Consumer and Corporate Affairs | Consommation et corporations

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**NOTICE OF APPROVAL**
**AVIS D'APPROBATION**

G-122

Ottawa, March 7, 1978

# FISHER CONTROLS COMPANY
# PILOT OPERATED
# PRESSURE REGULATORS, TYPE S251C

## Apparatus

| | |
|---|---|
| Maximum Inlet Pressure: | as listed in Table No. 1. |
| Outlet Pressure Range: | 2 to 20 psig |
| Maximum Flow for 0.6 specific gravity gas: | as listed in Table No. 2. |
| Main Orifice Diameters, inches: | 1/8, 3/16, 1/4, 3/8 |
| Main Orifice Diameters, MM | 3.2, 4.5, 6.4, 9.5 |
| Main Body Connections, NPT: | 3/4" 1", 1" 1" |
| Pilot Spring No.: | 1B 9860 |
| Pilot Spring Colour Code: | Green |

Approval is hereby granted for the use of the above named apparatus in Pressure Factor Measurement installations. This approval applies only to installations which conform strictly to Part VIII of the "Departmental Instructions for Inspection of Gas Meters and Auxiliary Devices" issued by the Legal Metrology Branch.

The document published by the manufacturer which pertains to this regulator Type S251C is the Fisher Controls Bulletin 71.2:S251C dated January 1978.

## Description

The type S251 regulator is a pilot operated type, (sometimes referred to as pilot loaded type). The pilot senses the downstream (controlled) pressure via the control line and uses the upstream pressure to "look-up" the main operating diaphragm. The operating sequence is detailed in manufacturer's bulletin number 71.2:S251C dated January 1978. A sectional view of this regulator is shown in figure 1. For further information, refer to the bulletin above. The specifications and capacities of this regulator are listed in Tables 1 and 2 of this approval

For field test procedure refer to Technical Gas Circular G75/3.

Table 1. Specifications

| MAXIMUM ALLOWABLE INLET PRESSURE | PORT DIAMETER | | ALLOWABLE INLET PRESSURE RANGE FOR MAINTAINING OUTLET PRESSURE WITHIN ± 1 PERCENT OF SETTING* | | | | |
|---|---|---|---|---|---|---|---|
| | | | 2 psig Outlet Pressure Setting+ | 5 Psig Outlet Pressure Setting+ | 10 Psig Outlet Pressure Setting+ | 15 Psig Outlet Pressure Setting+ | 20 Psig Outlet Pressure Setting+ |
| Psig | Inches | mm | Psig | Psig | Psig | Psig | Psig |
| 125 | 1/8 | 3.2 | $P_1 \pm 40$++ | $P_1 \pm 40$++ | 15 to 125 | 20 to 125 | 25 to 125 |
| 100 | 3/16 | 4.8 | $P_1 \pm 30$++ | 10 to 100 | 15 to 100 | 20 to 100 | 25 to 100 |
| 60 | 1/4 | 6.4 | 5 to 60 | 10 to 60 | 15 to 60 | 20 to 60 | 25 to 60 |
| 30 | 3/8 | 9.5 | 5 to 30 | 10 to 30 | 15 to 30 | 20 to 30 | 25 to 30 |

* Accuracy applies to absolute outlet pressure psi absolute.

+ For best performance, outlet pressure setting should be made using an inlet pressure that is midway between the highest and lowest expected inlet pressure.

++ $P_1$ is the actual inlet pressure at which the outlet pressure setting is made. Variations must not be higher than the maximum allowable inlet pressure for the port diameter involved nor lower than the outlet pressure setting plus the 2 psi minimum pressure drop.

Table 2. Typical Regulating Capacities for Both Body Sizes

| PORT DIAMETER | | INLET PRESSURE | CAPACITIES * | | | | | WIDE-OPEN $C_g$ FOR RELIEF SIZING |
|---|---|---|---|---|---|---|---|---|
| | | | 2 Psig | 5 Psig | 10 Psig | 15 Psig | 20 Psig | |
| Inches | mm | Psig | Outlet Setting+ | Outlet Setting+ | Outlet Setting+ | Outlet Setting+ | Outlet Setting+ | |
| 1/8 | 3.2 | 5 | 200 | -- | -- | -- | -- | 13.5 |
| | | 10 | 375 | 275 | -- | -- | -- | |
| | | 15 | 440 | 375 | 300 | -- | -- | |
| | | 20 | 520 | 500 | 480 | 350 | -- | |
| | | 25 | 600 | 600 | 550 | 480 | 440 | |
| | | 30 | 660 | 660 | 660 | 625 | 565 | |
| | | 40 | 810 | 810 | 810 | 810 | 810 | |
| | | 60 | 1100 | 1100 | 1100 | 1100 | 1100 | |
| | | 80 | 1400 | 1400 | 1400 | 1400 | 1400 | |
| | | 100 | 1600 | 1600 | 1600 | 1600 | 1600 | |
| | | 125 | 2000 | 2000 | 2000 | 2000 | 2000 | |
| 3/16 | 4.5 | 5 | 400 | -- | -- | -- | -- | 28 |
| | | 10 | 700 | 550 | -- | -- | -- | |
| | | 15 | 850 | 800 | 610 | -- | -- | |
| | | 20 | 1000 | 1000 | 880 | 700 | -- | |
| | | 25 | 1150 | 1150 | 1100 | 980 | 750 | |
| | | 30 | 1300 | 1300 | 1300 | 1200 | 1000 | |
| | | 40 | 1700 | 1700 | 1700 | 1700 | 1600 | |
| | | 60 | 2400 | 2400 | 2400 | 2400 | 2400 | |
| | | 80 | 2800 | 2800 | 2800 | 2800 | 2800 | |
| | | 100 | 3400 | 3400 | 3400 | 3400 | 3400 | |
| 1/4 | 6.4 | 5 | 620 | -- | -- | -- | -- | 49 |
| | | 10 | 1200 | 900 | -- | -- | -- | |
| | | 15 | 1400 | 1300 | 1000 | -- | -- | |
| | | 20 | 1800 | 1600 | 1400 | 1000 | -- | |
| | | 25 | 2000 | 1900 | 1800 | 1500 | 1000 | |
| | | 30 | 2200 | 2200 | 2100 | 1900 | 1800 | |
| | | 40 | 2600 | 2600 | 2600 | 2600 | 2500 | |
| | | 60 | 3400 | 3400 | 3400 | 3400 | 3400 | |
| 3/8 | 9.5 | 5 | 730 | -- | -- | -- | -- | 84 |
| | | 10 | 1700 | 1300 | -- | -- | -- | |
| | | 15 | 2000 | 1800 | 1400 | -- | -- | |
| | | 20 | 2300 | 2200 | 1900 | 1600 | -- | |
| | | 25 | 2800 | 2700 | 2600 | 2200 | 1800 | |
| | | 30 | 3400 | 3400 | 3100 | 2800 | 2500 | |

* In scfh of 0.6 specific gravity natural gas capacities are based on ± 1 percent deviation in absolute pressure (psia)

+ Made at a flow of 65 scfh for each inlet pressure.

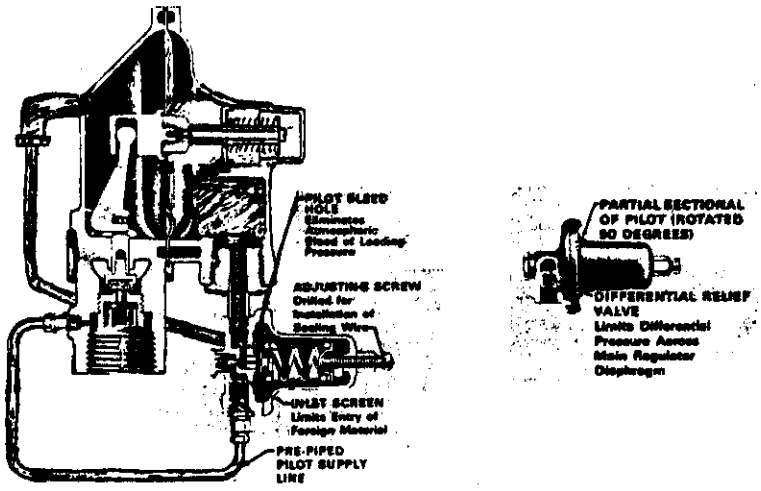


**Figure 1. Construction Features**

Approval Granted to:

Fisher Controls Company
of Canada Limited
Woodstock, Ontario

D. L. Smith, P. Eng.,
Chief, Electricity and Gas Division
Metrology Branch

Ref: 6635-F206-5

FISHER® Controls

# Type S251C Pilot Operated Regulator

March 1978/Advance Bulletin 71.2:S251C

The Type S251C is an accurate, pilot-operated pressure-reducing regulator, ideal for service applications involving pressure-factor measurement (fixed-factor billing).

Features

- Ideal for Pressure-Factor Measurement Applications -- High accuracy and low droop variations over broad flow ranges and inlet pressure variations; pilot action provides accurate pressure control at full valve disc travel, resulting in higher capacity than could be obtained without pilot.
- Rapid Response to Varying Demand Changes -- Accommodates large, rapid increases or decreases in demand without requiring relief to atmosphere.
- No Atmospheric Bleed of Gas -- Main regulator loading pressure from pilot bleeds downstream through pilot bleed hole and downstream registration hole; there is no bleed when regulator disc is closed.
- Ease of Installation -- Internal registration in main valve body means no downstream control line required.
- Simplicity of Adjustment -- Only one pilot control spring required for entire range of outlet pressures.

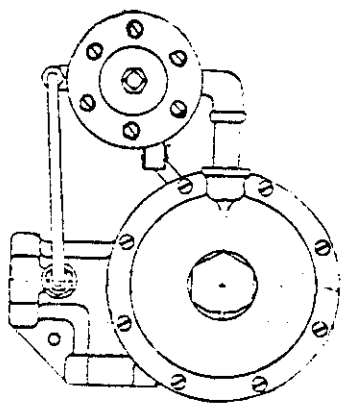

**Figure 1. Exterior of Type S251C Regulator**

- Possibility of Damage to Internal Components Minimized -- Limited-capacity differential relief valve, located in pilot, opens when necessary to relieve excessive differential pressure across main regulator diaphragm.
- Protection from Solid Impurities -- Fine-mesh screen in pilot inlet connection limits entry of rust, scale, and other solid impurities into flow stream.
- Factory-Piped Pilot Supply -- Supply pressure to pilot is supplied from inlet side of main regulator body through tubing furnished with regulator.
- Tamper-Resistant Adjustment -- Adjusting screw is drilled for installation of sealing wire to discourage or detect unauthorized adjustment of outlet pressure setting.

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## Specifications[1]

| | |
|---|---|
| AVAILABLE CONFIGURATION | Pilot-operated regulator with angle-style main regulator body |
| BODY SIZES AND END CONNECTION STYLE | Sizes: ■ 3/4-inch inlet and 1-inch outlet or ■ 1-inch inlet and outlet<br>End Connection Style: NPT screwed |
| MAXIMUM ALLOWABLE INLET PRESSURES[2] | See table 1 |
| MINIMUM PRESSURE DROP REQUIRED FOR FULL STROKE | 2 psi (14 kPa differential) |
| OUTLET PRESSURE RANGE | 2 to 20 psig (14 to 140 kPa) |
| OUTLET PRESSURE ACCURACY | ±1 percent of absolute outlet pressure setting[3] (psia or bar absolute) when inlet pressure is held within allowable variations shown in table 1; droop does not exceed 1 percent of absolute pressure setting for flow rates shown in table 2 |
| MAXIMUM EMERGENCY OUTLET PRESSURE[2] | 25 psig (170 kPa) |
| PORT DIAMETERS | See table 1 |
| TYPICAL REGULATING CAPACITIES | See table 2 |
| FLOW COEFFICIENTS | See table 2 |
| TYPICAL PERFORMANCE CURVES | See figures 3 and 4 |

1. 1 kPa = 0.01 bar.
2. Also see "Overpressure Protection" section.
3. Atmospheric pressure changes occuring after the outlet pressure setting is made will change the absolute outlet pressure (psia or bar absolute). Therefore, to express the 1 percent accuracy in pounds per square inch or bar, use the absolute outlet pressure existing when the setting is made. Add the gauge outlet pressure (psig or bar) to the atmospheric pressure existing when the setting is made. Multiply the sum by 0.01 to determine the pressure equivalent of 1 percent.

| | |
|---|---|
| CONSTRUCTION MATERIALS | **Main Regulator**<br>Body, Spring Case, and Diaphragm Plate: Aluminum<br>Valve Disc and Holder: Nitrile and aluminum<br>Diaphragm: Nylon fabric coated with nitrile<br>Seat Ring, Pusher Post and Valve Stem: Aluminum<br>Spring: Stainless steel<br>Lower Spring Seat and Closing Cap: Zinc<br>Closing Cap Gasket : Neoprene<br>Other Metal Diaphragm Stem Assembly Parts: Steel<br>Pusher Post Cap and Valve Lever: Zinc-plated steel<br>Pusher Power Seat Pads: Nylon<br>Tubing and Pipe Nipple: Steel<br>Tubing Fittings: Brass<br>Street Elbow: Malleable iron<br><br>**Pilot**<br>Body and Spring Case: Aluminum<br>Valve Plug: Brass/nitrile is standard; other materials available upon request<br>Diaphragm: Nylon fabric coated with nitrile<br>Stem Guide: Brass<br>Control Spring: Cadmium-plated steel<br>Valve Spring: Stainless steel<br>Pusher Post and Valve Spring Seat: Aluminum<br>Diaphragm Plate, Spring Guide, and Adjusting Screw: Plated steel<br>Inlet Screen: Monel[4]<br>Inlet Screen Body: Brass<br>Gasket: Asbestos<br>Spring Seat: Zinc-plated steel<br>Differential Relief Valve Parts: Aluminum with stainless steel spring |
| TEMPERATURE CAPABILITIES | -20° to +170°F (-29° to 77°C) |
| DOWNSTREAM PRESSURE REGISTRATION | Internal |
| PILOT INLET SCREEN SIZE | 200-mesh wire |
| PILOT BREATHER VENT | Drilled hole in pilot spring case |
| APPROXIMATE WEIGHT | 4.5 pounds (2 kg) |
| OPTIONS | ■ Wire seal or ■ 1/4-inch NPT tapped pilot spring case (with or without closing cap) for attachment of remote vent line |

4. Trademark of International Nickel Co.

FISHER Controls

Table 1. Additional Specifications

| MAXIMUM ALLOWABLE INLET PRESSURE | | PORT DIAMETER | | ALLOWABLE INLET PRESSURE RANGE FOR MAINTAINING OUTLET PRESSURE WITHIN ± 2 PERCENT OF SETTING* | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 2 psig (14 kPa) Outlet Pressure Setting+ | | 5 Psig (34 kPa) Outlet Pressure Setting+ | | 10 Psig (69 kPa) Outlet Pressure Setting+ | | 15 Psig (100 kPa) Outlet Pressure Setting+ | | 20 Psig (140 kPa) Outlet Pressure Setting+ | |
| Psig | kPa | Inches | mm | Psig | kPa | Psig | kPa | Psig | kPa | Psig | kPa | Psig | kPa |
| 125 | 860 | 1/8 | 3.2 | $P_1 \pm 40$ ++ | $P_1 \pm 280$ ++ | $P_1 \pm 40$ ++ | $P_1 \pm 280$ ++ | 15 to 125 | 100 to 860 | 20 to 125 | 140 to 860 | 25 to 125 | 170 to 860 |
| 100 | 690 | 3/16 | 4.8 | $P_1 \pm 30$ ++ | $P_1 \pm 210$ ++ | 10 to 100 | 69 to 690 | 15 to 100 | 100 to 690 | 20 to 100 | 140 to 690 | 25 to 100 | 170 to 690 |
| 60 | 410 | 1/4 | 6.4 | 5 to 60 | 34 to 410 | 10 to 60 | 69 to 410 | 15 to 60 | 100 to 410 | 20 to 60 | 140 to 410 | 25 to 60 | 170 to 410 |
| 30 | 210 | 3/8 | 9.5 | 5 to 30 | 34 to 210 | 10 to 30 | 69 to 210 | 15 to 30 | 100 to 210 | 20 to 30 | 140 to 210 | 25 to 30 | 170 to 210 |

* Accuracy applies to absolute outlet pressure (psi or kPa absolute). 1 kPa = 0.01 bar.

+ For best performance, outlet pressure setting should be made using an inlet pressure that is midway between the highest and lowest expected inlet pressure.

++ $P_1$ is the actual inlet pressure at which the outlet pressure setting is made. Variations must not be higher than the maximum allowable inlet pressure for the port diameter involved nor lower than the outlet pressure setting plus the 2 psi (14 kPa differential) minimum pressure drop.

## Overpressure Protection

As is the case with most regulators, the Type S251C regulator has an outlet pressure rating that is lower than the inlet pressure rating. Overpressure protection is needed if the inlet pressure can exceed the maximum emergency outlet pressure.

WARNING

Overpressuring any portion of this equipment may cause leakage, damage to regulator parts, or personal injury due to bursting of pressure-containing parts or explosion of accumulated gas. To avoid overpressure, provide appropriate overpressure protection device(s) to ensure that neither the maximum allowable inlet pressure given in table 1 nor the maximum emergency outlet pressure of 25 psig (170 kPa) will be exceeded.

Regulator operation below the maximum allowable inlet pressure and maximum emergency outlet pressure does not preclude the possibility of damage from external sources or from debris in the gas line. Inspect the regulator for damage after any overpressure condition.

## Principle of Operation

The superior performance of this regulator is due to the amplifying effect of the pilot and the two-path control system (figure 2). Changes in outlet pressure act quickly on the main regulator diaphragm to provide fast response to system changes. Then the pilot amplifies any small system changes to position the main regulator value disc for precise pressure control.

Inlet pressure is used for the pilot supply pressure. If downstream flow increases, lowering the reduced pressure below the regulator set point, pressure under the pilot diaphragm and the main regulator diaphragm decreases. The pilot opens to supply the required loading pressure increase. The increased loading pressure from the pilot overcomes the spring force, and the main regulator valve disc moves farther open, to supply the required flow.

When downstream pressure increases due to lowered demand, greater pressure is registered beneath the pilot and main diaphragms. The pilot starts to close, and the excess loading pressure bleeds off to downstream through the pilot body. With the lower loading pressure, the spring can move the main regulator disc closer to the seat ring.

Since a main regulator diaphragm differential pressure of less than 2 psi (14 kPa) differential) is sufficient to stroke the main regulator valve disc fully open, a relief valve is used to keep loading pressure in the main regulator spring case within acceptable limits. The relief valve opens and excess loading pressure is dumped into the downstream system when the pilot output exceeds the downstream pressure by about 5 psi (34 kPa differential). The relief valve, located in the pilot body, is nonadjustable.

Under normal flow conditions, the excess loading pressure bleeds through the pilot restriction hole to the downstream system until the pressures are equal.

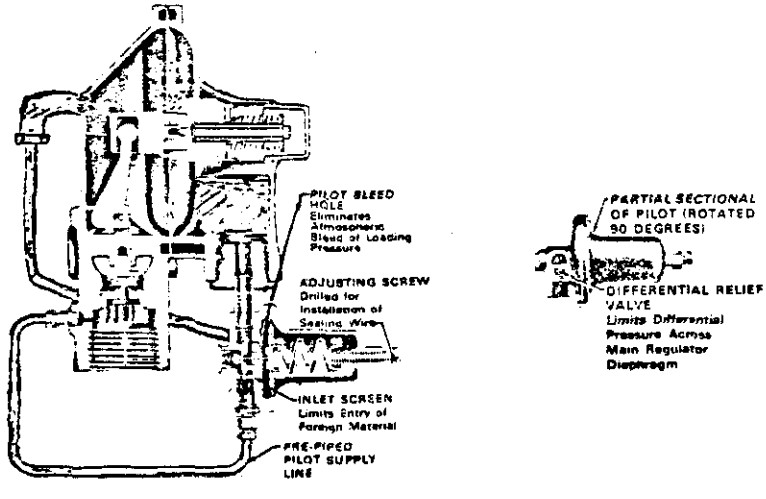


**Figure 2. Construction Features**

Capacity Data

Flow capacities for various inlet pressures and outlet pressure settings are shown in table 2. Capacities are given in standard cubic feet per hour (scfh) of 0.6 specific gravity natural gas at 60°F and 14.7 psia. To convert to equivalent capacities of other gases, multiply the values shown by the appropriate conversion factor: air-0.775; propane-0.628; butane-0.548; nitrogen-0.789. To convert scfh to cubic meters per hour at 15°C and 101.325 kPa, multiply by the conversion factor of 0.0283.

To determine the wide-open capacity of these regulators (for relief valve sizing) with the flow coefficients (Cg) given in table 2, use the appropriate procedure as follows:

1. If the pressure drop is such that the critical pressure ratio is reached (absolute outlet pressure is approximately equal to or less than one-half the absolute inlet pressure), use the equation:

Flow = (Absolute Inlet Pressure) (Cg) (1.29)

The flow determined will be in standard cubic feet per hour of 0.6 specific gravity gas. Use the conversion factors above to convert to equivalent capacities of other gases or to cubic meters per hour ($m^3$/hr).

2. If the pressure drop is less than critical (absolute outlet pressure is greater than one-half the absolute inlet pressure), use the Fisher sizing slide rule or the sizing nomographs in Fisher Catalog 10 (use $C_1 = 35$).

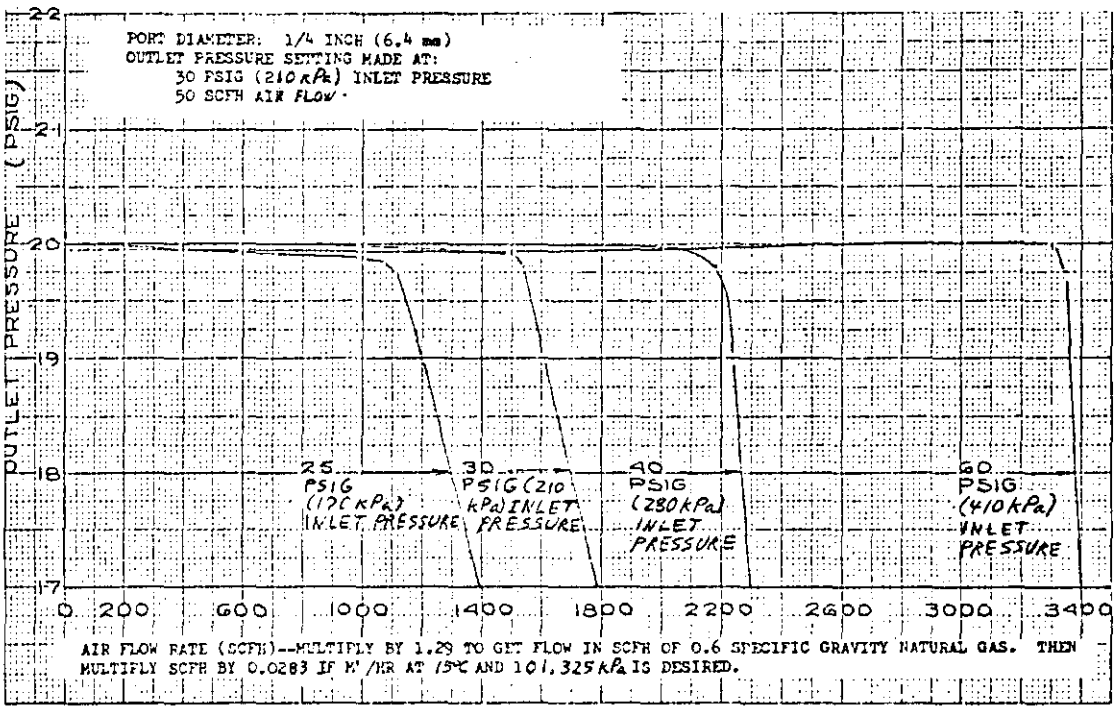


Figure 3. Typical Performance Curve at 20 Psig (140 kPa) Outlet Pressure Setting

Table 2. Typical Regulating Capacities for Both Body Sizes

| PORT DIAMETER | | INLET PRESSURE | | CAPACITIES * | | | | | WIDE-OPEN C FOR RELIEF SIZING |
|---|---|---|---|---|---|---|---|---|---|
| Inches | mm | Psig | kPa† | 2 Psig (14 kPa†) Outlet Setting ## | 5 Psig (34 kPa†) Outlet Setting ## | 10 Psig (69 kPa†) Outlet Setting ## | 15 Psig (100 kPa†) Outlet Setting ## | 20 Psig (140 kPa†) Outlet Setting ## | |
| 1/8 | 3.2 | 5 | 34 | 200 | -- | -- | -- | -- | 13.5 |
| | | 10 | 69 | 375 | 275 | -- | -- | -- | |
| | | 15 | 100 | 440 | 375 | 300 | -- | -- | |
| | | 20 | 140 | 520 | 500 | 480 | 350 | -- | |
| | | 25 | 170 | 600 | 600 | 550 | 480 | 440 | |
| | | 30 | 210 | 660 | 660 | 660 | 625 | 565 | |
| | | 40 | 250 | 810 | 810 | 810 | 810 | 810 | |
| | | 60 | 410 | 1100 | 1100 | 1100 | 1100 | 1100 | |
| | | 80 | 550 | 1400 | 1400 | 1400 | 1400 | 1400 | |
| | | 100 | 690 | 1600 | 1600 | 1600 | 1600 | 1600 | |
| | | 125 | 860 | 2000 | 2000 | 2000 | 2000 | 2000 | |
| 3/16 | 4.5 | 5 | 34 | 400 | -- | -- | -- | -- | 28 |
| | | 10 | 69 | 700 | 550 | -- | -- | -- | |
| | | 15 | 100 | 850 | 800 | 610 | -- | -- | |
| | | 20 | 140 | 1000 | 1000 | 880 | 700 | -- | |
| | | 25 | 170 | 1150 | 1150 | 1100 | 980 | 750 | |
| | | 30 | 210 | 1300 | 1300 | 1300 | 1200 | 1000 | |
| | | 40 | 280 | 1700 | 1700 | 1700 | 1700 | 1600 | |
| | | 60 | 410 | 2400 | 2400 | 2400 | 2400 | 2400 | |
| | | 80 | 550 | 2800 | 2800 | 2800 | 2800 | 2800 | |
| | | 100 | 690 | 3400 | 3400 | 3400 | 3400 | 3400 | |
| 1/4 | 6.4 | 5 | 34 | 820 | -- | -- | -- | -- | 49 |
| | | 10 | 69 | 1200 | 900 | -- | -- | -- | |
| | | 15 | 100 | 1400 | 1300 | 1000 | -- | -- | |
| | | 20 | 140 | 1800 | 1600 | 1400 | 1000 | -- | |
| | | 25 | 170 | 2000 | 1900 | 1800 | 1500 | 1000 | |
| | | 30 | 210 | 2200 | 2200 | 2100 | 1900 | 1800 | |
| | | 40 | 280 | 2600 | 2600 | 2600 | 2600 | 2500 | |
| | | 60 | 410 | 3400 | 3400 | 3400 | 3400 | 3400 | |
| 3/8 | 9.5 | 5 | 34 | 730 | -- | -- | -- | -- | 84 |
| | | 10 | 69 | 1700 | 1300 | -- | -- | -- | |
| | | 15 | 100 | 2000 | 1800 | 1400 | -- | -- | |
| | | 20 | 140 | 2300 | 2200 | 1900 | 1600 | -- | |
| | | 25 | 170 | 2800 | 2700 | 2600 | 2200 | 1800 | |
| | | 30 | 210 | 3400 | 3400 | 3100 | 2800 | 2500 | |

*In scfh of 0.6 specific gravity natural gas. Multiply by 0.0283 to convert scfh to $m^3$/hr at 15°C and 101.325 kPa. Capacities are based on ±1 percent deviation in absolute outlet pressure (psia or kPa absolute).

† 1 kPa = 0.01 bar.

##Made at a flow of 65 scfh for each inlet pressure.

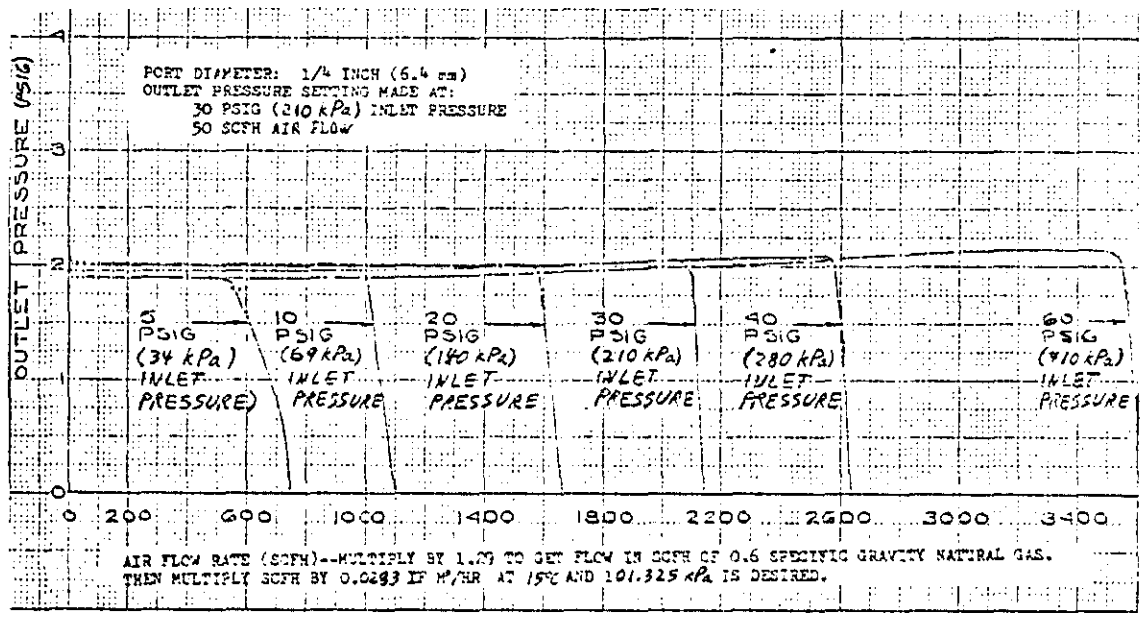


Figure 4. Typical Performance Curve at 2 Psig (14 kPa) Outlet Pressure Setting

## Installation

The regulator may be installed in any position. However, for outdoor installations, the regulator should be installed with the pilot above the body as shown in figure 5. Figure 5 also gives envelope dimensions.

For any installation, the pilot spring case vent must be protected against the entrance of rain, snow, debris, and any other foreign material that may plug the opening.

Flow through the body must be as indicated by the flow direction arrow cast on the body.

## Ordering Information

### Application

When ordering, specify:

1. Type of gas being controlled (natural gas, air, etc.).
2. Specify gravity of the gas.
3. Temperature range of the gas.
4. Inlet pressure; state expected range of inlet pressure, if known.
5. Outlet pressure setting.

Note

If a specific inlet pressure should be used for making the factory outlet pressure setting, specify the inlet pressure to be used. If an inlet pressure is not specified, factory outlet pressure settings will be made using the following inlet pressures:

1/8-inch (3.2 mm) port diameter: 100 psig (690 kPa) for 2 through 5 psig (14 through 34 kPa) outlet pressure settings, and 80 psig (550 kPa) for higher outlet settings.

3/16-inch (4.8 mm) port diamter: 60 psig (410 kPa)

1/4-inch (6.4mm) port diameter: 40 psig (280 kPa)

3/8-inch (9.5 mm) port diameter: 20 psig (140 kPa) for 2 through 10 psig (14 through 69 kPa) outlet pressure settings, and 30 psig (210 kPa) for higher outlet settings.

Regulator Configuration

Review the description to the right of each specification on pages 2 and 3 and in the referenced tables; specify the desired selection wherever there is a choice to be made. Always include the regulator type number.

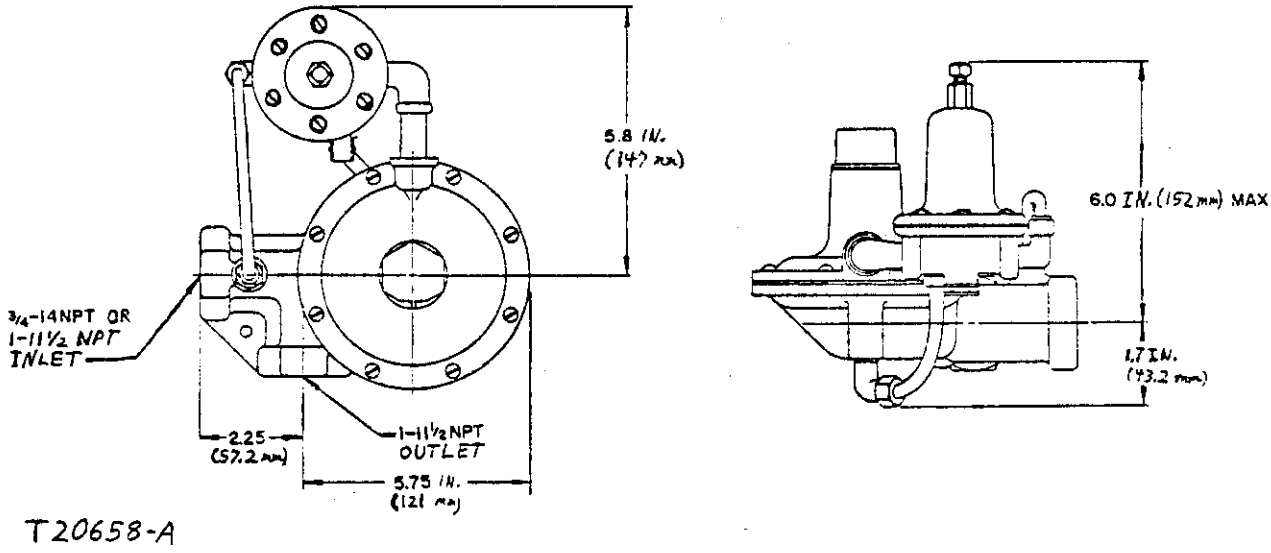


Figure 5. Dimensions