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## **Introduction**

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The INVALCO 3/4" - 2" Series Cartridge Gas Turbine Meter is a unique one-piece cartridge design which has been adapted to include a gas rotor and bearing assembly. Each meter has three separate rotor designs which overlap adjacent meter ranges and will conform to more pipe sizes without reduction or expansion requirements. Covering flow rates from 0.5 to 200 ACFM, these meters will work within pressures from vacuum to 2000 PSI. Replacement cartridges are fully-calibrated and are ready for installation with no special tools required.

INVALCO's Tungsten Carbide V-cup bearing design provides excellent performance and unequalled service life in non-lubricating and solids-contaminated gases.

## **Specifications**

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### **Linearity <sup>1</sup>**

±1.0%

### **Repeatability <sup>1</sup>**

±0.25%

### **Maximum Over-range**

125% of flow rate for intermittent periods

### **Frequency Output**

0 to 1,100 Hz

### **Voltage Output**

Approximately 100 mV@ 100 Hz to 1.5 V (RMS)@ 1,000 Hz.

### **Pressure Drop**

0.5 PSI at 100% of flow range

### **Pressure Rating <sup>2</sup> - PSI (kPa)**

3/4" - 2" NPT.....2,000 (13,780)

### **ANSI Raised Face Flanges**

Class 150.....275 (1,896)

Class 300.....720 (4,964)

Class 600.....1,440 (9,929)

### **Installation**

Vertical or horizontal (any direction).

### **Materials of Construction**

Body: 316 L Stainless Steel.

Flanges: 316 Stainless Steel

Rotor: 431 Stainless Steel.

Rotor Shaft/Bearings:

Standard: Tungsten Carbide V-Cup

Cartridge Frame Retainer: 302 Stainless Steel

Cartridge Frame: 316 L Stainless Steel.

### **Temperature Range**

Meter with Bearing Structure of:

Standard: Tungsten Carbide: -40°F to 300°F (-40°C to 149°C).

For other temperatures consult factory.

## **Magnetic/RF Pick-up Coils:**

Either low drag magnetic (sine wave output) or R.F. no drag (square wave output) pick-up coils must be used with INVALCO Gas Turbine Flow Meters.

The two pin low drag pick-up (p/n 64920774) requires no external power and is used in most applications where the flow rates are from the lower 15% to the upper 100% of the meters flow range.

If the meter is consistently used in the lower part of its flow range, such that the drag on the rotor by the magnet in the pick-up is causing inaccuracies, then the use of R.F. no drag pick-ups should be considered. These pick-ups have three pins and require external power for operation. They do not affect rotor speed.

a) P/N 64921733 requires 10 to 18 VDC.

b) P/N 64921734 requires 21 to 30 VDC.

Both the low drag and the zero drag R.F. pick-ups are available with wire leads if desired. Please contact the factory for information.

### **Notes:**

1 Based on Air at 60°F.

2 Maximum non-shock service pressure at 100°F.

## **Principle of Operation**

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Within the working range of the meter the rotor spins proportional to the actual velocity of gaseous material flowing. A pick-up coil produces an electrical signal as each blade crosses through its low magnetic or RF field. This signal is amplified and conditioned by a transmitter or fed directly into a rate/totalizer, and represents the actual cubic feet per minute (ACFM) flowing through the meter. The K-factor is stenciled on the meter body in pulses per actual cubic feet (P/ACF). Because gases are compressible, most people desire to measure the equivalent amount of gas corrected for the line pressure and temperature to standard cubic feet per minute (SCFM at 60°F, 14.69 PSIA). If the flow temperature and pressure are relatively constant, then a simple correction can be calculated to shift the K-factor from P/ACF to P/SCF and a simple totalizer (INVALCO Model 202D) may be used. When flow temperature and pressure are not constant, a flow computer (INVALCO Model 705) is recommended.

## Principle of Operation (con't)

The INVALCO cartridge design uses a carbide V-cup bearing. This robust bearing design is comparable to a strong jeweled bearing that provides a nearly frictionless pivot. The low drag bearing and six bladed rotor make the INVALCO GT Series Gas Meter a very sensitive instrument that can measure low flow applications. The V-cup bearing is virtually self cleaning and is not prone to the problems often encountered with ball bearing style gas meters. Our meters are designed to produce an output from 100 Hz to 1000 Hz and can often be used in lower flow applications depending on rotor size, type of pick-up, and gas density.

## Installation

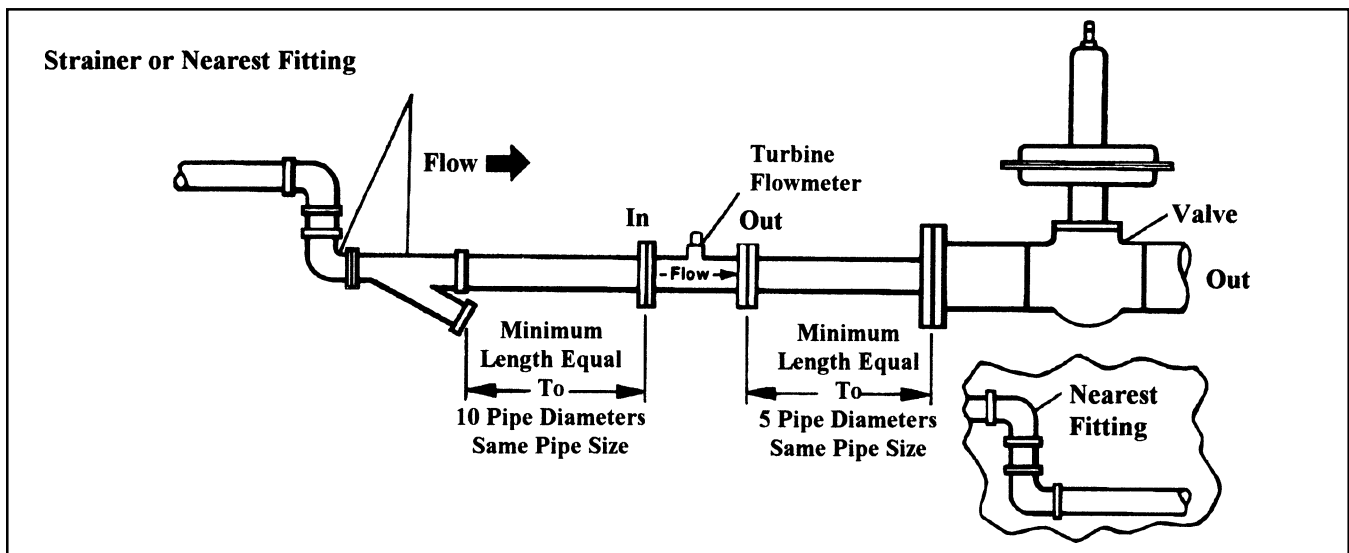
The gas meter must be installed with the arrow (etched on the body) pointing in the direction of the flow. This is the direction of flow used when the meter was calibrated at the factory. Other than flow direction, there is no preferred orientation. The meter may be installed at any angle from horizontal to vertical and with the pick-up adapter pointed in any convenient direction. For units without conduit or meter mounted electronics, it is recommended that the pick-up adapter be pointed down to avoid collecting dust or rain.

INVALCO Gas Meters are designed to measure reasonable clean and dry gas. High velocity sand or water can destroy the rotor. It is the customer's responsibility to provide the necessary traps and strainers to insure the quality of the gas flow. Failure to do this will cause the warranty to be void as this is a precision instrument. It is recommended that a minimum length of 10 pipe diameters of straight pipe be installed on the up stream side and at least a length of five diameters of straight pipe down stream of the gas meter to assure good flow conditions. A gas turbine meter's accuracy can be greatly affected by the flow conditions in the line.

Do not locate the gas meter, electronics, or connecting cables close to electric motors, transformers, sparking devices, high voltage lines, radio transmitter antennas, strong electric fields, strong magnetic fields, or place the connecting cables in conduit with wires used to supply power to such devices. These devices can induce noise into the signal from the meters pick-up coil or cable. A shielded cable should always be used when the electronics are not mounted on the top of the meter. The shield of this cable should be grounded only at the electronics to avoid any possible ground loop problems. All wiring should conform to standard safe practices and all applicable electrical and safety codes. Power should be off and the line should be relieved of pressure and emptied before servicing the meter in accordance with good safety practices.

## Maintenance

The INVALCO GT3 Series Gas Meters are simple to service. Power should be off and the line should be relieved of pressure and emptied before servicing the meter. After the meter is removed from the line, the lock ring can be removed from the up stream side of the meter by using a small screw driver. This is done by locating the cut out at the end of the ring and pushing the blade down through the cut out, popping the end of the ring down and out of the slot. Now the ring can be picked back up and pulled out of the meter. New rings are shipped with each Internal Kit to help reduce repair time. With the lock ring removed, the cartridge is free to slide out the front of the meter. A gentle push may be required to slide Internal Kit out of the body. If the rotor is simply fowled, it can be carefully cleaned and placed back into service. If the rotor shaft has developed end play and is running irregular, the cartridge should be replaced. Likewise, if the rotor is bent or shows any sign of damage, the cartridge should be replaced. The new cartridge is slid into the body with the flow direction. The lock ring can now be installed and the meter placed back into service.



## **Maintenance (con't)**

Depending on the application and amount of use, the gas meter may need to be recalibrated in the field by a company that proves gas meter, sent to a flow lab or back to INVALCO for calibration or service. As a meter wears, some change in K-factor can be expected.

Care should be taken when handling the gas meter, the gas cartridge internal kit, and the electronic totalizer. This meter package is a precision instrument and should be treated as such. Dropping, hitting or banging the meter package can damage the end connections of the meter, destroy the gas cartridge, or damage the totalizer. Abuse of the meter package will cause the warranty to be void. Just a little care in installation and service will allow years of accurate measurement from this gas meter package.

### **Ideal Gas Equations**

Most gas meters are corrected to read out in standard cubic feet using ideal gas laws. For increased accuracy with non ideal gases, we recommend the INVALCO Model 705 Gas Flow Computer which can be set for ideal gas equations, Redlich-Kwong state equation, or the NX - 19 equation. The INVALCO Model 705 compensates for pressure and temperature. Applications that have constant pressure and temperature can use the INVALCO Model 202D Rate/Totalizer corrected for the line pressure and temperature to read standard cubic feet. This correction is calculated by using the ideal gas laws as follows; or by using the charts on pages 11-18 in this manual.

### ***Ideal Gas Equation:***

$$\frac{P_1 \times V_1}{T_1} = \frac{P_2 \times V_2}{T_2}$$

### ***Variables:***

LP = LINE PRESSURE (PSIG)

LT = LINE TEMPERATURE (F)

K = METER K-FACTOR (P/ASCF)

SCF = STANDARD CUBIC FEET (60 F, 0 PSIG)

ACF = ACTUAL CUBIC FEET (@LT,LP)

ACFH = ACTUAL CUBIC FEET PER HOUR

SCFH = STANDARD CUBIC FEET PER HOUR

P/ACF = ACTUAL METER K FACTOR AT STANDARD PRESSURE AND TEMPERATURE

P/SCF = CORRECTED K FACTOR TO GIVE SCF

## **Ideal Gas Equations (con't)**

### ***Equations:***

$$ACFH = SCFH \times \frac{14.69 \text{ PSIA} \times (LT + 459.69 \text{ R})}{(LP + 14.69 \text{ PSIA}) \times 519.69 \text{ R}}$$

$$SCFH = ACFH \times \frac{(LP + 14.69 \text{ PSIA}) \times 519.69 \text{ R}}{14.69 \text{ PSIA} \times (LT + 459.69 \text{ R})}$$

$$P/SCF = P/ACF \times \frac{14.69 \text{ PSIA} \times (LT + 459.69 \text{ R})}{(LP + 14.69 \text{ PSIA}) \times 519.69 \text{ R}}$$

## **Simplified Set Up for 202D Totalizer (Revised 5/01)**

1. Insert screwdriver blade under end of dark gray strip at bottom of 202D and pry up. Remove strip and swap it end for end. Reinstall.
2. Unit will be in calibration mode.
3. See Chart Below.

Cal 00	This step is not applicable if you are using an internally battery powered unit. Just press Program Key to go to calibration step Cal 01. However, for external DC powered models: 0 = Low and High Alarms, but no pulse output. 1 = Low Alarm and Scaled pulse output. 2 = Low Alarm and Unscaled pulse output. Press Program Key.
Cal 01	<b>If you are measuring liquid</b> , enter the meter factor located on the side of meter body. Example: Assume K-Factor is 950.25. Enter 000950. Press Program Key.
Cal 01A	<b>If you are measuring gas</b> , and want the readings to be in SCF, multiply the meter factor by the multiplying factor obtained from the charts found on pgs. 11-18. Enter the whole numbers of the new factor starting from right to left. (See Cal 01 for an example.) Press Program Key.
Cal 02	Does K-Factor have numbers after the decimal? If so, enter them. Using K-Factor example of Cal 01 with decimal of .25. You enter 250. Press Program Key.
Cal 03	Set to .99 for 2" and small meter. Set to .50 for 3" and larger meters. Press Program Key.
Cal 04	Do you want Flow Rate to be displayed with decimals? If no, enter 0. If yes, enter 1, 2, or 3 for number of decimal places to be shown. Press Program Key.
Cal 05	Do you want rate to be in secs., min., hrs., or days? 0 = Sec. 1 = Min. 2 = Hr. 3 = Day Press Program Key.
Cal 06	Enter a number from 1 to 99 to smooth out flow rate reading fluctuations. 1 is minimum smoothing and 99 is maximum. Press Program Key.
Cal 07	Do you want readout to show total with decimals? If no, enter 0. If yes, enter 1, 2, or 3 for the number of decimal places desired. Press Program Key.
Cal 08	<b>If you are measuring liquids</b> , do you want the total readout to be in gallons? If so, enter 000001. If you want total to be in barrels, then enter 000042. For other volumes see manual. Press Program Key.
Cal 08A	<b>If you are measuring gas</b> , do you want the total readout to be in cubic feet? If so, enter 000001. If you want the total to be in MCF, enter 001000. Press Program Key.
Cal 09	Does the value entered in Cal 08 have numbers after a decimal point? If so, enter them. Example: If the number for Cal 08 was xxx.123, - you enter 1230. Press Program Key.

**If you are using the internal battery powered model, calibration is complete.**

4. Pry up the dark gray strip on bottom of 202D and swap it end for end. Reinstall. You are now in operation mode.  
**If you are using the external DC powered version with High & Low Alarms, or the loop powered 4-20 mA output version - you need to do Cal 10 through 16 on the following page as applicable.**

### ***Simplified Set Up for 202D Totalizer (con't)***

Cal 10	Enter the whole flow rate number that below which, you want the low flow alarm to actuate. Example: 50.15. Enter 000050. Press Program Key.
Cal 11	Does the Cal 10 flow rate have numbers after the decimal? If so, enter them. Using the flow rate of 50.15 you would enter 15000. Press Program Key.
Cal 12	Enter the whole flow rate number that above which, you want the high flow alarm to actuate. Example: 450.30 Enter 000450. Press Program Key.
Cal 13	Does the Cal 12 flow rate have numbers after the decimal? If so, enter them. Using the flow rate of 450.30, you would enter 30000. Press Program Key.
Cal 14	Enter the whole flow rate number at which you want 4 ma output. Example: 70.75 Enter 00070. Press Program Key.
Cal 15	Does the Cal 14 flow rate have numbers after the decimal? If so, enter them. Using the flow rate of 70.75, you would enter 750000. Press Program Key.
Cal 16	Enter the whole flow rate number at which you want 20 ma output. Example: 400.50 Enter 000400. Press Program Key.
Cal 17	Does the Cal 16 flow rate have numbers after the decimal point? If so, enter them. Using the flow rate of 400.50, you would enter 500. Press Program Key.
Soft	This number identifies the software of your Totalizer. Ignore it.

5. Pry up the dark gray strip on the lower front of the 202. Turn it end for end. Reinstall.  
You are now in operational mode.

## 202 D Rate/Totalizer Test

### Test information

INVALCO Turbine Flow Meters (gas and liquid) are designed to run in the frequency range of 100 Hz to 1000 Hz at maximum flow for 2" and smaller meters. It is important not to over range the meter as this can destroy the meter and violate the warranty. When installing a new meter it is recommended that the maximum flow is checked to insure that it will not over range the meter. This is easily done by setting the 202D Totalizer to display rate in Hz and then checking the flow rate (1000 Hz is maximum flow for the meter, 500 Hz is mid range, and 100 Hz is minimum flow for the meter.) Most meters are sized for max. flow slightly above the mid range of the meter (800 Hz) as this provides for good accuracy, low pressure drop and long life.

For meters 3" and larger, the design frequency range is 50 Hz to 500 Hz. Again, the flow should be checked to prevent over ranging and damage.

In order to check frequency, set the 202D as follows:

CAL00						IGNORE, GO TO CAL01
CAL01	0	0	0	0	1	K-FACTOR (WHOLE NUMBERS)
CAL02		0	0	0	0	K-FACTOR (DECIMALS)
CAL03				.9	9	CUT OFF FREQUENCY
CAL04					1	RATE-NUMBER OF DECIMAL PLACES DISPLAYED
CAL05					0	TIME BASE (0=SEC, 1=MIN, 2=HR, 3=DAY)
CAL06				0	1	RATE FILTER (01=NO FILTER - 99=MAX FILTERING)
CAL07					1	TOTAL-NUMBER OF DECIMAL PLACES DISPLAYED
CAL08	0	0	0	0	1	TOTAL CONVERSION FACTOR (WHOLE NUMBERS)
CAL09		0	0	0	0	TOTAL CONVERSION FACTOR (DECIMAL)
CAL10	0	0	0	0	0	LOW ALARM (WHOLE NUMBERS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL11		0	0	0	0	LOW ALARM (DECIMALS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL12	0	0	0	0	0	HIGH ALARM (WHOLE NUMBERS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL13		0	0	0	0	HIGH ALARM (DECIMALS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL14	0	0	0	0	0	4m A FLOWRATE (WHOLE NUMBERS - GENERALLY 0) - 4-20mA VERSION ONLY
CAL15		0	0	0	0	4m A FLOWRATE (DECIMALS - GENERALLY 0) - 4-20mA VERSION ONLY
CAL16	0	0	0	0	0	20mA FLOWRATE (WHOLE NUMBERS) - 4-20mA VERSION ONLY
CAL17		0	0	0	0	20mA FLOWRATE (DECIMALS) - 4-20mA VERSION ONLY
SOFT						IGNORE, SOFTWARE I.D.

A 2" Medium Flow Gas Meter (GT3/2000M) has a K-factor of 1123 pulses per actual cubic feet. The line temperature is 70°F and the pressure is 100 PSIG, both are constant.

Use the charts on the following pages (11-18) in order to obtain a corrected K-factor which when used in setting up the 202D (or 705) will result in readings in standard cubic feet. To use the charts, project a line down from the desired pressure readings at the top of the chart and across from the desired temperature readings at the left side of the chart. At the intersection, there is a computer calculated number. Multiply that number by the meter K-factor found on the meter body. This will give you a new K-factor corrected for pressure and temperature. Using the numbers in the chart will give the desired readout in standard cubic feet. (Not using the charts to obtain a corrected K-factor will cause your readout to be in actual cubic feet.) For example, we obtained 0.1305 from the charts which we then multiply times the original K-factor of 1123 to get a corrected K-factor of 146.5515. Use the new corrected K-factor to set up the 202D in order to read standard cubic feet.

CAL01	0	0	1	4	6	K-FACTOR (WHOLE NUMBERS)
CAL02		5	5	1	5	K-FACTOR (DECIMALS)
CAL03				.9	9	CUT OFF FREQUENCY
CAL04					1	RATE-NUMBER OF DECIMAL PLACES DISPLAYED
CAL05					2	TIME BASE (0=SEC, 1=MIN, 2=HR, 3=DAY)
CAL06				0	1	RATE FILTER (01=NO FILTER - 99=MAX FILTERING)
CAL07					1	TOTAL-NUMBER OF DECIMAL PLACES DISPLAYED
CAL08	0	0	0	0	1	TOTAL CONVERSION FACTOR (WHOLE NUMBERS)
CAL09		0	0	0	0	TOTAL CONVERSION FACTOR (DECIMAL)
CAL10	0	0	0	0	0	LOW ALARM (WHOLE NUMBERS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL11		0	0	0	0	LOW ALARM (DECIMALS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL12	0	0	0	0	0	HIGH ALARM (WHOLE NUMBERS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL13		0	0	0	0	HIGH ALARM (DECIMALS)- ALARM VERSIONS ONLY, OTHERWISE IGNORE
CAL14	0	0	0	0	0	4m A FLOWRATE (WHOLE NUMBERS - GENERALLY 0) - 4-20mA VERSION ONLY
CAL15		0	0	0	0	4m A FLOWRATE (DECIMALS - GENERALLY 0) - 4-20mA VERSION ONLY
CAL16	0	0	0	0	0	20mA FLOWRATE (WHOLE NUMBERS) - 4-20mA VERSION ONLY
CAL17		0	0	0	0	20mA FLOWRATE (DECIMALS) - 4-20mA VERSION ONLY

## Repair Kits

It is recommended that at least one spare Internal Parts Kit be kept for each size and flow range of gas meter. This will provide a calibrated replacement should a problem develop with the meter in service. This avoids costly delays associated with even a short down time. The internal parts kits include a calibrated gas cartridge and a new spiral lock ring.

### Gas Turbine Meter Repair Kits

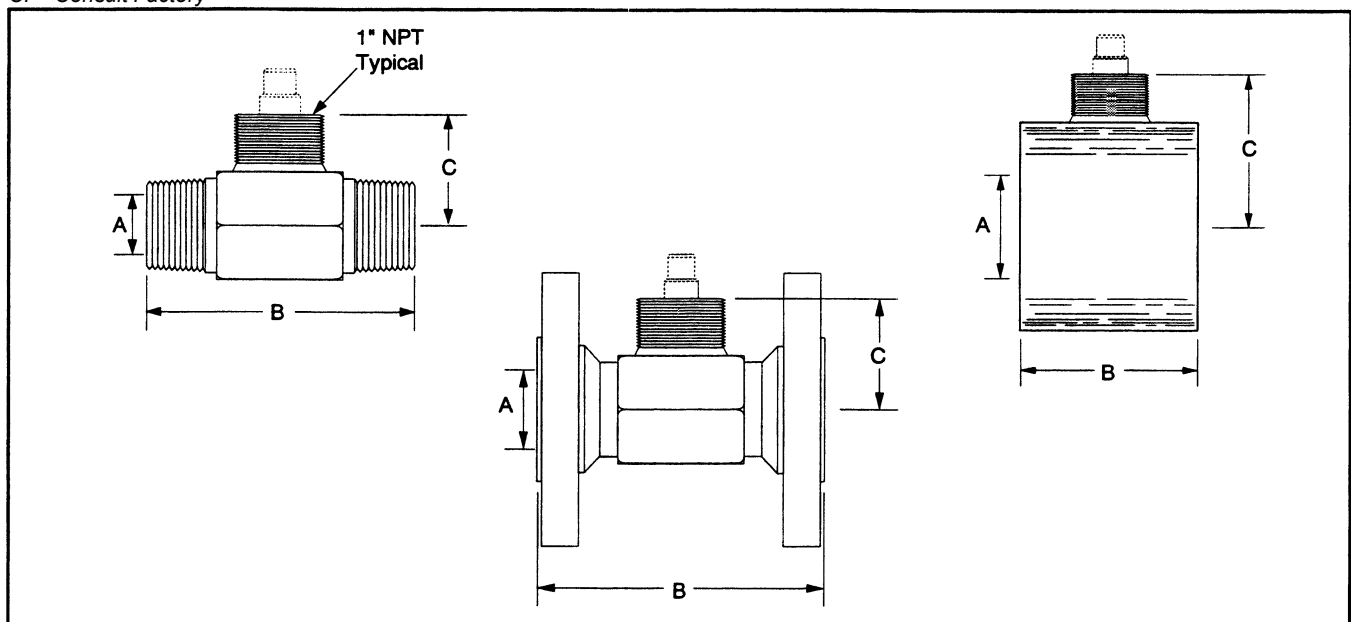
	3/4"	1"	1-1/2"	2"
Low Flow	GT31IPK0750L 81014600	GT31IPK1000L 81014601	GT31IPK1500L 81014602	GT31IPK2000L 81014603
Medium Flow	GT31IPK0750M 81034600	GT31IPK1000M 81034601	GT31IPK1500M 81034602	GT31IPK2000M 81034603
High Flow	GT31IPK0750H 81054600	GT31IPK1000H 81054601	GT31IPK1500H 81054602	GT31IPK2000H 81054603
Extended High Flow	-- --	-- --	-- --	GT31IPK2000XH 81154603

## Dimensions

Inches (mm)

						ANSI Flanged - Class			
	Bore	NPT		Wafer		150	300	600	
	A	B	C	B	C	B	B	B	C
3/4" & 3/4" E	0.6" (16)	3.4" (83)	1.8" (46)	CF	CF	3.8" (99)	4.5" (114)	5.0" (127)	1.8" (46)
1"	0.9" (22)	3.6" (93)	1.9" (48)	CF	CF	4.1" (105)	4.8" (121)	5.3" (133)	1.9" (48)
1.5"	1.3" (33)	4.7" (117)	2.1" (53)	CF	CF	5.3" (133)	5.9" (149)	6.5" (165)	2.1" (53)
2"	1.8" (45)	6.0" (154)	2.3" (61)	CF	CF	6.8" (171)	7.4" (187)	8.1" (207)	2.3" (61)

CF - Consult Factory



**Note:** Dimensions - Inches to the nearest tenth (millimeters to the nearest whole mm), each independently dimensioned from respective engineering drawings.