyer, unless Buyer has entered into and agreed to Seller's Standard Credit Application and Agreement, in which event such Agreement is incorporated herein by reference and made a part hereof, unless and until such Agreement is terminated. The prices specified are in USA currency.
8. Warranties; Remedies. Tyco Valves & Controls LP, Black Mountain (Kunkle) warrants only that the goods delivered hereunder when paid for and properly installed, operated, and maintained shall be free from defects in material and workmanship under normal use and service for a period of twelve (12) months from the date of installation by the first user of such goods or eighteen (18) months from date of shipment from the factory, whichever period shall be first completed. The warranty hereunder granted does not apply to products or components (such as electric or pneumatic mechanisms) manufactured by other companies or to any goods manufactured by Tyco Valves & Controls LP, Black Mountain (Kunkle) that have been subjected to misuse, improper installation, improper storage or protection prior to installation or use, negligence by Buyer or user, accident, corrosion, chemical attack or misapplication, or that have been modified or repaired by unauthorized persons. Tyco Valves & Controls LP, Black Mountain's (Kunkle) obligation and Buyer's remedy under this warranty are limited to: (a) correction, repair, or replacement, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, of any defective unit of goods or (b) refund to Buyer of the purchase price allocable to the defective unit of goods if Tyco Valves & Controls LP, Black Mountain (Kunkle) is unable to repair, replace or correct such defect in a reasonable time. Tyco Valves & Controls LP, Black Mountain's (Kunkle) liability under this warranty is conditioned upon Buyer giving Tyco Valves & Controls LP, Black Mountain (Kunkle), immediate (but in any event within five (5) working days) written notice of any such defect. Any goods repaired or replaced of defective goods or parts shall, at Tyco Valves & Controls LP, Black Mountain's (Kunkle) option, occur at its plant in Houston, Texas and Tyco Valves & Controls LP, Black Mountain (Kunkle) shall reimburse Buyer all reasonable freight costs incurred in transporting defective goods or parts to and from Tyco Valves & Controls LP, Black Mountain's (Kunkle) plant in the event of a valid warranty claim. In the event Tyco Valves & Controls LP, Black Mountain (Kunkle) elects to provide replacement good or parts to buyer to repair defective goods, Buyer agrees to install said replacement parts or goods at its cost and, further, Tyco Valves & Controls LP, Black Mountain (Kunkle), shall in no event be liable for any labor or material costs of Buyer with respect to de-installing or repairing defective goods or installing replacement parts or goods. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall have the option of requiring the return of the defective goods or parts thereof, transportation prepaid, to establish the claim. Tyco Valves & Controls LP, Black Mountain (Kunkle) shall not be held liable for damages caused by delays in repair or replacement of any defective items. Certification by a separate writing as to compliance with specifications, blueprints, part numbers, quality test or otherwise will not create any warranty by or obligation of Tyco Valves & Controls LP, Black Mountain (Kunkle). The provisions in Tyco Valves & Controls LP, Black Mountain's (Kunkle) literature and specifications are descriptive only unless expressly stated as warranties. EXCEPT FOR THE LIMITED EXPRESS WARRANTY SET FORTH IN THIS SECTION, KUNKLE EXPRESSLY DISCLAIMS ALL WARRANTIES, EXPRESS AND IMPLIED, ORAL AND WRITTEN, INCLUDING, WITHOUT LIMITATION, AND FITNESS FOR A PARTICULAR PURPOSE, WHETHER ARISING FROM STATUTE, COMMON LAW, CIVIL CODE, CUSTOM OR OTHERWISE. KUNKLE'S WARRANTY OBLIGATIONS AND BUYER'S REMEDIES FOR BREACH OF WARRANTY, EXCEPT AS TO TITLE, ARE SOLELY AND EXCLUSIVELY AS STATED IN THIS SECTION. No modification or addition to this document with respect to the foregoing warranty by Tyco Valves & Controls LP, Black Mountain (Kunkle) either before or after execution of this document, shall be made except in writing by the President or a Vice President of Tyco Valves & Controls LP, Black Mountain (Kunkle).
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Terms and Conditions of Sales

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KUNKLE
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Black Mountain, North Carolina 28711-2549
Customer Service Phone: 1-828-669-3700

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SMALL COMPACT FILTER SILENCERS
w/ "Hockey Puck" *Patented* Element
"FS" Series 1/4" - 1" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Hobby
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers

FEATURES & SPECIFICATIONS

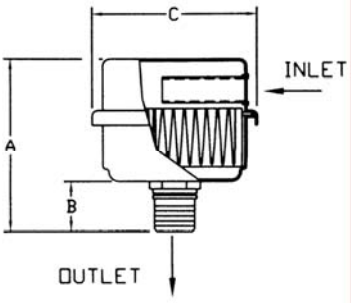
- Patented high grade element w/**Built-in** Butterfly gasket seal
  Creates positive seal between housing hemispheres
  New seal with each element, Minimizes parts
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable **Compact** carbon steel construction with black powder coated finish
- Ability to mount vertically, horizontally
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- A single noise attenuation graph is insufficient; please inquire for your specific requirement

OPTIONS (Inquiries Encouraged)

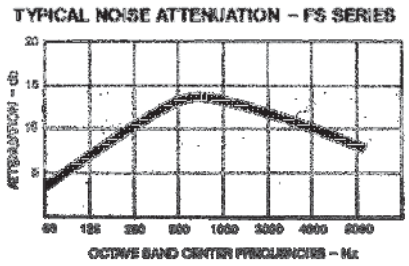
- Various media available
- Epoxy coated housings
- Straight Through Design (Vertical)
- Custom connections

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-05-025	FS-04-025	1/4"	70	16	64	7	7	14	1	0.11
I	FS-05-038	FS-04-038	3/8"	70	16	64	10	14	14	1	0.11
S	FS-07-038	FS-06-038	3/8"	90	16	83	14	14	20	1	0.23
I	FS-05-050	FS-04-050	1/2"	76	22	64	10	14	14	1	0.11
I	FS-07-050	FS-06-050	1/2"	97	22	83	17	20	20	1	0.23
S	FS-11-050	FS-10-050	1/2"	105	22	105	20	20	60	1	0.45
I	FS-07-075	FS-06-075	3/4"	106	32	83	20	20	20	1	0.23
I	FS-11-075	FS-10-075	3/4"	114	32	105	34	43	60	1	0.45
I	FS-11-100	FS-10-100	1"	114	32	105	43	60	60	1	0.45

Note: Model offerings and design parameters may change without notice.

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SMALL COMPACT FILTER SILENCERS
w/ Standard Filter Design
"FS" Series 1/2" - 3" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Piston Compressors
- Screw Compressors
- Blowers - Side Channel & Roots
- Hydraulic Breathers – fine filtration
- Engines
- Construction\Contractor Industry
- Workshop
- Medical\Dental Industry
- Pneumatic Conveying
- Waste Water Aeration
- Nailers and Staplers
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

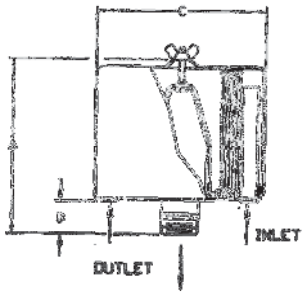
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with baked enamel finish and powder coated weatherhood
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

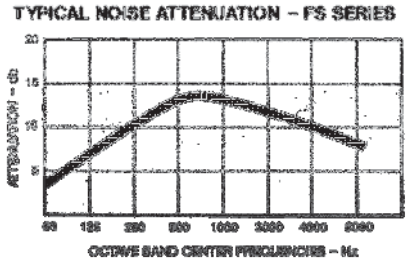
- 1/8" tap holes
- Pressure Drop Indicator
- Available in ***Stainless Steel***
- Epoxy coated housings
- Various media available
- Custom connections, MPT

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



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	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
I	FS-15-050	FS-14-050	1/2"	102	38	152	17	17	60	1	0.8
I	FS-15-075	FS-14-075	3/4"	102	38	152	34	43	60	2	0.9
I	FS-15-100	FS-14-100	1"	102	38	152	43	60	60	3	0.9
S	FS-19P-100	FS-18P-100	1"	168	41	152	60	94	170	3	1.4
I	FS-19P-126	FS-18P-126	1 1/4"	168	41	152	94	119	170	5	1.5
I	FS-19P-151	FS-18P-151	1 1/2"	168	41	152	119	145	170	5	2
I	FS-31P-201	FS-30P-201	2"	184	57	254	145	230	332	5	4
S	FS-231P-201	FS-230P-201	2"	311	57	254	230	230	510	5	6
I	FS-31P-251	FS-30P-251	2 1/2"	191	64	254	170	332	332	5	4
S	FS-231P-251	FS-230P-251	2 1/2"	318	64	254	332	332	510	9	7
I	FS-231P-301	FS-230P-301	3"	330	76	254	340	510	510	9	7

Note: Model offerings and design parameters may change without notice.

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COMPACT FILTER SILENCERS

"FS" Series 3" - 6" BSPT

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

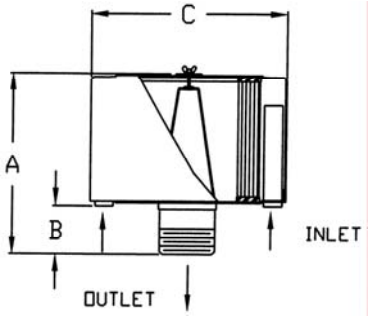
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380mm H_2O over initial delta P
- Pressure drop graphs available upon request

OPTIONS (Inquiries Encouraged)

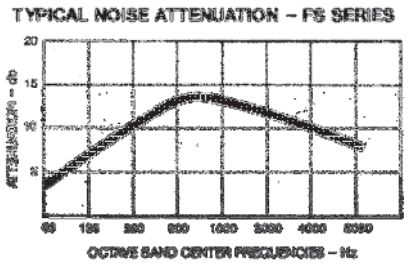
- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING



Dimension tolerance ± 6 mm



- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

	with Polyester Element	with Paper Element	BSPT Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-301	FS-234P-301	3"	330	76	406	340	510	970	9	13
S	FS-245P-301	FS-244P-301	3"	330	76	406	340	510	1500	9	14
E	FS-275P-301	FS-274P-301	3"	330	76	406	340	510	1870	9	15
I	FS-235P-401	FS-234P-401	4"	356	102	406	510	885	970	9	14
S	FS-245P-401	FS-244P-401	4"	356	102	406	765	885	1500	9	14
E	FS-275P-401	FS-274P-401	4"	356	102	406	765	885	1870	9	15
I	FS-245P-501	FS-244P-501	5"	356	102	406	850	1360	1500	14	15
S	FS-275P-501	FS-274P-501	5"	356	102	406	1105	1360	1870	14	16
I	FS-275P-601	FS-274P-601	6"	394	133	406	1105	1870	1870	18	17

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COMPACT FILTER SILENCERS

"FS" Series DN80 - DN150 PN10 Pattern Flange

APPLICATIONS & EQUIPMENT

- Industrial & Severe Duty
- Blowers - Side Channel & Roots
- Piston Compressors
- Screw Compressors
- Hydraulic Breathers – fine filtration
- Engines
- Fans
- Construction\Contractor Industry
- Medical
- Pneumatic Conveying
- Waste Water Aeration
- Sparging
- Factory Air
- Vacuum Vent Breathers

FEATURES & SPECIFICATIONS

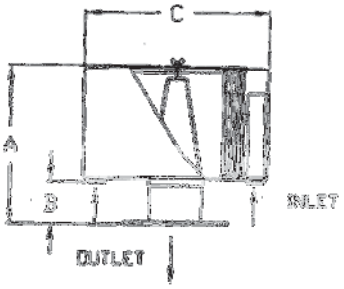
- Fully drawn weatherhood - no welds to rust or vibrate apart
- Tubular silencing design - tube is positioned to maximize attenuation and air flow while minimizing pressure drop
- Durable carbon steel construction with gray baked enamel finish and powder coated weatherhood
- Low pressure drop center bracket and outlet pipe design
- 1/8" tap hole
- Polyester: 99%+ removal efficiency standard to 5 micron
- Paper: 99%+ removal efficiency standard to 2 micron
- Interchangeable media: Polyester, Paper, HEPA
- Several element sizes available per given connection (safety factor)
- Temp (continuous): min -26°C (-15°F) max 104°C (220°F)
- Filter change out differential: 255-380 mm H_2O over initial delta P
- Pressure drop graphs available upon request

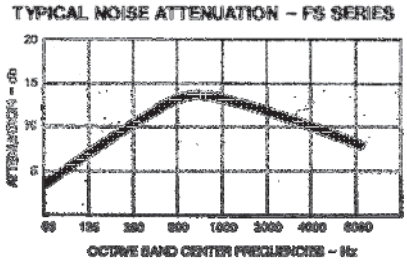
OPTIONS (Inquiries Encouraged)

- Various media available
- Pressure Drop Indicator
- Epoxy coated housings
- Available in ***Stainless Steel***
- Custom connections, NPT
- Side Access QB Series Filters for space restricted enclosures (Selected models)

CONFIGURATION

DRAWING





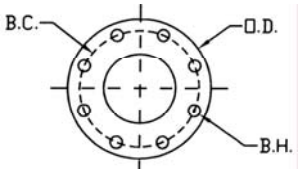
- Noise attenuation may vary due to the wide range of applications and machines

I = Industrial Duty S = Severe Duty E = Extreme Duty

Dimension tolerance ± 6 mm

	with Polyester Element	with Paper Element	Flange Outlet	DIMENSIONS - mm A	B	C	Rated Flow m^3/h Piston	Screw, Blower, Fan	Element Rating	No. of Silencing Tubes	Approx. Wt. Kg
S	FS-235P-DN80	FS-234P-DN80	DN80	330	76	406	340	510	970	9	13
S	FS-245P-DN80	FS-244P-DN80	DN80	330	76	406	340	510	1500	9	14
E	FS-275P-DN80	FS-274P-DN80	DN80	330	76	406	340	510	1870	9	15
I	FS-235P-DN100	FS-234P-DN100	DN100	356	102	406	510	885	970	9	15
S	FS-245P-DN100	FS-244P-DN100	DN100	356	102	406	765	885	1500	9	16
E	FS-275P-DN100	FS-274P-DN100	DN100	356	102	406	765	885	1870	9	18
I	FS-245P-DN125	FS-244P-DN125	DN125	356	102	406	850	1360	1500	14	17
S	FS-275P-DN125	FS-274P-DN125	DN125	356	102	406	1105	1360	1870	14	18
I	FS-275P-DN150	FS-274P-DN150	DN150	394	133	406	1105	1870	1870	18	19

PN10 Pattern Flg	DIMENSIONS - mm O.D.	B.C.	B.H.	No. of Holes	Thickness Flg - mm
DN80	200	160	18	8	10
DN100	220	180	18	8	10
DN125	250	210	18	8	10
DN150	285	240	22	8	10



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