

# GTS/GTX/E-Class Turbine Meters Installation, Operation and Maintenance



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This bulletin is intended as a basic reference to assist in the proper selection, application and maintenance of American Meter gas turbine meters. Refer to Sales Bulletin SB-4510 for rated capacities and sizes and weights.

**TABLE 1: Definitions Of Metering Terms**

TERMS	DESCRIPTION	TYPICAL VALUE
ACFH	Actual cubic feet per hour at line conditions ( $P_g$ and $T_f$ )	
CF	Cubic feet (also $ft^3$ )	
CFD	Cubic feet per day at stated conditions ( $ft^3/day$ )	
CFH	Cubic feet per hour at stated conditions ( $ft^3/h$ )	
$^{\circ}F$	Degrees Fahrenheit	
G	Specific Gravity (Air = 1.00)	Natural Gas = 0.60
in. w.c.	Inches of water column	
$P_a$	Pressure, atmospheric	14.48 psia
$P_b$	Pressure, base (contract)	14.73 psia
$P_g$	Pressure, gauge (or line or operating)	
psia	Pounds per square inch, absolute	
psig	Pounds per square inch, gauge	
$\Delta P$	Differential pressure	in. w.c.
Q	Actual flow rate at line conditions	ACFH or ACMH
$Q_b$	Flow rate at base conditions ( $P_b$ and $T_b$ )	SCFH or ACMH
$Q_{max}$	Maximum flow rate at stated conditions	CFH or ACMH
$Q_{min}$	Minimum flow rate at stated conditions	CFH or ACMH
$^{\circ}R$	Degrees Rankine (or absolute) ( $^{\circ}F + 460$ )	
$^{\circ}K$	Kelvin (absolute units) ( $^{\circ}C + 273$ )	
SCF	Standard cubic feet	
SCFD	Standard cubic feet per day (also $Sft^3/day$ )	
SCFH	Standard cubic feet per hour (also $Sft^3/h$ )	
T	Temperature degrees absolute	$^{\circ}R$ or K
$T_b$	Temperature, base (contract)	$^{\circ}R$ or K
$T_f$	Temperature, flowing gas	$^{\circ}R$ or K
V	Volume, actual at line conditions ( $P_g$ and $T_f$ )	CF
$V_b$	Volume at base conditions ( $P_b$ and $T_b$ )	SCF
S	Compressibility Ratio $Z_b/Z_f$	
Z	Compressibility Factor = $1/(F_{pv})^2$	
Standard Cubic feet	$V_b = V \times \frac{P_g + P_a}{P_b} \times \frac{T_b + 460}{T_f + 460} \times S = SCF$	

## General Description

Meters used in the gas industry fall into two general categories: either positive displacement or inferential. Meters in the positive displacement category are diaphragm and rotary. Inferential types include turbine and orifice meters.

Diaphragm and rotary meters measure gas with compartments that alternately fill and empty. A slight pressure drop across the meter causes the meter and its measurement compartments to rotate. Each stroke of the diaphragm meter and each revolution of the rotary meter traps a small volume of gas, delivering it to the meter outlet.

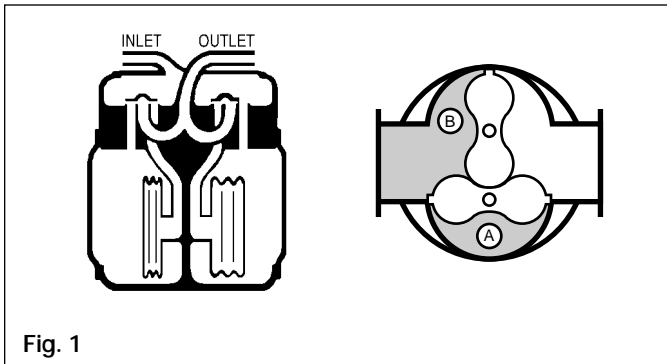


Fig. 1

Turbine meters contain no measurement compartments. Instead, a rotor with multiple blades is placed directly in the gas stream. Gas flows through the meter, passing through the rotor blades, causing the rotor to turn. The rotor rotational speed is proportional to the gas flow rate, which is directly related to the gas velocity at the rotor. This is why turbine meters are sometimes referred to as velocity meters.

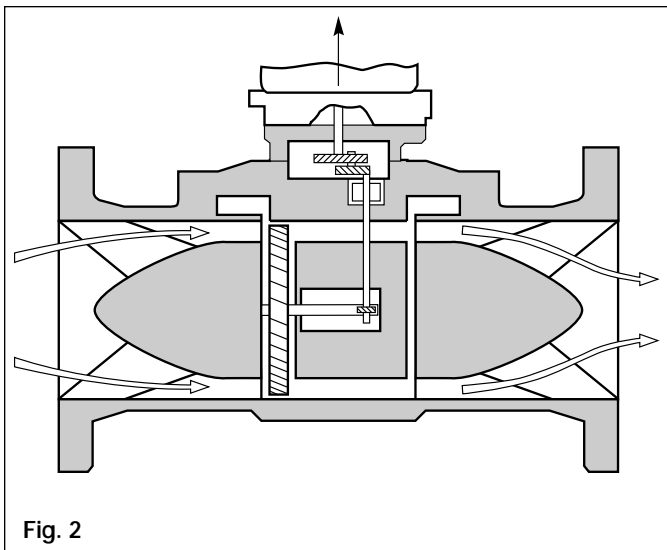


Fig. 2

Turbine meter rotor revolutions are converted to measured volume by means of internal gearing, resulting in meter output shaft revolutions in either cubic feet or cubic meters. In addition to a mechanical output, turbine meters may be also equipped with high frequency pulsers, where each pulse represents a small increment of volume, defined during meter calibration as a "K" factor.

Since turbine meters measure gas by sensing gas velocity, proper installation is essential, to make certain the gas is uniform as it approaches the measurement rotor.

## Typical Meter Performance

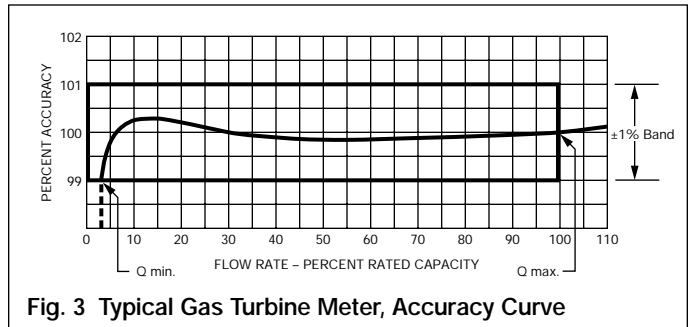


Fig. 3 Typical Gas Turbine Meter, Accuracy Curve

The graph of Fig. 3 shows a typical accuracy curve for the GTS meter. As shown, rated rangeability over the  $\pm 1\%$  band is the ratio of maximum flow rate ( $Q_{max}$ ) to minimum flow rate ( $Q_{min}$ ). Rangeability of GTS meters becomes greater with increasing line pressures.

### METER PRESSURE DROP (Differential Pressure in Inches W.C.)

#### Meter Differential Pressure

The approximate differential pressure developed across the turbine meter at operating conditions can be calculated using the following formula.

$$\Delta P = \Delta P_{avg} \times \frac{P_g + P_a}{P_b} \times \frac{G}{0.60} \times \left[ \frac{Q}{Q_{max}} \right]^2$$

#### Example:

Calculate the differential for the following conditions:

6" GTS ( $\Delta P_{avg} = 3.3$  in. w.c.,  $Q_{max} = 35,000$  ACFH)

$G = 0.64$ ,  $P_g = 60$  psig,  $Q = 27,600$  ACFH

$$\Delta P = 3.3 \times \frac{60 + 14.48}{14.73} \times \frac{0.64}{0.60} \times \left[ \frac{27,600}{35,000} \right]^2$$

$\Delta P = 11$  in. w.c.

#### Average Differential Pressures

@  $Q_{max}$  and @ 0.25 psig in inches w.c.

	3" GTS	4" GTS	6" GTS	8" GTS	12" GTS
45° Rotor	4.5	2.4	3.3	1.6	2.1
30° Rotor	N/A	3.9	8.9	3.4	N/A

## Basis Of Capacity Tables

Capacity tables are contained in Sales Bulletin SB 4510 in both English and metric units. The tables include values of  $Q_{max}$  and  $Q_{min}$  in standard  $Ft^3/hr.$  or  $M^3/hr.$  units at each gauge pressure listed. Standard capacities are shown for 45° rotor angle. Extended capacities are listed for 30° rotor angle. The top plate of the meter cartridge is labeled 30° or 45° rotor angle.

**Maximum Flow Rates** at elevated pressure are equal to the base flow rate at 0.25 psig times the pressure factor, times the compressibility ratio "S" and are independent of the specific gravity of the gas being measured.

$$(A) \quad Q_{max} @ P_g = Q_{max} @ 0.25 \text{ psig} \times \frac{P_g + P_a}{P_b} \times S$$

Where  $P_g$  = gauge press.,  $P_a$  = atmos. press.,  $P_b$  = base press.,  $S$  = comp. ratio

**Minimum Flow Rates** are based on the minimum rotor speed that produces a measurement accuracy within an error band of  $\pm 1\%$ , as shown in Fig. 3.

$$(B) Q_{\min} @ P_g = Q_{\min} @ 0.25 \text{ psig} \times \sqrt{\frac{P_g + P_a}{P_b}} \sqrt{\frac{0.60}{G}} \sqrt{S}$$

A temperature factor is not included in equations A & B since it has minimal affect on  $Q_{\min}$ .

## Meter Sizing

### Base Conditions

English	Metric
$P_b = 14.73 \text{ psia}$	101.325 kPa absolute
$P_a = 14.48 \text{ psia}$	99.8 kPa absolute
$T_b = 60^\circ\text{F} + 460 \text{ or } 520^\circ\text{R}$	$15.56^\circ\text{C} + 273, \text{ or } 288.56\text{K}$
$T_f = \text{Temperature of flowing gas} + 460 \text{ for } ^\circ\text{R} \text{ (or } + 273 \text{ for K)}$	

If the required flow rate is given in Standard Cubic Feet (or meters) per hour, (SCFH or SCMh) convert this value to actual Cubic Feet (or meters) per hour, e.g.

$$Q = Q_b \times \frac{P_b}{P_g + P_a}$$

Select the meter with the smallest  $Q_{\max}$  (@ 0.25 psig or 2.0 kPa) that is larger than  $Q$ .

**Example:** Select the proper meter size to handle 145,000 SCFH at 60 psig,  $S = 1.009$

$$Q = 145,000 \times \frac{14.73}{60 + 14.48} \times 1/1.009 = 28,421 \text{ ACFH}$$

Choose a 6" GTS with  $Q_{\max}$  (@ 0.25 psig) = 35,000 CFH (45° rotor).

Rangeability increases with increased gas density which can result from either increased operating pressure or specific gravity of the gas at a particular pressure:

$$\text{Rangeability} = \text{Rangeability} \times \sqrt{\frac{P_g + P_a}{P_b}} \times \sqrt{\frac{\text{Sp.Gr.}}{0.60}} \times \sqrt{S}$$

(@ 0.25 psig or 2.0 kPa)

**Example:** From above, 6" GTS (Rangeability @ 0.25 psig = 18)  
 $P_g = 60 \text{ psig}$   $\text{Sp.Gr.} = 0.64$ .

$$\text{Rangeability} = 18 \times \sqrt{\frac{60 + 14.48}{14.73}} \times \sqrt{\frac{0.64}{0.60}} \times \sqrt{1.009} = 42 \text{ or } 42:1$$

Minimum flow rate,  $Q_{\min}$  is:

$$Q_{\min} = \frac{Q_{\max}}{\text{Rangeability}}$$

**Example:** From above,  $Q = 35,000 \text{ ACFH}$ , Rangeability = 42

$$Q_{\min} = \frac{35,000}{42} = 833 \text{ ACFH}$$

## Recommended Installation

GTS Meters in sizes from 4" through 12" have ANSI 150, 300 or 600 flanges, depending on the pressure rating. The 3" GTS bolts between flanges as shown in Fig. 4.

GTX Meters in sizes 4" through 8" have ANSI 150 flanges.

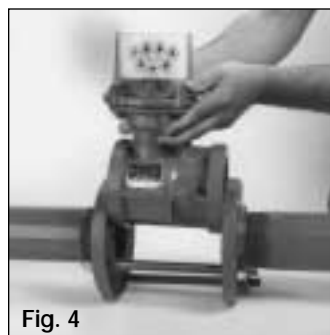
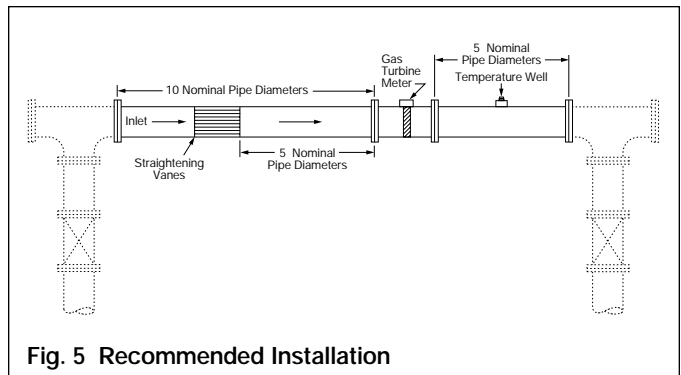


Fig. 4

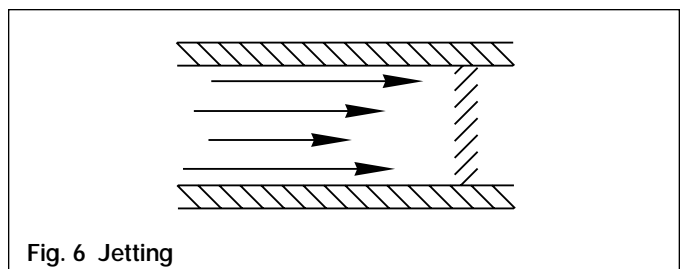
The 4" through 12" GTS meters are designed for horizontal installations. 3" GTS meters may also be installed in a vertical line, using an optional right-angle index or instrument mount.



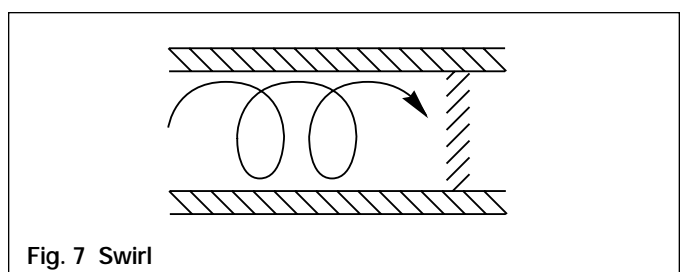
Recommended turbine meter installation requires a minimum of 10 pipe diameters upstream, with straightening vanes located 5 pipe diameters from the meter inlet as shown in Fig. 5. A length of 5 pipe diameters is recommended downstream of the meter. Both inlet and outlet piping should be the same nominal size as the meter.

The purpose of the 10 diameters of straight inlet piping is to remove jetting and swirl from the gas stream before the gas reaches the turbine rotor.

Jetting, shown in Fig. 6, is non-uniform gas velocity within the pipe, and can be caused by an upstream regulator, a valve, an elbow or a misaligned flange gasket. Jetting will cause the meter to over-register since the rotor responds to the higher, not the average velocity, in the pipe. For this reason, temperature wells and pressure taps should be located in the downstream piping. Any pressure tap fitting in the upstream piping should be ground flush with the inside pipe wall.



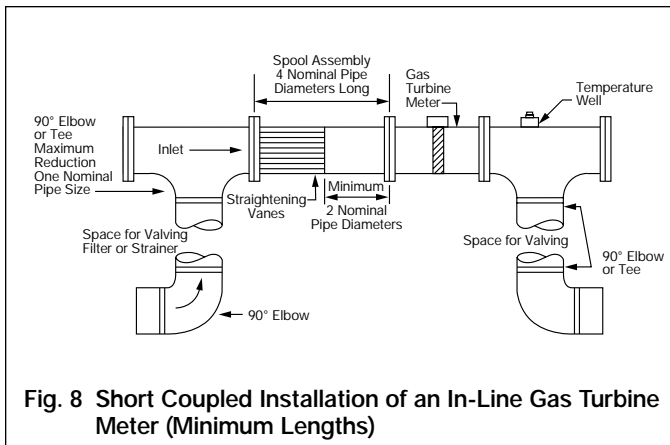
Swirl, Fig. 7, is a condition where the gas velocity is not totally parallel to the axis of the pipe, but has a spiral component. It may be caused by upstream valves, elbows or other fittings. Swirl in the direction of the rotor rotation will cause the turbine meter to over-register and vice-versa.



## Optional Installations

The following installations may result in some degradation in meter accuracy, and should only be used where space does not permit the recommended installation shown in Fig. 5.

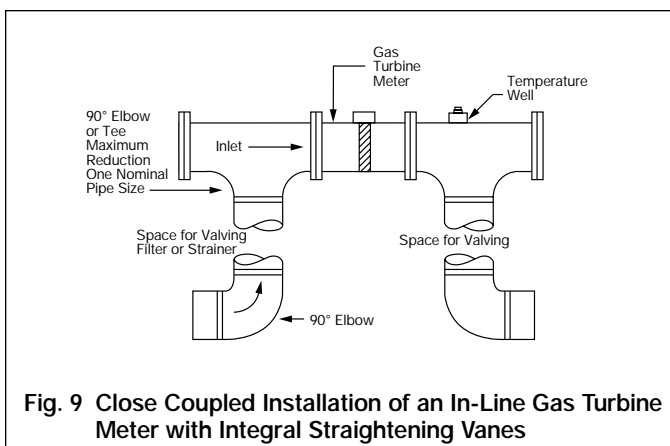
### Short Coupled Installation



This configuration uses a minimum of 4 pipe diameters ahead of the meter with straightening vanes a minimum of 2 pipe diameters from the meter inlet, Fig. 8. The meter is connected to vertical risers using a standard tee, as shown, to minimize jetting and to facilitate field proving.

The maximum pipe reduction to the risers is one nominal pipe size. Valving, filters or strainers may be installed in the risers.

### Close Coupled Piping



This installation would be used where the available space is critical and design considerations have eliminated jetting and abnormal swirl conditions. The meter is connected to vertical risers using a tee as shown. The maximum pipe reduction to risers is one pipe size. Valving, filters or strainers may be installed in the risers.

### STRAINERS or FILTERS – CAUTION

**Important:** Foreign matter in a pipe line, such as welding slag, can cause **SERIOUS** damage to turbine meters. Upstream piping must be cleared of all foreign matter before the meter is installed and commissioned.

Strainers are recommended where large particles may be present in the piping. They should be selected to operate with low flow distortion.

Filters are recommended where wide pressure fluctuations and dust are present in the pipe. Monitor the pressure drop across the filter to determine the need to replace the filter element.

### OVER-RANGE PROTECTION

Turbine meters can be operated up to 150% of capacity for short periods with no damaging effects. However, line blowdowns can cause severe over-ranging of the turbine rotor, causing possible rotor and/or bearing damage. In those installations where adequate pressure is available, either a critical flow orifice or a sonic nozzle may be installed downstream of the meter. It should be sized to limit the meter to approximately 120% of the meter's rated capacity.

### BY-PASS PIPING

By-pass piping will allow the meter to be maintained and calibrated without a service interruption. This should include proper valving relative to the calibration equipment used.

When tees are used in by-pass piping for the purpose of transfer proving, make certain the tee connections are in line with the axis of meter flow and are the same pipe diameter as the pipe to avoid jetting and possible calibration errors.

### ADDITIONAL INSTALLATION REMINDERS

Add oil – see Lubrication Section, page 6.

Minimize pipe stresses on the meter.

Make certain piping and gaskets are aligned properly to avoid possible errors caused by jetting.

No welding should be done in the immediate area of the meter.

Where liquids may be present, do not install the meter in the low point in the line.

When installation is complete, pressurize the meter slowly and bring the meter up to speed gradually. Shock loading by opening valves quickly will usually result in rotor damage. Perform a leak test with a bubble solution or other approved method.

## Maintenance

Routine turbine meter maintenance will insure measurement accuracy and enhance the service life of the meter.

Turbine meter maintenance consists of:

Lubrication	Inspection
Spin Testing	Cleaning
Repair	Calibration
Proof Adjustment	Cartridge Replacement



Fig. 10 Gas Turbine Meter Oil System

## Lubrication (GTS Meters only)

**CAUTION:** Add oil at installation; unit shipped dry. Use only the recommended oil listed below. Gas Turbine Meters require a high grade, low viscosity oil for long service life and stable accuracy.

The meter is equipped with a lubricating system which flushes the rotor bearings and replenishes the internal oil reservoir. The external oil fitting contains a check valve that allows the meter to be lubricated while in operation, at any operating pressure within its working range (Fig. 10).

Oil Specification: Anderol 401-D meets MIL-L 6085A

Ordering Information

Part No. 34928G004 - 1 quart can

Recommended oil may be purchased from Anderol 401-D or 402

Chemlube 201

Nye 200 Synthetic Instrument Oil

Inject the oil using one of the oil guns available from American Meter. The industrial gun (P/N 93723K001) requires one or two pumps to prime and five to six pumps to lubricate the meter. The small gun (P/N 93723K002) requires one pump to lubricate the meter.

## Field Maintenance

The lubrication period will depend on service conditions. Under clean, dry gas conditions the oil in the reservoir will last for several months to a year. If the gas contains dust, or entrained condensates, more frequent service may be required to maintain clean rotor bearings.

## FIELD INSPECTION

### 4" through 12" GTS/GTX/E-Class Meters

The most common field checks are visual inspection and spin testing. Depressurize the meter slowly.

To remove the cartridge of 4" through 12" meters for inspection, first remove the index or mechanical/electronic corrector mounted on the meter.

Next, remove the hex bolts from the cartridge top plate. Lift the cartridge from the meter body, Fig. 11. Inspect the rotor for chipped or missing blades. Check that the rotor spins freely and without wobble.

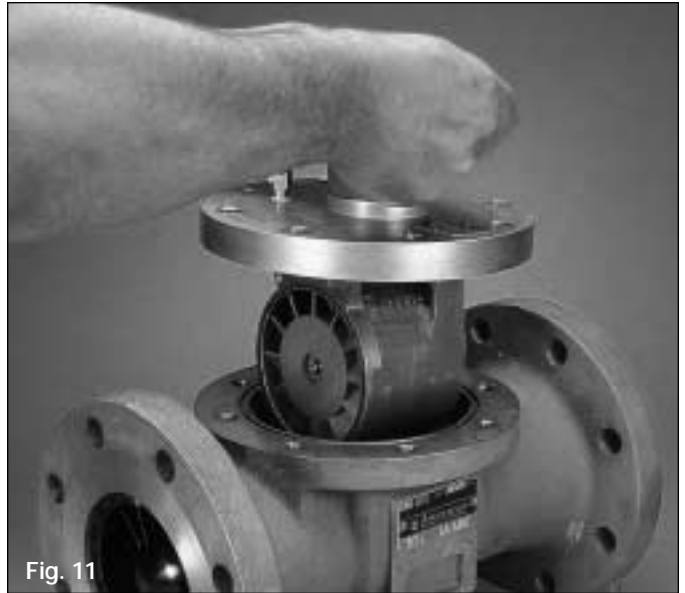


Fig. 11

Inspect the cartridge for dirt in the flow path ahead of the rotor. Remove any dirt buildup with a cloth.

Inspect the rotor for chipped, bent or missing blades or any damage that would affect the balance of the rotor.

Check the breather plug in the cartridge rear cover plate and clean if necessary.

Check O-ring seal around cartridge inlet. It should be held firmly in place. (GTS only)

Conduct a spin test as described below.

Before replacing the cartridge, make certain the upstream and downstream Flo-Guide® is not blocked or clogged with dirt buildup or foreign material.

### FIELD INSPECTION – 3" GTS Meters

Depressurize the meter slowly. Remove any correcting device on the meter or its index.

Remove the upper flange bolts and loosen the lower bolts to remove the meter from the line.

Remove the inlet and outlet Flo-Guides® and inspect the flow passage for dirt buildup or foreign matter. Inspect the rotor for chipped, bent or missing blades or other damage that would affect the balance of the rotor.

Conduct a spin test as described on page 7.

### SPIN TESTING – 3" GTS through 12" GTS Meters

The spin test is a method of detecting changes in mechanical friction of the turbine meter that can affect meter accuracy at flow rates less than 20% of capacity and at operating pressure less than 100 psig. It is a check for changes in friction in all moving parts of the cartridge; friction due to bearings running dry, bearings picking up dirt, wear of bearings, gears, binds, etc., physical damage and foreign matter in running clearances.

The spin test should always be done BEFORE lubricating the meter. Lubrication temporarily decreases the spin time, until excess oil drains from the rotor bearings.

### PERFORMING THE SPIN TEST

In a wind and draft free area, place a board behind the cartridge, Fig. 12. For the 3" GTS, place a board at the inlet of the meter.



Fig. 12

Spin the rotor with the index finger vigorously. Record the time in seconds it takes the rotor to come to rest with a stopwatch. Repeat 3 times and average the readings.

Compare this spin time to the following table:

#### Field Minimum Spin Times (in seconds) @ 60°F (15.5°C)

GTS Cartridge Less Index (Fig. 12)	3"	4"	6"	8"	12" L.P.
	45-degree plastic rotor (all pressures)	48	52	68	148
45-degree metal rotor (all pressures)	NA	68	138	204	NA
30-degree metal rotor (all pressures)	NA	66	118	177	NA
GT Cartridge Less Index					
	3"	4"	6"	8"	12" L.P.
45-degree plastic rotor (all pressures)	48	28	45	80	88

Minimum spin times listed above indicate a meter with acceptable friction levels and overall accuracy.

After re-oiling the turbine meter cartridge, the cartridge should be re-installed in the meter and exercised for at least 30 minutes at line conditions to remove any excess oil and to properly flush the dirt/grit that may have accumulated in the bearings. As designed, because the bearings are only shielded and are not of the sealed type, oil is allowed to accumulate in the bearings from the saturated oil pad located between the two (2) rotor bearings. Thus, when the meter is exercised at line conditions, centrifugal force will remove any excess oil plus, at the same time, flushing contaminants, leaving only a thin film that cannot be removed except by heat or liquid contamination. This thin film of oil is all that is needed for a turbine meter to continue to operate properly and retain its calibration accuracy. If a spin test is to be repeated after oiling the cartridge, it should be done so only after following the above instruction.

If spin times do not rise above minimum field values, this is an indication the cartridge needs further internal maintenance and should be returned to the meter repair shop.

An acceptable spin time only indicates the meter to be within tolerable limits of friction at a given temperature. It does not absolutely assure overall accuracy at line conditions.

### FIELD PROVING

The assembled meter may be proved using a portable transfer prover, up to the capacity of the prover. Most field transfer provers operate with flow rates up to 12,000 cfh. This will allow full testing of a 3" meter, 66% of a 4" meter and 40% of a 6" meter, which is sufficient to detect changes in the low end meter performance due to friction and wear.

**CAUTION:** BE CERTAIN TO PURGE THE METER OF GAS BEFORE TRANSFER PROVING TO AVOID AN EXPLOSION. FOLLOW THE PROVER INSTRUCTIONS TO BLOW AIR THROUGH THE METER AND DISPLACE THE GAS.

If the proving results do not fall within acceptable limits, the cartridge should be replaced.

### CARTRIDGE REPLACEMENT

If a cartridge cannot be repaired in the field, it may be replaced with a pre-calibrated cartridge. The cartridges and meter bodies both have serial numbers for record keeping purposes. Make certain the spin time of the replacement cartridge is recorded.

The following table shows the expected reduction in spin times at colder temperatures.

Ambient Meter / Air Temperature °F / °C	Reduction In Minimum Spintime
50°F / 10°C	2%
40°F / 4.8°C	5%
30°F / (-)1.2°C	10%
20°F / (-)6.5°C	15%

Spin testing below 20°F is not recommended since reductions due to increased oil viscosity cannot be distinguished from wear or damage to the cartridge.

## Shop Maintenance Procedures

The paragraphs that follow describe the step-by-step meter disassembly procedure. Partial or complete disassembly may be necessary, as determined by the spin test or the proving results.

Conduct a spin test of the returned meter or cartridge and compare results to the original "as-new" results. Follow the spin test guidelines described above.

Lubricate the meter or cartridge and exercise the meter for approximately 10 minutes to work out the excess oil.

Prove the meter or cartridge at flow rates up to 50% or higher with emphasis on the low end, 5% to 25%, where increased friction will have the greatest effect on accuracy. Compare the proof results to the meter's original results.

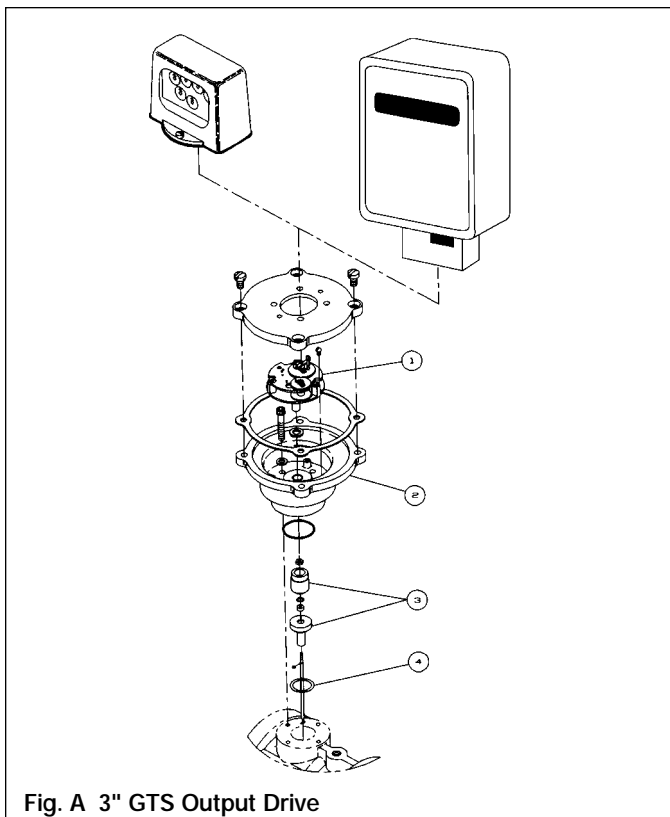
If the meter's spin test and/or proof performance is unsatisfactory, inspect for rotor damage, dirt buildup in the flow passages, gearing binds or bearing wear.

### METER DISASSEMBLY PROCEDURE - 3" GTS METERS

Remove the index or correcting device and base plate, held with 4 screws. This will expose the gear train assembly under the base plate, Fig. A.

Remove the gear train held with 3 screws, Item 1, Fig. A. Inspect for wear or damage. The gear train should turn easily by spinning the output drive wriggler. Also inspect the O-ring (or gasket) above the magnet drive. Replace if damaged.

Next, remove the gear housing, held with 4 socket head screws, Item 2. Lift the gear housing away from the meter body and inspect the O-ring at the bottom of the gear housing. Replace if damaged.



Lift the driving magnet assembly out of the meter body, Item 3. Also remove the wavy washer under the magnet drive, Item 4. The magnet shaft should spin freely in the shaft holder.

The entire measurement unit can now be removed from the inlet end of the meter, Fig. B. Grasp the inlet Flo-Guide® and pull the measurement section forward, being careful not to damage the rotor.

Remove the outlet Flo-Guide®, held to the meter body with 2 screws. The inside of the body can be inspected for dirt buildup and cleaned. Make certain the lubricating hole on the inside of the body, adjacent to the lubricating fitting, is not clogged.

### Measurement Unit Disassembly – 3" GTS Meters

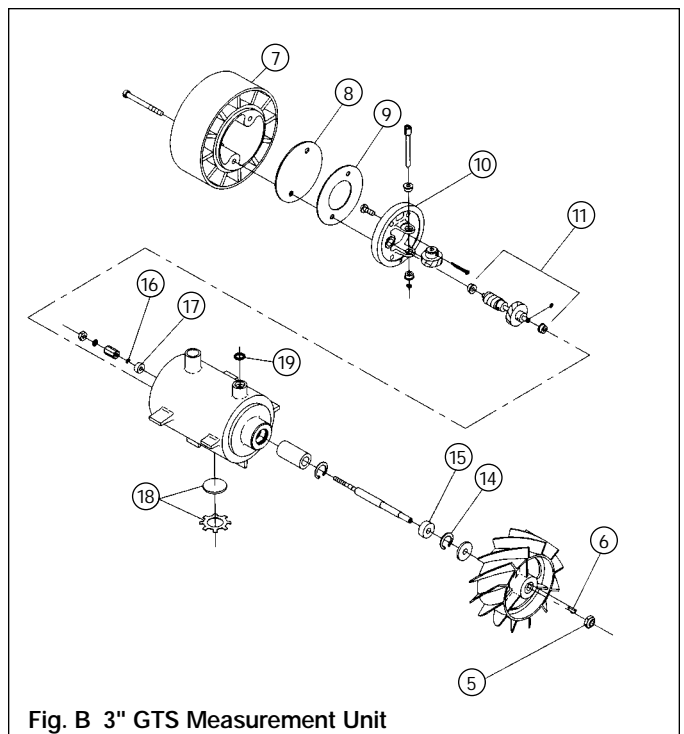
Examine the rotor for dirt buildup, damaged or missing blades. Replace the rotor if damaged. To remove the rotor, place the left hand around the outside diameter of the rotor and loosen the locknut, Item 5, with a 3/8-inch wrench, Fig. B. Pull the rotor off of the shaft, being careful not to drop the shaft key, Item 6. Remove the key and bearing dust shield.

Remove the inlet Flo-Guide® diffuser held by 2 screws, Item 7. Also remove the "Clean Chamber" cover plate and gasket, Items 8 and 9.

Remove 2 pan head screws from recessed holes in the bearing housing. Carefully slide out the bearing housing, Item 10, which is aligned with the measurement unit housing by a pin. Inspect the worm gear and spin the shaft. It should turn freely.

Remove the worm, gear and shaft assembly, Item 11, which has a ball bearing at each end. Inspect the helical worm, the gear and check the ball bearings are free turning.

Remove the nut and lockwasher, Item 12, from the end of the main rotor shaft. Then unscrew the 10-tooth pinion from the main rotor shaft, Item 13.



Use a pair of "C"-ring pliers to remove the retaining ring, Item 14, holding the ball bearing closest to the rotor. Remove this bearing, Item 15, and the rotor shaft at the same time. Inspect the bearing for wobble and/or friction. Replace if necessary.

From the other end of the measurement unit housing, use "C"-ring pliers to remove the upstream "C"-ring, Item 16. Then remove the main rotor bearing, Item 17. Inspect this bearing for wobble and/or friction and replace if necessary.

Remove and replace the "Clean Chamber" filter disk and retaining ring, Item 18.

Inspect the lubrication hole O-ring, Item 19, for nicks and replace, if necessary.

This completes the meter disassembly.

### **Measurement Unit Reassembly – 3" GTS Meters**

Install the upstream main rotor bearing and the "C"-ring.

Replace the rotor shaft and downstream rotor bearing from the downstream end of the measurement unit housing. Replace the "C"-ring.

Screw on the 10-tooth pinion (large hole first) and tighten gently. Install the lockwasher and nut and tighten gently using the screwdriver slot at the end of the rotor shaft.

Install the worm, gear and shaft assembly, with ball bearings at each end.

Install the gear housing, being careful to engage the alignment pin into the measurement unit housing and to engage the ball bearing of the worm and gear shaft into the gear housing. **DO NOT FORCE THE GEAR HOUSING INTO POSITION.** Secure with 2 pan head screws.

Place the "Clean Chamber" gasket and cover over the gear housing and align the mounting holes. Place the inlet Flo-Guide® over the cover plate and align the same 2 holes. Secure Flo-Guide® with 2 filister head screws.

Install the bearing dust shield and key in the rotor shaft, making certain the key has no burrs and that its flat edge is parallel with the rotor shaft.

Install rotor (hub side out) and retaining nut and tighten.

Slide the measurement unit into the body housing from the inlet end until the worm gear drive dog is directly below the output shaft hole.

Install the outlet diffuser with 2 screws.

Install the wavy spring washer into the output shaft hole. Then install the driving magnet assembly into the output shaft hole making certain to engage the drive dog without forcing it.

Now assemble the gear housing (after applying grease to the O-ring at the base), using 4 hex socket screws. The casting number on the gear housing should be facing the front of the meter.

Install gear train assembly with 3 round head screws.

The meter is now ready for spin testing and calibration.

### **METER DISASSEMBLY PROCEDURE – 4" through 12" GTS/GTX/E-Class Meters**

Remove the Index or Correcting Device mounted on the gear train housing with 4 screws.

Remove the gear train held with 3 screws. Inspect gear train for wear or damage. The gear train should turn easily by spinning the output drive wriggler. Also, inspect the O-ring above the magnet drive. Replace if damaged.

Next, mark the position of the gear train housing with a pencil. Remove the 4 socket head screws. Lift the gear housing away from the cartridge top plate. Inspect the O-ring at the bottom of the gear housing for damage. Replace if damaged.

Lift the driving magnet out of the cartridge top plate. The magnet should spin freely in the shaft holder.

Remove the measurement cartridge by first removing the top plate bolts. Lift the cartridge from the body. Inspect the O-ring between the cartridge top plate and the meter body. Replace if damaged.

Remove the inlet Flo-Guide® held with 3 screws. Inspect the straightening vanes for damage and/or dirt buildup. Clean with a mild detergent.

Remove the outlet flow conditioner held by 1 screw in the cartridge opening. Clean and inspect. (GTS only)

### **Cartridge Disassembly**

The measurement unit housing is held to the underside of the top plate with 4 pan head screws. Separate the measurement housing from the top plate, exposing the intermediate gears.

Remove the intermediate gears held by cotter pins. Mark the positions of the gears and housing "A" and "B" for reassembly.

To remove the upshaft below the intermediate gear, remove the retaining ring and lift up on the shaft. The ball bearing can now be removed and inspected and/or oiled.

The rotor is fastened to the rotor shaft with a washer and locknut. Grasp the rotor and remove the locknut. Slide the rotor off the shaft, being careful not to drop the shaft locking pin. Inspect the rotor for missing or damaged blades. If the rotor is not damaged, clean with a damp cloth and a mild detergent. Remove the shim and dust shield behind the rotor.

Next, remove the end cover on the opposite side of the measurement unit held by 2 flat head screws. Inspect and clean the vent screen in the center of the cover plate. The vent allows the clean chamber behind the cover plate to equalize pressure.

To remove the rotor shaft/bearing holder assembly, remove the spring nut located behind the rotor. Slide the bearing holder assembly out of the measurement unit housing. Inspect the assembly for wear of the main rotor bearings or wear of the worm and worm gear. It is recommended that this assembly be replaced as a complete assembly, if required.

Clean and inspect the measurement housing.

### **Cartridge Reassembly**

Insert the bearing holder into the measurement housing, being careful to align the locating pin with the hole in the bearing holder. Secure the bearing holder with the spring nut.

Replace the bearing dust shield and shim on the rotor shaft. Place the locking pin in the shaft groove, align the rotor groove with the groove in the rotor shaft and slide the rotor into position. Secure the rotor with the washer and lock nut.

Install the upshaft down through the cartridge hole until it fully engages the drive coupling on the bearing holder. Slide the upshaft ball bearing in place and install the retaining ring. Install the adjacent ball bearing and retaining ring. Place the intermediate gears in original positions and fasten with cotter pins. Spin the rotor to be certain the assembly turns freely.

Attach the end cover to the outlet side of the cartridge with 2 flat head screws.

The cartridge measurement assembly can now be fastened to the underside of the top plate with 4 pan head screws. Make certain the gasket between the top plate and cartridge is aligned correctly.

Install the driving magnet assembly in the center of the top plate with the O-ring under the magnet drive. The driven magnet shaft must seat in the coupling of the intermediate gear assembly. Spin the rotor. Check the driving magnet for smooth rotation.

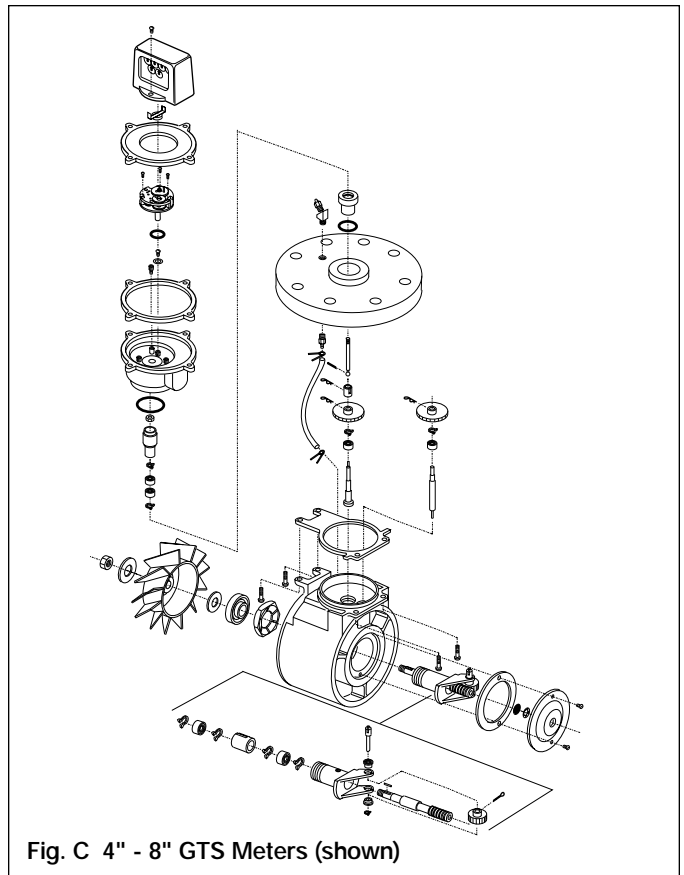
Assemble the gear train housing and O-ring with 4 socket head screws, noting the correct position by the pencil lines. Install the gear train using 3 screws.

The cartridge is now ready for spin testing and calibration. See Page 7 for the spin testing procedure.

**Note:** Always record the final spin time and date on the meter records and/or calibration sheet after repairing a meter cartridge. The spin time will be used as a comparison for future meter-shop spin tests.

**Minimum Meter-Shop Spin Times (in seconds)  
@ 70°F (21°C)**

GTS Cartridge Less Index					
	3"	4"	6"	8"	12" L.P./H.P.
45-degree plastic rotor (all pressures)	60	65	85	185	110/57
45-degree metal rotor (all pressures)	NA	85	172	255	NA
30-degree metal rotor (all pressures)	NA	82	147	223	NA
GT Cartridge Less Index					
	3"	4"	6"	8"	12" L.P./H.P.
45-degree plastic rotor (all pressures)	60	35	57	101	110/57



**Fig. C 4" - 8" GTS Meters (shown)**

Replace the inlet Flo-Guide® and outlet flow conditioner in the meter housing.

The cartridge is ready for installation into the meter housing. Apply a thin film of grease to the top plate O-ring and position it on top plate. Lower the cartridge into the meter housing, noting the inlet side of the meter. Install and tighten the top plate bolts.

Before returning the meter to service, lubricate the main rotor bearings as described on Page 6. (GTS only)

**Calibration**

Assuming the meter has an acceptable spin time, proceed with calibration. If the spin time does not approach the spin times listed, check the meter for binds.

Follow the prover instructions when testing the meter.

The calibration test should include flow rates of approximately 50% of the meter's rated capacity. This is the rate at which the calibration changes gears are selected. Use Table 2 to select change gears.

**ADJUSTING METER ACCURACY**

The two output gears of the gear train, Fig. D, are called change gears and are used to adjust the accuracy (or proof) of the meter. **These gears should not be changed to correct for a shift in meter accuracy without first finding and correcting the cause of the accuracy shift.**

The Percent Accuracy Adjustment Table (Table 2), provides a guide to increase or decrease the meter accuracy after servicing and during calibration of the meter. Here's how to use it:

1. Locate the change gear ratio of your present meter assembly (see Table 2). The number of gear teeth is stamped on each of two gears. For example, in Table 2, Gear A has "43" and Gear B, "58." In the table, 43:58 corresponds to Ratio No. 22.
2. Select the new ratio which provides the nearest desired change in accuracy. For example, if an increase of about 0.65% above Ratio 22 is desired, choose Ratio 19 (47:63). This will increase the percent accuracy by:  $0.08 + 0.52 + 0.04 = 0.64\%$  as given the "Accuracy Change %" column.

Refer to PDB-4101 for a more detailed discussion.



Fig. D GTS Meter Gear Train and Change Gears

TABLE 2: PERCENT ACCURACY ADJUSTMENT

INCREASED PERCENT	CHANGE GEARS			ACCURACY CHANGE PERCENT
	RATIO NUMBER	A TEETH	B TEETH	
	1	47	57	1.75
	2	47	58	.41
	3	46	57	1.31
	4	47	59	.44
	5	46	58	.46
	6	45	57	.78
	7	47	60	.47
	8	46	59	.49
	9	45	58	.51
	10	44	57	.19
	11	47	61	.50
	12	46	60	.52
	13	45	59	.54
	14	44	58	.07
	15	47	62	.49
	16	43	57	.04
	17	46	61	.55
	18	45	60	.53
	19	47	63	.04
	20	44	59	.52
	21	46	62	.08
	22	43	58	.50
	23	45	61	.12
	24	42	57	.48
	25	44	60	.43
	26	46	63	.18
	27	43	59	.41
	28	45	62	.23
	29	42	58	.39
	30	44	61	.65
	31	43	60	.33
	32	45	63	.34
	33	42	59	.31
	34	44	62	.68
	35	43	61	.70
	36	42	60	.23
	37	44	63	.70
	38	43	62	.73
	39	42	61	.88
	40	43	63	.76
	41	42	62	1.61
	42	42	63	

FASTER ↑  
 ↓ SLOWER  
 INCREASED PERCENT  
 DECREASED PERCENT

$M_2$  → 19  
 $M_1$  → 22

$M_1$  = Present meter gear ratio.       $M_2$  = New gear ratio.

### Electronic Output

American Meter offers optional Medium-Frequency Pulsers (MFP) and High-Frequency Pulsers (HFP) for its lines of Gas Turbine Meters. The Medium-Frequency Pulsers are available as original equipment on new 3" thru 12" GTS/GTX/E-Class Meters or in retrofit kit form for existing meters in the field. High-Frequency Pulsers are available as original equipment or in retrofit form on 4" thru 8" GTS Meters only.

The MFP/HFP outputs a square-wave pulse train with a frequency proportional to the actual flow rate. For more information, please refer to the proper bulletin listed on the back page of this publication.

## A Complete Family of Gas Measurement, Pressure Regulation, and Filtering Systems



### Diaphragm Meters

American Meter's compact, light-weight, aluminum-case meters are designed to provide positive displacement accuracy for industrial or commercial loads. See bulletin SB 3510 for more information.



### Rotary Gas Meters

RPM Series Rotary Meters are designed for commercial and industrial loads to provide accurate flow measurement and outstanding performance in the most adverse conditions. See bulletin SB 5500 for more information.



### Pressure Regulators

Inlet- and outlet-pressure regulators with a wide range of capacities. These regulators have optional overpressure and under-pressure shutoff and full-capacity internal relief.



### Pilot-Loaded Regulators

1800 PFM industrial regulators are designed for applications requiring medium-to-high capacity, extremely precise outlet-pressure control, and fast response to changing loads. See bulletin SB 8551 for more information.



### Filters

Filtration down to 10 microns. Protects meter and regulator stations from dirt and pipe scale damage. See bulletin SB 12521 for more information.



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### Axial Flow Valve

Axial Flow Valves (AFV) provide pressure and flow control at extremely high pressures and flow rates. The AFV is compact and lightweight and has a streamlined flow path for quiet operation. See bulletin SB 9509 for more information.



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