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Turbine Flow Meters



Installation, Operation and Maintenance Manual

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TM-86675, Rev AS

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1 INTRODUCTION

1.1 Scope

This manual provides information and guidance for personnel responsible for the installation, operation, and maintenance of the Standard Line Turbine Flow meters manufactured by Flow Technology, Inc.

1.2 Purpose

The contents of this manual are for general information and to describe the operational characteristics of the Standard Line turbine Flow meters. This manual does not include instructions for special application or factory repair.

1.3 Description

The Standard Line Turbine Flow meter is a volumetric flow measuring instrument. The flow sensing element is a freely suspended, bladed rotor positioned axially in the flow stream with the flowing fluid pushing against the blades. The rotational speed of the rotor is proportional to the velocity of the fluid. Since the flow passage is fixed, the turbine rotors rotational speed is also a true representation of the volume of fluid flowing through the flow meter. The rotation of the turbine rotor generates electrical pulses in the pickoff that is attached to the flow meter housing in close proximity to the turning rotor. Each one of these pulses represents a discrete volume of fluid. The frequency or pulse repetition rate represents the volumetric flow rate and the accumulated pulse total represents the total volume measured. Meters provided for liquid applications are not interchangeable with meters provided for gas applications. All requests for information concerning a specific meter should contain the flow meter model number and the flow meter serial number.

The Standard Line Flow meter consists of 3 basic assemblies.

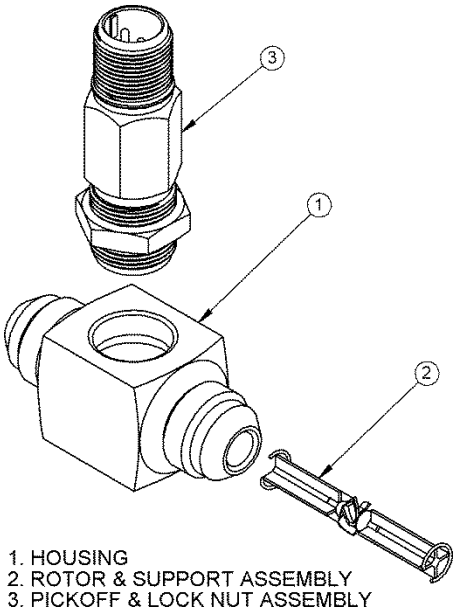
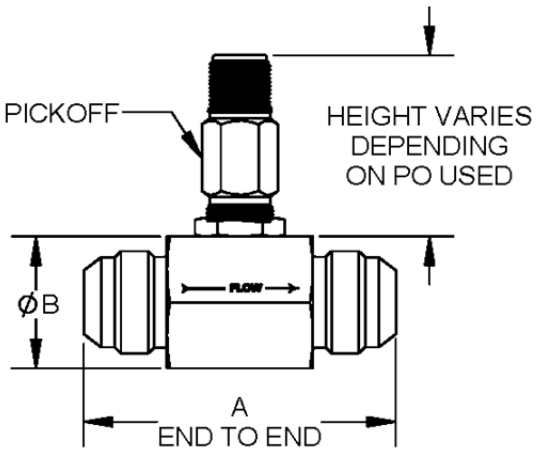


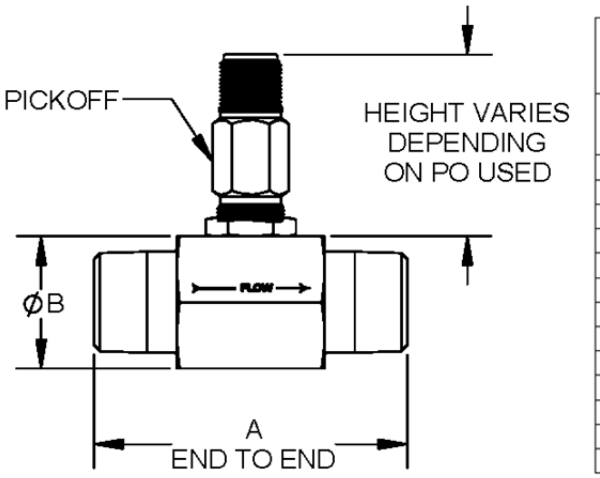
Figure 1 - Flow meter Basic Parts

Overall dimensions are given in in Figure 2 though Figure 5



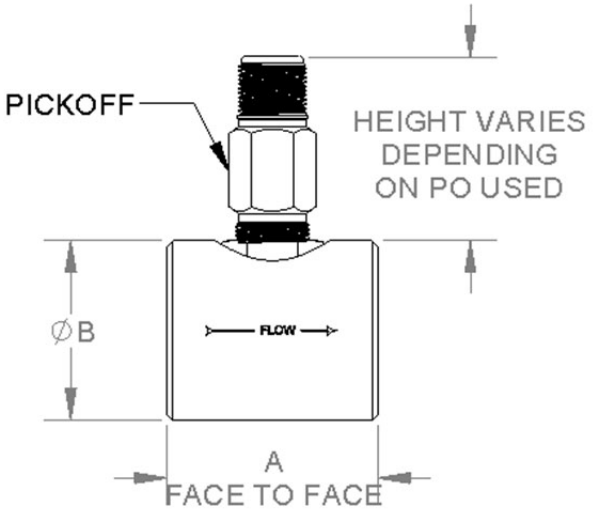
AN OR MS EXTERNAL THREADS			
MODEL NO.	END FITTING	A	B
		in.	in.
FT4-6	3/8"	2.45	1.00
FT4-8	1/2"	2.45	1.00
FT_ _08	1/2"	2.45	1.00
FT-10	5/8"	2.72	1.38
FT-12	3/4"	3.25	1.38
FT-16	1"	3.56	1.63
FT-20	1 1/4"	4.06	1.88
FT-24	1 1/2"	4.59	2.25
FT-32	2"	6.06	2.75
FT-40	2 1/2"	8.90	3.50

Figure 2 - Overall Dimensions, AE Fittings



NPT OR BSP EXTERNAL THREADS			
MODEL NO.	END FITTING	A	B
		in.	in.
FT4-6	3/8"	2.45	1.00
FT4-8	1/2"	2.45	1.00
FT_ _08	1/2"	2.45	1.00
FT-10	3/4"	2.72	1.38
FT-12	3/4"	3.25	1.38
FT-16	1"	3.56	1.63
FT-20	1 1/4"	4.06	1.88
FT-24	1 1/2"	4.59	2.25
FT-32	2"	6.06	2.75
FT-40	2 1/2"	8.90	2.88
FT-48	3"	13.0	3.50
FT-64	4"	12.0	4.50

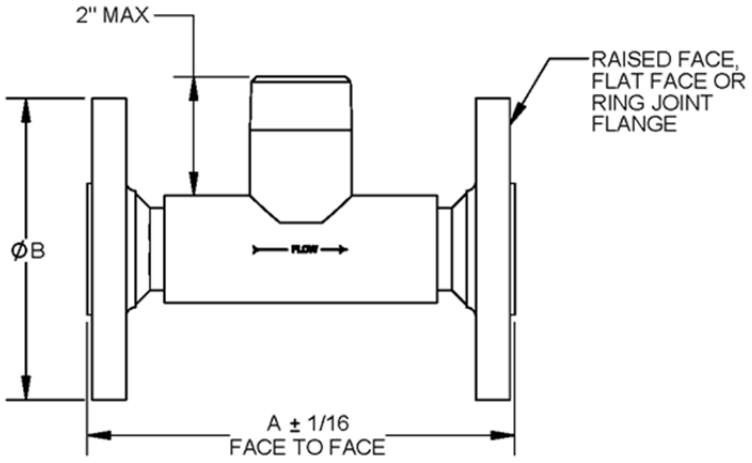
Figure 3 - Overall Dimensions, NE Fittings



WAFER			
MODEL NO.	END FITTING	A	B
		in.	in.
FT6-8	1/2	1.88	1.38
FT8-8	1/2	1.88	1.38
FT-08	1/2	1.88	1.38
FT-10	3/4	1.90	1.70
FT-12	3/4	1.90	1.70
FT-16	1	2.50	2.00
FT-20	1 1/4	2.50	2.50
FT-24	1 1/2	2.50	2.88
FT-32	2	3.00	3.62
FT-40	2 1/2	5.25	4.12
FT-48	3	5.75	5.00
FT-64	4	5.00	6.18

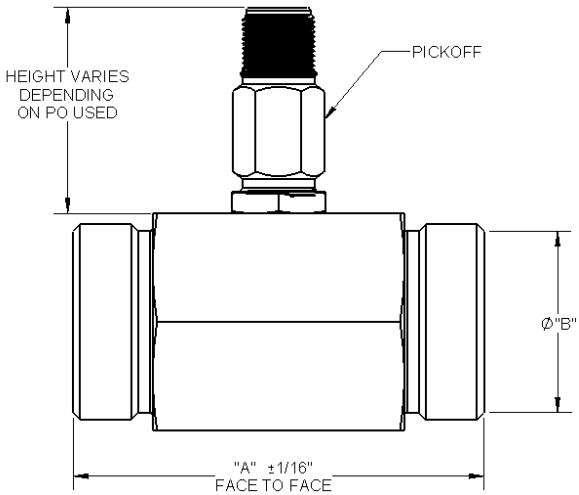
NOTE: 1" NPT enclosure connection is standard on FT-16 and larger wafer meters. Meters smaller than FT-16 will have pickoff connection only.

Figure 4 - Overall Dimensions, WF Fittings



ANSI FLANGED													
	END	150#		300#		600#		900#		1500#		2500#	
Series	FITTING	A	B	A	B	A	B	A	B	A	B	A	B
		in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.	in.
FT4-8	1/2	5.00	3.50	5.00	3.75	5.00	3.75	7.00	4.75	7.00	4.75	7.00	5.25
FT6-8	1/2	5.00	3.50	5.00	3.75	5.00	3.75	7.00	4.75	7.00	4.75	7.00	5.25
FT8-8	1/2	5.00	3.50	5.00	3.75	5.00	3.75	7.00	4.75	7.00	4.75	7.00	5.25
FT-08	1/2	5.00	3.50	5.00	3.75	5.00	3.75	7.00	4.75	7.00	4.75	7.00	5.25
FT-10	3/4	5.50	3.88	5.50	4.63	5.50	4.63	5.50	5.12	5.50	5.12	N/A	N/A
FT-12	3/4	5.50	3.88	5.50	4.63	5.50	4.63	7.00	5.13	7.00	5.12	7.00	5.50
FT-16	1	5.50	4.25	5.50	4.88	5.50	4.88	8.00	5.88	8.00	5.88	8.00	5.88
FT-20	1 1/4	6.00	4.63	6.00	5.25	6.00	5.25	8.00	6.25	8.00	6.25	8.00	6.25
FT-24	1 1/2	6.00	5.00	6.00	6.12	6.00	6.12	9.00	7.00	9.00	7.00	9.00	8.00
FT-32	2	6.50	6.00	6.50	6.50	6.50	6.50	9.00	8.50	9.00	8.50	9.00	9.25
FT-40	3	7.00	7.00	7.00	7.50	7.00	7.50	9.00	9.62	9.00	9.62	10.00	10.50
FT-48	3	10	7.50	10	8.25	10	8.25	10	9.50	10	10.50	10	12.00
FT-64	4	12.00	9.00	12.00	10.00	12.00	10.75	12.00	11.50	12.00	12.25	12.00	14.00

Figure 5 - Overall Dimensions, Flange Fittings



O-RING FACE SEAL			
MODEL NO.	END FITTING	"A"	"B"
		in.	in.
FT4-8FS	08 (1/2")	2.45	.719
FT6-8FS	12 (3/4")	3.00	1.063
FT8-8FS	12 (3/4")	3.00	1.063
FT-08FS	12 (3/4")	3.00	1.063
FT-10FS	12 (3/4")	2.72	1.063
FT-12FS	12 (3/4")	3.25	1.063
FT-16FS	20 (1-1/4")	3.56	1.564
FT-20FS	20 (1-1/4")	3.56	1.564
FT-24FS	24 (1-1/2")	4.59	1.876

Figure 6 – Overall Dimensions, O-Ring Face Seal

2 INSTALLATION

2.1 Inspection

The flow meter should be unpacked carefully and inspected to verify that no damage occurred during shipment. Make certain that the internal parts are clean and free from packing materials or debris.

C A U T I O N

The flow meter is a precision instrument and may be damaged if pressurized air is used for cleaning the flow meter or for checking the rotation of the rotor.

2.2 Mechanical Installation

2.2.1 Flow conditioning

The turbine flow meter is sensitive to velocity profile disturbances in the flow stream. For optimizing the velocity profile it is recommended that a straight run of constant diameter piping with length of at least 10 diameters upstream of the meter and at least 5 diameters downstream be provided. (See Figure 7) The upstream section should have straightening vanes or other flow conditioners. The presence of major flow disturbance generators such as pumps, valves or elbows may require longer straight sections. If swirl is present in the line ahead of the flow meter installation, a longer straight section or additional flow conditioning may be required. Flow Technology, Inc. provides an array of innovative state of the art flow conditioners.

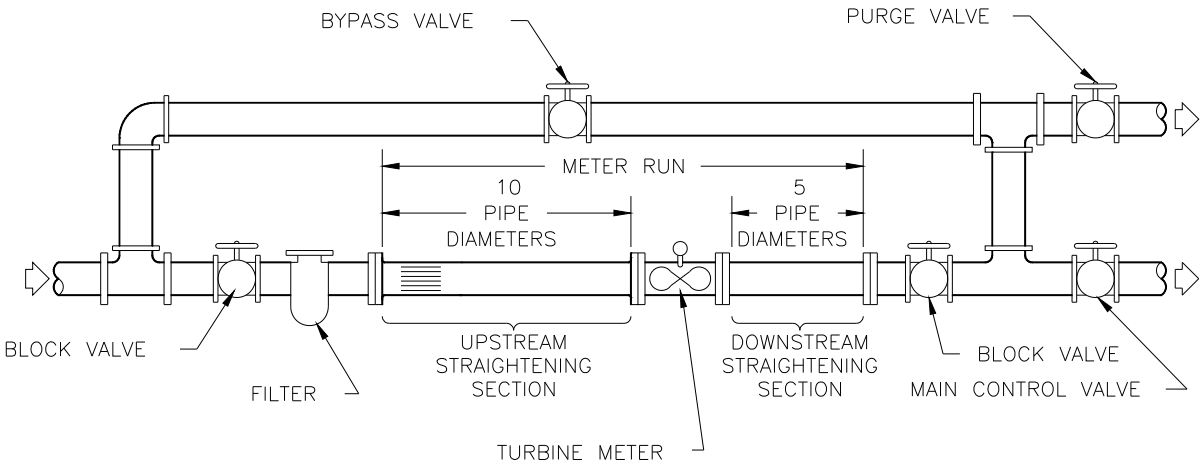


Figure 7 - 3-Valve Bypass Manifold Pipe Schematic

2.2.2 Flow Pulsations

Piping and system components should be arranged to minimize pulsations entering the turbine meter. Pulsations may cause the meter to read high, and excessive pulsations may cause permanent bearing damage. Pulsations should be kept below 10% of the current flow rate at the meter location.

C A U T I O N

Pressure should be built up gradually at start-up to avoid possible damage by over-speeding the rotor. Any severe water hammering from improper start-up or flow surges during operation must be avoided to prevent over-speeding, shaft or rotor blade breakage.

NOTE

Water hammering is a term used during start-up (introducing fluid into the piping) to describe a high velocity flow impact on the turbine rotor. This must be avoided to prevent damage to the mechanical parts.

2.2.3 Purging

All flow lines in the meter system should be purged prior to installation of the meter. This will remove pipe dope, metal shavings, slag and debris that may damage the turbine meter. Control valves should be located downstream from the turbine meter. (See Figure 7) System start-ups with upstream control valves in an unfilled system can result in a hydraulic shock on the meter, causing damage and a change in calibration in liquid systems, or can cause over speed conditions in gas meter systems.

2.2.4 Installation Recommendation

For liquid flow meters, it is recommended that the flow meter be installed so that it remains full of fluid when the flow ceases. When the flow meter is left installed in a line that is temporarily out of service and has been partially or fully drained, severe bearing corrosion may occur. The type and corrosiveness of the fluid being metered, the type of bearing used in the flow meter and the length of time the line will be out of service are factors which may affect the life and operation of the flow meters. If it is economically feasible and conditions permit, the flow meter should be removed, cleaned and stored when there is any doubt about the fluid level in the line during these out-of-service periods. See section 7.1 inspection cleaning and storage.

2.2.5 Orientation and Calibration

While the orientation of the turbine flow meter may influence the nature of the load on the rotor bearings, and thus the performance of the meter at low flow rates, the effect is negligible for most users. For optimum accuracy a turbine meter should be installed in the same orientation in which it was calibrated. FTI's standard calibration orientation is with the meter axis horizontal.

2.2.6 Filtration

A filter should be installed upstream of the flow meter (See Figure 6). Filtration is a tradeoff between bearing life, meter performance and pressure drop across the system. For optimum bearing life the smallest filter the system pressure drop can withstand should be installed.

For ball bearing meters the standard recommendation is 10 micron for ½ inch meters, 20 micron for ¾ and 1 inch, and 50 micron for 1 ½ inch and larger.

For journal bearing meters the standard recommendation is 75 to 100 micron filtration.

2.2.7 Torque Requirements

The following table provides the recommended torques in pound-feet for tightening AS-4395 flared-tube end fittings: For best practice use aluminum or copper seals. See Table 13 for part numbers.

Table 1 - Torque Requirements

SIZE	ALUMINUM TUBING		STEEL TUBING	
	MIN.	MAX.	MIN.	MAX.
3/8"	13	16	18	23
½"	23	29	39	45
5/8"	30	35	51	62
¾"	38	45	71	87
1"	58	70	95	114
1-1/4"	71	85	127	152
1-1/2"	75	90	158	190

2”	150	166	222	245

3 PICKOFFS

3.1 Installation

Pickoffs should bottom in the well of the flow meter housing but should only be finger tightened to approximately 4 lb-in (4500 gm-cm max) to prevent distortion of the coil housing. The pickoff is secured in position by tightening the lock nut to approximately 25 lb-in (30000 gm-cm). The pickoff is removed by loosening the hex lock nut and unscrewing the pickoff from the housing.

C A U T I O N

Meter pressure ratings are established with a pickoff installed. Do not operate a flow meter under pressure without a pickoff installed.

3.2 Explosion Proof Housings

Flow meters with explosion proof housings may have the pickoff installed inside a short section of conduit pipe (spud) that is welded to the housing. Since the spud is longer than the pickoff, the pickoff cannot be finger tightened directly and an alternate method must be used to install the pickoff. A modified 11/16-inch deep socket is required to screw the pickoff into the housing and a modified 13/16-inch deep socket is used to tighten the lock nut.

3.3 Pickoff Installation Sockets

Modify a standard 11/16-inch deep socket with an elongated 3/8-inch hole as shown in Figure 8. This socket will fit the pickoff and allow easy feed through of the lead terminals without damaging the leads. Modify a standard 13/16-inch deep socket with an elongated hole. (See Figure 8) Cut the outside diameter of the socket to 1.015 inches as shown to permit the socket to tighten the lock nut inside the conduit without damaging the pickoff leads.

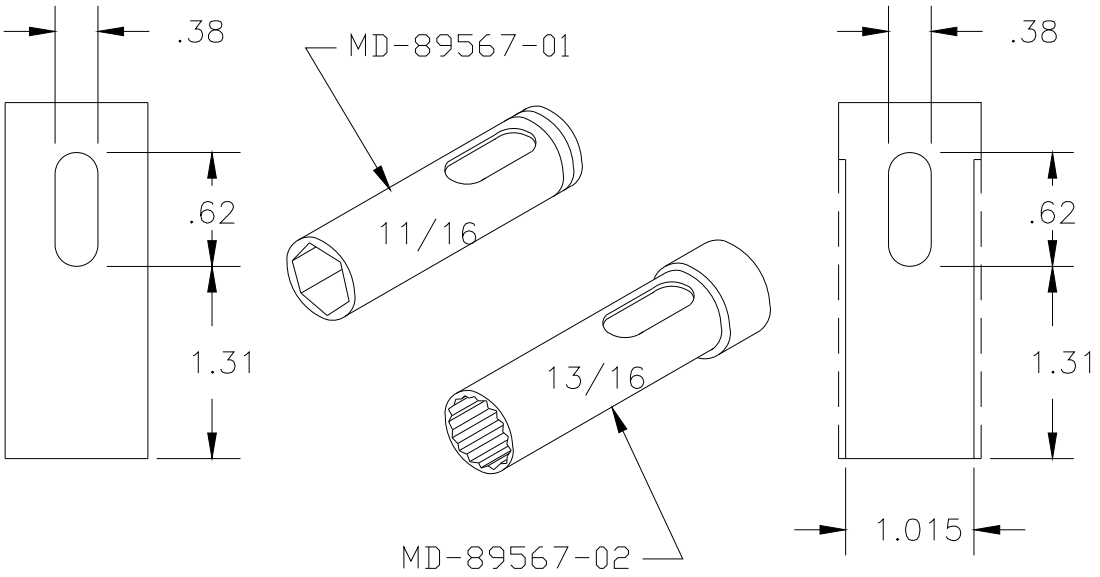


Figure 8 - Pickoff Installation Sockets

3.4 Magnetic Pickoff

The magnetic pickoff output is a low level signal that ranges from 10 mV to several volts peak-to-peak. A pulse amplifier may be needed to convert the pickoff low level signal to a 10 V peak-to-peak pulse signal suitable for process instrumentation. Typical resistance of magnetic pickoffs is 2275 Ω ± 20%.

3.5 RF Pickoff

The modulated carrier (RF) pickoff must be installed with an appropriate amplifier (consult factory). The amplifier is needed to convert the modulated carrier signal to a 10 V peak-to-peak pulse signal suitable for process instrumentation. Typical resistance of modulated carrier pickoffs is 10 Ω ± 10%.

4 ELECTRICAL CONNECTIONS

4.1 Connections

Standard pickoffs are available with a two-contact type MS3102A-10SL-4P connector or with threaded body and pigtail connectors.

4.2 Connection Cable

The connecting cable between the flow meter and the electronic instrumentation should be a two conductor, 22 AWG, shielded and twisted cable with a vinyl jacket (Belden 8761 or equivalent). The cable should not be installed in a conduit or tray containing power lines, or close to strong electromagnetic sources such as electric lines, electric motors, transformers, welding machines, or high voltage lines. These sources may induce transient electrical noise in the coil and cause false pulse signals. Connections from standard pickoffs are not polarized and may be connected in either position. For non-standard pickoffs please refer to manufacturer's specifications.

4.3 Grounding considerations

The shield of the cable is to be grounded at only one point in accordance with the instruction of the display instrument. Flow Technology, Inc. display instruments specify where the shield is to be grounded.

4.4 Signal Processing

An electronic signal conditioning circuit is required to either convert the frequency output of the flow meter into a visual presentation on a display or to provide process control signals. Flow Technology, Inc. manufactures a complete line of electronic packages, which include rate and total displays, rate converters and microprocessor based units for linearization and temperature / pressure compensation.

Table 2 - Signal Processing Specifications

PICKOFF	CONNECTOR	SPECIFICATIONS
Standard	2 Pin MS	Non-polarized Pins Mating Connector FTI P/N:15-89515-101
Amplified Pickoffs 27-94057	3 Pin MS	A = Power B = Ground C = Pulse Mating Connector FTI P/N: 15-89515-102
	Wire Leads	Red = Power Black = Ground White = Pulse Input Power = 8 to 30 VDC @ 10 mA Output = 0 to 5 VDC Pulse Output Impedance = 2.2 kΩ Mag Amp: Frequency Range = 10 Hz to 10 kHz Input Sensitivity = 20 mV p-p RF Amp: Frequency Range = 10 to 3200 Hz Oscillator Carrier Frequency = 45 kHz Junction Box with Terminal Strip FTI P/N 73-31836-105
Pickoff w/RTD RF 27-62730 Mag 27-62731	4 Pin MS	A = Coil B = Coil C = RTD High D = RTD Low and RTD Compensation Mating Connector FTI P/N: 15-93825-01
	Wire Leads	White= Coil Non-polarized Red= RTD high Black= RTD low & RTD compensation RTD= 100 Ohm Platinum

5 OPERATION

5.1 Over Range

In general, turbine flow meters remain quite linear when they are over ranged, and may not provide any indication that the instrument is being misused. However, the pressure drop will become excessive and over speeding of the bearings could cause permanent damage. Bearings may also be damaged by excessive downstream thrust load. The probability of an over speed condition for a liquid meter usually occurs during system start up when there is

still air in the lines. Air should be bled carefully from the lines before high flow range is established. The flow rate or output frequency should be monitored to insure maximum capability is not exceeded. Flow Technology's specifications should be consulted for specific maximum operating flow rates. See Table 4, Table 5, Table 6. Under extreme conditions, the maximum operating flow rates can be exceeded for brief periods of time without meter damage. Following are the maximum allowable over range capabilities:

Table 3 - Maximum Overspeed Limits

Bearing Type	Liquid	Gas
Ball	50%	10%
Pivot	10%	N/A
Journal	50%	N/A

5.2 Under Range

When used below the minimum specified range, turbine meters may become very non-linear. The repeatability of the meter may also be reduced due to bearing and magnetic pickoff drag.

Table 4 - Liquid Service Ball Bearing

Meter Size	Standard Range 10:1 RF& MAG Pickoff (GPM)	Extended Range RF Pickoff (GPM)	Extended Range MAG Pickoff (GPM)	Nominal K Factor (PULSE/ GALLON)	Maximum Frequency (Hz)
FT4-8	.25-2.5	.03-3	.1-3	48000	2000
FT6-8	.5-5	.05-5	.12-5	25000	2100
FT8-8	.75-7.5	.08-8	.16-8	16000	2000
FT-08	1-10	.1-10	.2-10	12000	2000
FT-10	1.25 - 12.5	.15-15	.3-15	9600	2000
FT-12	2-20	.25-25	.5-25	6000	2000
FT-16	5-50	.6-60	1-60	2400	2000
FT-20	9-90	1-100	1.5-100	1300	1950
FT-24	15-150	1.6-160	2.5-160	600	1500
FT-32	22-225	2.5-250	3.5-250	350	1300
FT-40	40-400	4.5-450	5.0-450	180	1200
FT-48	65-650	N/A	7.5-750	75	812
FT-64	125-1250	N/A	15-1500	30	625

Notes:

1. RF Pickoff not applicable for meter sizes FT-48 and larger.
2. Extended range MAG is not valid for pickoffs R3 and X3. Use standard range 10:1 only for all sizes.
3. Repeatability = ± .05%, over 10:1 range
   ±0.1% typical, over extended range
4. Linearity = ± 0.5% of reading over 10:1 range, less than 3.0 centistokes

Table 5 - Liquid Service Journal Bearing

Meter Size	Standard Range 10:1 RF& MAG Pickoff (GPM)	Extended Range RF Pickoff (GPM)	Extended Range MAG Pickoff (GPM)	Nominal K Factor (PULSE/ GALLON)	Maximum Frequency (Hz)
FT4-8	.25-2.5	.1-3.0	.12-3.0	48000	2000
FT6-8	.5-5.0	.15-5.0	.2-5.0	25000	2000
FT8-8	.75-7.5	.2-8.0	.25-8.0	16000	2000
FT-08	1.0-10.0	.25-10	.3-10	12000	2000
FT-10	1.25 - 12.5	.3-15	.4-15	9600	2000
FT-12	2-20	.5-25	.5-25	6000	2000
FT-16	5-50	1.0-60	1.0-60	2400	2000
FT-20	9-90	1.0-100	1.5-100	1300	1950
FT-24	15-150	1.6-160	2.5-160	600	1500
FT-32	22-225	2.5-250	3.5-250	350	1300
FT-40	40-400	4.5-450	5.0-450	180	1200
FT-48	65-650	N/A	7.5-750	75	812
FT-64	125-1250	N/A	15-1500	30	625

Notes:

1. RF pickoff not applicable for meter sizes FT-48 and larger.
2. Extended range MAG is not valid for pickoffs R3 and X3. Use standard range 10:1 only for all sizes.
3. Repeatability = ± .19%, over 10:1 range, FT4-8 thru FT-10
   ±.05% over 10:1 range, FT-12 and above
4. Linearity = ± 2% over 10:1 range, less than 1.3 centistokes
   ± 0.75% over 10:1 range, FT6-8 thru FT-08, less than 1.3 centistokes
   ± 0.5% over 10:1 range, FT-10 and above, less than 1.3 centistokes

Table 6 - Gas Service Ball Bearing H and A Code

Meter Size	Standard Range RF& MAG Pickoff (AFCM)	Nominal K Factor (PULSE/ CUBIC FOOT)	Maximum Frequency (Hz)
FT4-8	.40-3.0 (RF) N/A (MAG)	40800	1700
FT6-8	.65-5.0	24000	2000
FT8-8	1.0-8.0	16000	2000
FT-08	1.5-10.0	12000	2000
FT-10	2.0- 15.0	9600	2000
FT-12	3.5-25	6000	2000
FT-16	5-60	2400	2000
FT-20	9-100	1300	1950
FT-24	15-160	600	1500
FT-32	22-250	350	1300
FT-40	40-450	180	1200
FT-48*	65-750	75	812
FT-64*	125-1500	30	625

Notes:

1. Table data based on Air @ 14.7 PSIA AND 60°F.
2. Typical Repeatability = ± .1%
3. Typical FT4-8 repeatability is ± 0.3%
4. Typical FT6-8 repeatability is ± 0.15%
5. Typical linearity of ±0.1%. Can be achieved with linearizing electronics.

*6 Magnetic pickoff only.

5.3 Liquid Turbine Flow Meter Characteristics

5.3.1 Introductions

Optimum performance of a turbine meter system depends upon a valid calibration as well as the correct selection of supporting equipment. The rotational speed of a turbine rotor depends upon fluid properties as well as the fluid velocity. The most significant fluid property for a liquid meter is the kinematic viscosity. As liquid viscosity increases, the slip of the turbine rotor due to viscous drag is increased, and the rotational speed and hence pickoff frequency is decreased. Due to these effects, the kinematic viscosity of the calibration fluid should approximate the service conditions as closely as possible.

5.3.2 Standard Calibration

Standard liquid calibrations at FTI are done with MIL-C-7024 Type II solvent or water at room temperature. The viscosity of these fluids is approximately 1.25 and 1 centistokes respectively. The standard calibration consists of 10 data points distributed over the normal 10:1 range of the flow meter. If viscosities or flow ranges other than these are required, they must be specified.

5.3.3 Single viscosity Calibration

If the flow meter is to be used at a viscosity other than the standard calibration viscosities, an oil blend calibration should be done on the meter to simulate the operating conditions. The calibration curve produced will represent the flow meter's output characteristics for that specific viscosity. If the flow meter is used with liquids having viscosities greater than 3 centistokes, the linearity of the K-factor will be reduced.

5.3.4 Multiple Viscosity Calibrations

If the viscosity is changing due to varying temperature in the system, the performance characteristics over a range the viscosities can be established. This is done by performing multiple calibrations at different viscosities to cover the range of interest. The K-factor of the meter is then plotted as a function of Hz/*v*. The K-factor is the number of pulses generated by a flow meter for every unit volume of fluid passing through it. Hz is the output frequency of the meter and *v* is the kinematic viscosity of the fluid in centistokes. The plot of K vs. Hz/*v* is commonly referred to as a universal viscosity curve. The data is plotted in this manner because all points fall on a single smooth curve. To obtain a useful curve, calibration points for calibrations at several viscosities are required. By observing the output frequency of the flow meter and obtaining the viscosity or temperature of the fluid, the value of Hz/*v* can be calculated. Using the universal viscosity curve, the value of K corresponding to the known value of Hz/*v* can be determined. With the K-factor known, the flow through the meter can be determined from the expression:

$$GPM = \frac{Freq * 60}{KFactor}$$

Optimum performance requires the following factors:

1) FT Series flow meter
2) Ball bearings
3) RF pickoff (FT-40 and larger magnetic pick off)
4) Viscosity range from 0.8 to 100 centistokes
5) For every factor of ten the viscosity changes, a calibration is required

5.4 Gas Turbine Flow meters Characteristics

5.4.1 Introduction

Accurate performance of gas turbine flow meters depend on a valid calibration that simulates the conditions the meter will operate in. Changes in the pressure and temperature of a gas directly affect the density and kinematic viscosity of the fluid. These changing fluid properties affect the performance of gas flow meters in much the same way as liquid flow meters.

Due to the nature of gasses to be compressed, the volume of gas measured is dependent on the pressure and temperature as established by Boyle's Law and Charles' Law. Using these relationships, the actual volume of gas measured can be related to a standard set of conditions that provide useful technical data. The standard conditions for pressure and temperature used at Flow Technology, Inc. are 14.7 pounds per square inch absolute (PSIA) and 520 degrees Rankine (60 degrees Fahrenheit) respectively. For proper conversions, the absolute measurement for pressure and temperature must be used.

The following equation is used to convert the actual volumetric flow rate to the equivalent standard flow rate.

$$Q_S = Q_A \left(\frac{P_A}{P_S}\right)\left(\frac{T_S}{T_A}\right)$$

Where:

Q_S = Standard flow rate (SCFM)
Q_A = Actual measured flow rate in (ACFM)
P_A = Actual measured pressure at pressure tap on meter (PSIA)
P_S = Standard Pressure (14.7 PSIA)
T_A = Actual measured temperature downstream of meter (R)
T_S = Standard temperature (520 R)

5.4.2 Air Calibration

Gas calibrations at FTI are done using air at ambient conditions. These conditions are typically 14.2 PSIA and 72°F. The standard calibration consists of 10 data points distributed over the normal 10:1 range of the flow meter. If conditions or flow ranges other than these are required, they must be specified.

5.4.3 Single Pressure Calibrations

If the flow meter is to be used at conditions that vary significantly from the standard calibration, a calibration at equivalent conditions should be performed to simulate the actual operating conditions. The calibration curve produced will represent the flow meter's output characteristics for the specified gas at the actual operating conditions.

5.4.4 Multiple Pressure Calibrations

Performance characteristics over a range of pressures can be established for operating conditions where the temperature and pressure are changing. This is done by performing

multiple calibrations at different pressures to cover the range of interest. The information obtained is then plotted on a curve of K-factor verses Hz/*v* where the K-factor is the pulses per unit volume generated by the flow meter and the Hz/*v* is the frequency output of the flow meter divided by the kinematic viscosity of the fluid. The procedure is similar to liquid meters using the universal viscosity curve. By reading the output frequency of the flow meter during operation and dividing it by the kinematic viscosity of the fluid being used, the volumetric flow rate can be determined by reading the K-factor from the universal viscosity curve and calculating the flow rate:

$$CFM = \frac{Freq * 60}{KFactor}$$

Electronic instrumentation is available that can be programmed with the universal viscosity curve and setup with pressure and temperature transducers that will automatically make these calculations and read out the corrected flow rate.

5.5 Bidirectional flow meters

Turbine flow meters can be configured to measure flow in both directions and provide direction-sensing capability. This is accomplished by adding a second pickoff located with respect to the first pickoff in such a way as to achieve a 90-phase shift. The location of the pickoffs is determined by the number of blades on the rotor.

6 TROUBLESHOOTING

The following guide shows some of the common problems that may occur during the operation of turbine flow meters. Various causes are given for each problem including a description of the cause and the corrective action to be taken.

Table 7 - Meter Reads High

PROBABLE CAUSE	CORRECTIVE ACTION
Line not full of fluid. Jetting through meter.	Fill and bleed system.
Cavitation, fluid vaporizes as it slips over rotor blades. Cavitation of the fluid as it passes through the meter.	Check for insufficient back pressure and insure that the flow rate is throttled downstream of the meter. Increase static pressure of system if it is safe and feasible.
Meter installed backwards.	Check to see if the flow direction arrow on the flow meter is aligned with the direction of flow.
Internals installed backwards.	Verify internals are installed properly.
Meter installed in different orientation than when calibrated.	Insure meter is installed in horizontal position unless otherwise specified on data sheet.
Flow meter is not mated to proper electronics.	Check data sheets and assemble system correctly.
Operating fluid has a different kinematic viscosity than the original calibration.	Recalibrate meter at correct kinematic viscosity.
Electronics picking up noise. A.C. signals override flow meter signals and are detected as pulses.	Separate power cables from signal cables and check for noise signal of sufficient amplitude to be mistaken as a flow meter signal. Check for improper connection of ground shield. Shield to be connected at only one end of system.
Foreign material upstream or in flow meter creating jetting.	Remove material, install manufactures recommended filtration.
Input line to flow meter has a much smaller opening than meter, creating jetting.	Check input line connections and size per manufacturer's recommendations.
Swirl in flow stream created by valves, line geometry, fittings and insufficient flow straightening causing rotor to have artificially high frequency.	Check the geometry of the line, install appropriate flow straighteners.
Diagnostic equipment used to check the turbine meter is incorrect.	Check calibration and accuracy of diagnostic equipment used to check turbine flow meter.

Table 8 - Meter Reads Low

PROBABLE CAUSE	CORRECTIVE ACTION
Corroded or worn bearings.	Replace bearings.
Bearing misapplication.	Use proper bearings.
Improper flow meter assembly after installing bearing kit.	Check for proper internal component assembly.
Fluid contamination.	Clean internals and check location, size and condition of filter and/or replace fluid.
Meter installed backwards.	Check to see if the flow direction arrow on the flow meter is aligned with the direction of flow.
Internals installed backwards.	Verify internals are installed properly.
Meter installed in different orientation than calibration.	Insure meter is installed in horizontal position unless otherwise specified on data sheet.
Bent rotor blades.	Visually inspect and replace rotor if necessary.
Fluid pulsations.	Provide damping in the system.
Shift in fluid viscosity.	Insure the operating condition remains equivalent with the calibration conditions. If the viscosity cannot be stabilized contact the factory for additional information.
Swirl in flow stream created by valves, line geometry, fittings and insufficient flow straightening causing rotor to have artificially low frequency.	Check the geometry of the line, install appropriate flow straighteners.
Electronics not detecting some pulses.	Adjust amplifier gain.
A.C. signals override flow meter signals and are detected as pulses.	Check for A.C. signals that override flow meter signals. Insure signal and power cables are not run together.
Flow meter is not mated to proper electronics.	Check data sheets and assemble system correctly.
Loose pickoff.	Verify that the pickoff bottoms in the housing and secure locknut.
Improper hook-up of cable shield.	Check for improper connection of ground shield. Shield to be connected at only one end of system.

Table 9 - Zero Output

PROBABLE CAUSE	CORRECTIVE ACTION
Pickoff not connected or not properly installed.	Check connection between pickoff and amplifier or readout. Verify that the pickoff bottoms in the housing and secure locknut.
Pickoff defective. Impedance mismatch.	Perform resistance test on pickoff. Insure that amplifier has been matched to flow meter. Some amplifiers require tuning for non-standard pickoffs. Verify proper type of amplifier is used.
System temperature above meter rating.	Insure the fluid temperature is not above the operational temperature of the meter.
Amplifier overheated.	Insure that the temperature range of the amplifier is not exceeded.
Flow meter and readout device are not connected properly.	Check wiring connections of system and verify connections are correctly installed.
Broken wire in system.	Check continuity of interconnecting wires between components.
Excessive distance from flow meter to readout device.	Check distance between pickoff and amplifier. Distance should not exceed 300 feet for magnetic pickoffs and 30 feet for RF pickoffs. (Dependent on environmental conditions and flow meter range).
Flow meter rotor locked and will not turn.	Disassemble flow meter and inspect for debris lodged in rotor. Inspect for damaged bearings or other internal components.
Flow rate below minimum required for meter operation.	Check flow meter and electronic data sheet for low cutoff frequency.
No flow in system.	Check for closed valves in system or a by-pass valve in an open position.

Table 10 - Intermittent Operation

PROBABLE CAUSE	CORRECTIVE ACTION
Loose electrical connections.	Check and tighten connections.
Improperly seated pickoff.	Verify that pickoff is bottomed and retighten lock nut.
Intermittent electromagnetic noise.	Separate power cables from signal cables and check for noise signal of sufficient amplitude to be mistaken as a flow meter signal.
Electronic malfunction.	Troubleshoot electronics. Consult electronics manual.
Fluid temperature exceeds range of pickoff.	Replace with high temperature pickoff or reduce operating temperature.
Ambient temperature exceeds range of electronics.	Relocate the electronics to reduce temperature to an acceptable level.
Bearings are worn, broken or contaminated.	Replace bearings and recalibrate meter. Provide appropriate filtration.
Uneven flow, flow surging or pulsating.	Increase system back pressure or provide damping.

Table 11 - Non-repeatable Meter Output

Probable Cause	Corrective Action
Bearings have become worn, damaged or corroded.	Replace bearings as necessary and recalibrate meter. Check for appropriate filtration and material / fluid compatibility.
Internals have become contaminated with foreign material.	Clean or replace meter internals including supports, cones, rotor and/or bearings and recalibrate meter. Check for appropriate filtration as necessary.
Damaged internals.	Replace internals and recalibrate meter.
Line not full of fluid - bubbles or froth present.	Check plumbing for source of bubbles or froth and correct. Bleed line of foreign gas.
Cavitation of the fluid as it passes through the meter.	Check for insufficient back pressure and insure the flow rate is throttled downstream of the meter. Increase static pressure of the system if it is safe and feasible.
Shift in fluid viscosity.	Insure the operating condition remains equivalent to the calibration conditions. If viscosity cannot be stabilized, contact the factory for additional information.
Internals not properly secured.	Inspect retaining rings for proper seating. Inspect bore for signs of scoring. Reseat retaining ring(s) and/or replace internals if necessary.
Piping configuration changed.	Insure the operational piping configuration is the same as that with which the meter was calibrated. If not, recalibrate meter with the new piping configuration.
Intermittent operation.	Intermittent operation will cause non-repeatable meter output. Refer to the trouble shooting section on intermittent operation.

Table 12 - Constant Non-Zero Output

Probable Cause	Corrective Action
Improper oscillation of amplifier circuit.	Pickoff and amplifier mismatch, replace with compatible component.
Electronics picking up noise.	Separate power cables from signal cables and check for noise signal of sufficient amplitude to be mistaken as a flow meter signal.
Improper wiring.	Check for appropriate wiring configuration and connections.
Electronic malfunction.	See electronic manual troubleshooting guide to correct problem.

7 ROUTINE MAINTENANCE

Maintenance of the FT Series flow meter consists of periodic inspections to insure that the internal parts have not suffered any corrosion or incrustation by measuring fluid. Should the assembly be damaged, it should be returned to the factory for exchange or repair.

7.1 Inspection Cleaning and Storage

For inspection and cleaning of internal parts, the rotor and support assembly may be withdrawn from the housing. The rotor support assembly and the housing may be cleaned with appropriate solvent or alcohol. If liquid flow meters are to be stored or out of service for an extended period, it should be dipped in a light rust proofing preservative or machine oil and capped. Gas flow meters should be cleaned and capped to prevent dust or foreign materials.

C A U T I O N

Service for some fluids may require special cleaning procedures before installation. Please consult fluid manufacturer and/or use industry accepted procedures.

One of the largest single sources of poor turbine meter performance is foreign material buildup on bearings whether they are journal type or ball type. It is recommended that whenever possible, the turbine meter be thoroughly flushed with an appropriate solvent immediately after use. The solvent should be chemically neutral and highly volatile so that complete drying can take place soon after the flushing operation. Some appropriate solvents would be ethyl alcohol or stoddard solvent.

All turbine flow meters include some type of bearing for supporting its rotor. The standard line flow meter is normally equipped with ball bearings, but journal bearings fabricated of tungsten carbide, ceramic, epoxy impregnated graphite and other non-metallic materials are also available. If the bearings in the flow meter become damaged or worn, the meter should be sent to the factory for bearing replacement. If this is not possible, a bearing replacement kit is available for most models. All bearings are not field replaceable. Consult the factory and describe the particular flow meter before ordering a bearing replacement kit.

7.2 Removing Internals

There are several variations of the basic turbine flow meter design. This section will explain the general procedure for disassembling Flow Technology, Inc. turbine flow meters. Refer to the following sections for detailed instructions on disassembly of specific flow meters.

C A U T I O N

Observe flow direction markings carefully. Some of the internal parts are symmetrical and may fit and function forward and reverse. The calibration will shift due to variations in the rotor blade edges and the degree of bend in the support trim tabs if installed incorrectly.
Before removing the housing retaining ring note the orientation of the retaining ring, the hook on the retaining ring prevents the support/spacer from spinning.

1. Familiarize yourself with the figure applicable to your model before proceeding.
2. Remove the upstream retaining ring, note the orientation.
3. Insert a plastic rod into the downstream end of the meter and gently press against the downstream support. Select a large enough rod so that it cannot accidentally slip past the support vanes and impact the rotor. Gently slide the internal assembly out of the housing being careful not to drop any of the internal parts as they clear the housing. Maintain compression between the supports to insure that the internals remain assembled until you have noted the flow direction markings on the supports and the rotor.
4. Locate the flow direction of the supports and the rotor. The downstream side of the rotor will have two small marks which are typically hand scribed on the hub. If the marks are not clear, remark the rotor to assure correct re-assembly. If you use a marking pen or pencil, be aware that your markings may be removed during cleaning.
5. Spin the rotor slowly, and note any signs of scoring, wobble, damaged or bent blades. Replace the rotor if it shows any signs of damage.

I M P O R T A N T:

<u>Do not straighten the tabs</u> on the support adjacent to the rotor. These are trim tabs used to improve meter performance. Altering the tab angle will cause a shift in the K-factor.

6. Clean or replace parts as necessary.
7. Reverse procedure to reinstall. Insure that the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled.

7.3 General Handling Techniques

1. All work with bearings should be done in a clean, dry, dust and static free area.
2. Consider all foreign materials to be abrasive, corrosive or otherwise destructive.
3. Verify that the shaft and rotor have been cleaned and are free of oil, contamination and burrs.
4. Keep all bearings in their original unopened packages until ready for installation. Remove the bearings from their protective packages one at a time, as required.
5. The bearings should be handled with tweezers or other special non-magnetic tools
6. Never touch high precision bearings with fingers unprotected by finger cots or lint free gloves.
7. Seat the bearing squarely and apply even pressure to the race making contact. (See Figure 9)
8. When installing a bearing in the rotor apply pressure to the outer race.
9. When installing a bearing onto a shaft, apply pressure to the inner race.
10. Never transfer force between the outer and inner races, or damage could result and cause increased friction, increased torque, and shortened bearing life.
11. Shock or impact techniques should never be used to seat the bearing.
12. Installing the small retaining rings requires a quality pair of sharp tweezers and good dexterity. The bearing retaining rings are under spring tension and can easily shoot out while removing or installing. Wear eye protection.

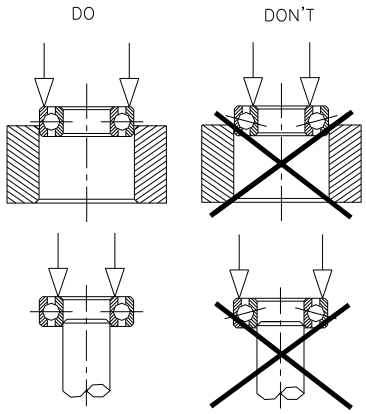


Figure 9 - Bearing Seating

7.4 Ball Bearing Replacement

Ball bearings may be replaced in the field by the customer without significantly changing the flow meter performance, provided the downstream orientation of the rotor is maintained. Complete replacement sets of calibrated internals are also available.

7.4.1 Ball bearing replacement for

Liquid Models:	FT4-8
Gas Models Bearing Code H:	FT-10; FT-12

Refer to Figure 11 and Figure 15

1. Remove the retaining ring (2) from either end of the flow meter housing, note the orientation.

2. Gently slide the flow meter rotor support assembly out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove the downstream support (6) and the cone (7A) from the shaft (7B). Note on the FT4-8 flanged meters there is an upstream and downstream spacer (8) between the support (6) and the retaining ring (2).

4. Note that the rotor (7C) is marked on the downstream side with two lines on the rotor hub.

5. Gently slide the rotor assembly from the shaft (7B).

6. Slide both bearings (10) and the bearing spacer (11) out of the rotor hub (7C).

7. Verify the retaining ring (9) is in good condition and seated in the center of the rotor.

8. Reverse steps 1 through 5 for re-assembly. Insure the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7C) is properly oriented with markings on the downstream side.

7.4.2 Ball Bearing Replacement For:

Liquid Models	FT6-8; FT8-8; FT-08; FT-10; FT-12; FT-16; FT-20; FT-24
Gas Models Bearing Code A & H:	FT4-8; FT6-8; FT8-8; FT-08; FT-16; FT-20; FT-24
Gas Models Bearing Code A:	FT-10; FT-12

Refer to Figure 12, Figure 14, and Figure 14 – FT4-8, FT6-8, FT8-8, & FT-08 Gas Bearing Code H

1. Remove the retaining ring (2) from either end of the flow meter housing, note the orientation.

2. Gently slide the flow meter rotor support assembly out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove the downstream support (6) and cone (7A) from the shaft (7B). Note on the flanged FT4-8 thru FT-08 meters there is an upstream and downstream spacer (8) between the support (6) and the retaining ring (2).

4. Note that the rotor (7C) is marked on the downstream side with two lines on the rotor hub.

5. Gently slide the rotor assembly from the shaft.

6. Remove the retaining ring (9) from the marked side of the rotor (7C) and slide both bearings (10) and bearing spacer (11) out of the rotor hub.

   Note: No bearing spacers (11) are present on liquid meter sizes FT6-8 through FT-08. Gas meter models FT4-8 through FT-08 with bearing code H have only one bearing and no spacer.

7. Install the two new ball bearings (10), spacer (11) as required, and retaining ring (9) into rotor hub (7C).

8. Reverse steps 1 through 5 for re-assembly. Insure that the flow direction arrow on the internals match the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7C) is properly oriented with markings on the downstream side

7.4.3 Ball Bearing Replace For:

Models (Liquid and Gas) Bearing Code A & H	FT-32

Refer to Figure 17

1. Remove the retaining ring (2) from either end of the flow meter housing, note the orientation.

2. Gently slide the complete set of internals out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove support (6) from the shaft (7B).

4. Note that the rotor (7C) is marked on the downstream side with two lines on the rotor hub.

5. Gently slide the rotor assembly from the shaft (7B).

6. Remove the retaining ring (9) from the marked side of the rotor (7C) and slide both bearings (10) and bearing spacer (11) out of the rotor hub.

7. Install the two new ball bearings (10), spacer (11) and retaining ring (9) into the rotor hub.

8. Reverse steps 1 through 5 for re-assembly. Insure that the flow direction arrow on the internals matches the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (7C) is properly oriented with markings on the downstream side.

7.4.4 Ball Bearing Replacement For:

Models (Liquid and Gas) Bearing Code A & H	FT-40; FT-48; FT-64

Refer to Figure 18

1. Remove the retaining ring (5) from the upstream end of the flow meter housing (1).

2. Gently slide the complete set of internals out of the housing, being careful not to drop any of the internal parts as they clear the housing.

3. Remove one of the self-locking nuts (3), from one end of the shaft (7).

4. Remove support (4), cone (8), and spacer (11) or (9) from the shaft (7). Note wider spacer (9) is on the downstream side.

5. Note that the rotor (6) is marked on the downstream side with two lines on the rotor hub.

6. Gently slide the rotor assembly (6) and sleeve (14) from the shaft (7).

7. Remove the retaining ring (10) from the marked side of the rotor (6) and slide both ball bearings (13) and bearing spacer (12) out of the rotor hub.

8. Install the two new ball bearings (13), spacer (12) and retaining ring (10) into the rotor hub. Slide sleeve (14) back into the inside diameter of the ball bearings (13).

9. Reverse steps 1 through 6 for re-assembly. Insure that the flow direction arrow on the internals matches the flow direction arrow on the housing when the internals are reinstalled. Insure the rotor (6) is properly oriented with markings on the downstream side

7.5 Journal Bearing Replacement

Flow Technology, Inc. has bearing replacement kits available for turbine flow meters equipped with journal bearings. The use of a replacement kit will allow the customer to repair the flow meter in the field. To maintain accuracy it is necessary that the meter be recalibrated or the entire internal assembly be replaced with a complete set of calibrated internals. Replacement kits are ordered by specifying the flow meter model number and serial number.

Flow Technology, Inc. however does **NOT** recommend field replacement of journal bearings. Replacing the journal bearing often requires special tools and can easily result in damage to other components.

N O T E
The flow meter will require calibration after installing a new journal bearing kit.

For epoxy impregnated graphite and non-metallic (Teflon, Torlon, etc.) journal bearings; the replacement kit consists of a journal bearing and rotor and shaft assembly that replaces the existing rotor subassembly. The rotor, the journal bearing, and the shaft are a factory matched set of components designed for a specific flow meter.

The replacement kit for tungsten carbide or ceramic journal bearings are factory matched components which consist of a journal bearing, a shaft, two thrust washers that are fitted in the cones, and a rotor.

8 PARTS LIST

The following pages contain a detailed listing of the turbine flow meter parts referenced in this manual. For non-standard material, please consult factory for part numbers. Information from the list must be used when contacting the factory for repairs, ordering spare parts or for questions in reference to the turbine flow meters.

Unless otherwise noted refer to Figure 10, Illustrated Parts Breakdown, for visual identification of the various components of the flow meters.

Table 13 – End fitting seals for Turbine Flow meters, FT4-6 Thru FT-40

FTI METER SIZE	ALUMINUM SEAL	COPPER SEAL
FT4-6	50-94946-06	50-82425-06
FT_-08	50-94946-08	50-82425-08
FT-10	50-94946-10	50-82425-10
FT-12	50-94946-12	50-82425-12
FT-16	50-94946-16	50-82425-16
FT-20	50-94946-20	50-82425-20
FT-24	50-94946-24	50-82425-24
FT-32	50-94946-32	50-82425-32
FT-40	50-94946-40	50-82425-40

Table 14 - Liquid Service Turbine Flow meter Parts List, FT4-8 & FT6-8

ITEM	DESCRIPTION	QTY	FT4-8	FT6-8
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-30837-03	13-30514-04
	b. NE (NPT)		13-31314-46	13-31314-16
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85778-101 13-85778-102	13-85779-101 13-85779-102
	d. WF (Wafer)		13-82869-03	13-82869-06
2	Retaining Ring	2	57-11235-01	57-31648-02
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-11702-44	54-11702-43
	b. NE (NPT)		54-11702-44	54-11702-43
	c. Flanged		54-11702-44	54-11702-43
	d. WF (Wafer)		54-11702-81	54-80956-06
		Refer to:	Figure 11	Figure 12
7	Rotating Assembly (Brg Code A)	1	53-84921-101	53-84922-101
7	Rotating Assembly (Brg Code B)	1	53-101400-01	53-101400-102
7A	Cones	2	55-11703-14	5511703-01
7B	Shaft	1	52-11234-03	52-10907-14
	Rotor Assembly (Brg Code A)	1	53-84442-101	53-30896-102
	Rotor Assembly (Brg Code B)	1	53-84442-106	53-30896-138
7C	Rotor	1	53-84219-01	53-31166-14
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17413-102	86-17414-101
9,10,11	Ball Bearing Kit (Brg Code B)	1	86-17413-104	86-17414-105
8*	Spacers, Support	2	41-84900-01	41-84900-02

* FT4-8 and FT6-8 flanged meters require support spacers between the retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 11 and Figure 12.

Table 15 - Liquid Service Turbine Flow meter Parts List, FT8-8 & FT-08

ITEM	DESCRIPTION	QTY	FT8-8	FT-08
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-30514-06	13-31219-02
	b. NE (NPT)		13-31314-36	13-31314-26
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85780-101 13-85780-102	13-85781-101 13-85781-102
	d. WF (Wafer)		13-82869-09	13-82869-12
2	Retaining Ring	2	57-31648-01	57-31648-03
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-11702-40	54-11702-41
	b. NE (NPT)		54-11702-40	54-11702-41
	c. Flanged		54-11702-40	54-11702-41
	d. WF (Wafer)		54-80956-05	54-80956-04
		Refer to:	Figure 12	Figure 12
7	Rotating Assembly (Brg Code A)	1	53-89860-101	53-84924-101
7	Rotating Assembly (Brg Code B)	1	53-10140-103	53-101400-104
7A	Cones	2	55-11703-01	5511703-01
7B	Shaft	1	52-11907-14	52-10907-14
	Rotor Assembly (Brg Code A)	1	53-30896-124	53-30896-105
	Rotor Assembly (Brg Code B)	1	53-30896-140	53-30896-139
7C	Rotor	1	53-31677-04	53-31166-08
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17414-101	86-17414-101
9,10,11	Ball Bearing Kit (Brg Code B)	1	86-17414-105	86-17414-105
8*	Spacers, Support	2	53-84900-03	53-84900-04

* FT8-8 and FT-08 flanged meters require support spacers between the retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 12.

Table 16 - Liquid Service Turbine Flow meter Parts List, FT-10 & FT-12

ITEM	DESCRIPTION	QTY	FT-10	FT-12
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-30884-02	13-30877-02
	b. NE (NPT)		13-51275-02	13-51044-03
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85782-101 13-85782-102	13-85783-101 13-85783-102
	d. WF (Wafer)		13-82869-15	13-82869-18
2	Retaining Ring	2	57-11728-03	57-11728-03
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-31660-04	54-31333-08
	b. NE (NPT)		54-31660-04	54-31333-08
	c. Flanged		54-31660-04	54-31333-08
	d. WF (Wafer)		54-31660-09	54-31333-13
		Refer to:	Figure 13	Figure 13
7	Rotating Assembly (Brg Code A)	1	53-84925-101	53-84926-104
7	Rotating Assembly (Brg Code B)	1	53-101400-105	53-101400-106
7A	Cones	2	55-31334-02	55-31334-02
7B	Shaft	1	52-10182-09	52-10182-09
	Rotor Assembly (Brg Code A)	1	53-30888-101	53-30895-111
	Rotor Assembly (Brg Code B)	1	53-30888-108	53-30895-115
7C	Rotor	1	53-31167-02	53-31168-25
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17415-101	86-17415-101
9,10,11	Ball Bearing Kit (Brg Code B)	1	86-17415-105	86-17415-105

Table 17 - Liquid Service Turbine Flow meter Parts List, FT-16 & FT-20

ITEM	DESCRIPTION	QTY	FT-16	FT-20
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-80024-02	13-80023-02
	b. NE (NPT)		13-80024-04	13-80023-04
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-88335-01 13-85784-102	13-85785-101 13-85785-102
	d. WF (Wafer)		13-82869-21	13-82869-24
2	Retaining Ring	2	57-31920-05	57-31920-06
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-31194-20	54-31623-10
	b. NE (NPT)		54-31194-20	54-31623-10
	c. Flanged		54-31194-20	54-31623-10
	d. WF (Wafer)		54-31194-21	54-31623-11
		Refer to:	Figure 13	Figure 13
7	Rotating Assembly (Brg Code A)	1	53-84927-101	53-89860-107
7	Rotating Assembly (Brg Code B)	1	53-101400-107	
7A	Cones	2	55-11710-02	55-11710-02
7B	Shaft	1	52-13152-1-13	52-13152-1-13
	Rotor Assembly (Brg Code A)	1	53-30023-101	53-30947-102
	Rotor Assembly (Brg Code B)	1	53-30023-122	
7C	Rotor	1	53-31169-15	53-31170-01
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17416-101	86-17416-101
9,10,11	Ball Bearing Kit (Brg Code B)	1	86-17416-106	

Table 18 - Liquid Service Turbine Flow meter Parts List, FT-24 & FT-32

ITEM	DESCRIPTION	QTY	FT-24	FT-32
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-51892-02	13-51871-02
	b. NE (NPT)		13-51930-02	13-51870-03
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85786-101 13-85786-102	13-85787-101 13-85787-102
	d. WF (Wafer)		13-82869-27	13-82869-30
2	Retaining Ring	2	57-31920-03	57-31920-04
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6*	Supports	2		
	a. AE (AS4395)		54-51931-06	54-80972-01 *
	b. NE (NPT)		54-51931-06	54-80972-01 *
	c. Flanged		54-51931-06	54-80972-01 *
	d. WF (Wafer)		54-84031-01	54-85603-102
		Refer to:	Figure 13	Figure 17
7	Rotating Assembly (Brg Code A)	1	53-84929-101	N/A
7	Rotating Assembly (Brg Code B)	1	53-101400-109	N/A
7	Cones	2	55-11820-04	N/A
7*	Shaft	1	52-13152-2-17	52-13152-2-17 *
	Rotor Assembly (Brg Code A)	1	53-30037-101	53-61031-101 *
	Rotor Assembly (Brg Code B)	1	53-30037-114	53-30030-109
7C	Rotor	1	53-31171-13	53-31172-10
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17417-103	86-17417-103
9,10,11	Ball Bearing Kit (Brg Code B)	1	86-17417-106	86-17417-106

* For FT-32 meters with S/N 3202339 and up.
For FT-32 meters with S/N below 3202339 consult factory.

Table 19 - Liquid Service Turbine Flow meter Parts List, FT-40 & FT-48

ITEM	DESCRIPTION	QTY	FT-40	FT-48
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-86223-01	N/A
	b. NE (NPT)		13-85738-101	13-85754-101
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85788-101 13-85788-102	13-85789-101 13-85789-102
	d. WF (Wafer)		13-82869-50	13-82869-49
2	Retaining Ring	1	57-13038-225	57-13038-287
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-85632-101	N/A
	b. NE (NPT)		54-85632-101	54-85753-101
	c. Flanged		54-85632-101	54-85753-101
	d. WF (Wafer)		54-85632-102	54-85753-102
		Refer to:	Figure 18	Figure 18
8	Cones	2	55-85631-01	55-85750-01
7	Shaft	1	52-85122-02	52-85122-04
	Rotor Assembly (Brg Code A)	1	53-85744-101	53-61457-106
	Rotor Assembly (Brg Code B)	1	53-85744-103	53-61457-106
6	Rotor	1	53-85739-01	53-85135-01
10,12,13	Ball Bearing Kit (Brg Code A)	1	86-17418-102	86-17418-102
10,12,13	Ball Bearing Kit (Brg Code B)	1	86-17418-106	86-17418-106

Table 20 - Liquid Service Turbine Flow meter Parts List, FT-64

ITEM	DESCRIPTION	QTY	FT-64
		Refer to:	Figure 10
1	Housing, Flow meter	1	
	a. AE (AS4395)		N/A
	b. NE (NPT)		13-85798-101
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85790-101 13-85790-102
	d. WF (Wafer)		13-82869-39
2	Retaining Ring	1	57-13038-400
3	Locknut, Pickoff	1	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101
6	Supports	2	
	a. AE (AS4395)		N/A
	b. NE (NPT)		54-86099-101
	c. Flanged		54-86099-101
	d. WF (Wafer)		54-80539-103
		Refer to:	Figure 18
8	Cones	2	55-86100-01
7	Shaft	1	52-85122-04
	Rotor Assembly (Brg Code A)	1	53-85159-101
	Rotor Assembly (Brg Code B)	1	53-85159-101
6	Rotor	1	53-85152-01
10,12,13	Ball Bearing Kit (Brg Code A)	1	86-17418-102
10,12,13	Ball Bearing Kit (Brg Code B)	1	86-17420-101

Table 21 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT4-8

ITEM	DESCRIPTION	QTY	FT4-8
		Refer to:	Figure 10
1	Housing, Flow meter	1	
	a. AE (AS4395)		13-86374-115
	b. NE (NPT)		13-86374-116
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-117 13-86374-185
	d. WF (Wafer)		13-86374-154
2	Retaining Ring	2	57-31648-03
3	Locknut, Pickoff	1	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101
6	Supports	2	
	a. AE (AS4395)		54-61232-01
	b. NE (NPT)		54-61232-01
	c. Flanged		54-61232-01
	d. WF (Wafer)		54-61232-04
		Refer to:	Figure 14
7	Rotating Assembly, (Brg Code H)	1	53-61462-102
7A	Cones	2	55-61231-01
7B	Shaft	1	52-10182-05
	Rotor Assembly (Brg Code H)	1	53-30896-129
7C	Rotor	1	53-61245-08
9,10	Ball Bearing Kit (Brg Code H)	1	86-17414-103
8*	Spacer support	2	41-84900-04

* FT4-8 flanged meters require support spacers between retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 14.

Table 22 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT6-8 & FT8-8

ITEM	DESCRIPTION	QTY	FT6-8	FT8-8
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-86374-115	13-86374-115
	b. NE (NPT)		13-86374-116	13-86374-116
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-117 13-86374-185	13-86374-117 13-86374-185
	d. WF (Wafer)		13-86374-154	13-86374-154
2	Retaining Ring	2	57-31648-03	57-31648-03
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-61232-01	54-61232-01
	b. NE (NPT)		54-61232-01	54-61232-01
	c. Flanged		54-61232-01	54-61232-01
	d. WF (Wafer)		54-61232-04	54-61232-04
		Refer to:	Figure 14	Figure 14
7	Rotating Assembly, (Brg Code H)	1	53-61462-103	53-61462-104
7A	Cones	2	55-61231-01	55-61231-01
7B	Shaft	1	52-10182-05	52-10182-05
	Rotor Assembly (Brg Code H)	1	53-30896-131	53-30896-133
7C	Rotor	1	53-61245-02	53-61245-01
9,10	Ball Bearing Kit (Brg Code H)	1	86-17414-103	86-17414-103
8*	Spacers, support *	2	41-84900-04	41-84900-04

* FT6-8 and FT8-8 flanged meters require support spacers between retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 14.

Table 23 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT-08

ITEM	DESCRIPTION	QTY	FT-08
		Refer to:	Figure 10
1	Housing, Flow meter	1	
	a. AE (AS4395)		13-86374-115
	b. NE (NPT)		13-86374-116
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-117 13-86374-185
	d. WF (Wafer)		13-86374-154
2	Retaining Ring	2	57-31648-03
3	Locknut, Pickoff	1	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101
6	Supports	2	
	a. AE (AS4395)		54-61232-01
	b. NE (NPT)		54-61232-01
	c. Flanged		54-61232-01
	d. WF (Wafer)		54-61232-04
		Refer to:	Figure 14
7	Rotating Assembly, (Brg Code H)	1	53-61462-105
7A	Cones	2	55-61231-01
7B	Shaft	1	52-10182-05
	Rotor Assembly (Brg Code H)	1	53-30896-135
7C	Rotor	1	53-61245-04
9,10	Ball Bearing Kit (Brg Code H)	1	86-17414-103
8*	Spacers, support *	2	41-84900-04

* FT-08 flanged meters require support spacers between retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 14.

Table 24 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT-10 & FT-12

ITEM	DESCRIPTION	QTY	FT-10	FT-12
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-86374-118	13-86374-121
	b. NE (NPT)		13-86374-119	13-86374-122
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-120 13-86374-190	13-86374-123 13-86374-195
	d. WF (Wafer)		13-86374-155	13-86374-156
2	Retaining Ring	2	57-11728-03	57-11728-03
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-31660-04	54-31333-08
	b. NE (NPT)		54-31660-04	54-31333-08
	c. Flanged		54-31660-04	54-31333-08
	d. WF (Wafer)		54-31660-09	54-31333-13
		Refer to:	Figure 15	Figure 15
7	Rotating Assembly, (Brg Code H)	1	53-61462-106	53-61462-107
7A	Cones	2	55-31334-05	55-31334-05
7B	Shaft	1	52-10182-09	52-10182-09
	Rotor Assembly (Brg Code H)	1	53-30888-104	53-30895-113
7C	Rotor	1	53-31167-08	53-31168-29
9,10,11	Ball Bearing Kit (Brg Code H)	1	86-17415-104	86-17415-104

Table 25 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT-16 & FT-20

ITEM	DESCRIPTION	QTY	FT-16	FT-20
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-86374-124	13-86374-127
	b. NE (NPT)		13-86374-125	13-86374-128
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-126 13-86374-200	13-86374-129 13-86374-205
	d. WF (Wafer)		13-86374-157	13-86374-158
2	Retaining Ring	2	57-13038-90	57-13038-100
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-31194-20	54-31623-10
	b. NE (NPT)		54-31194-20	54-31623-10
	c. Flanged		54-31194-20	54-31623-10
	d. WF (Wafer)		54-31194-21	54-31623-11
		Refer to:	Figure 16	Figure 16
7	Rotating Assembly, (Brg Code H)	1	53-61462-108	53-61462-109
7A	Cones	2	55-11710-02	55-11710-02
7B	Shaft	1	52-13152-1-13	52-13152-1-13
	Rotor Assembly (Brg Code H)	1	53-61457-103	53-61457-104
7C	Rotor	1	53-31169-22	53-31170-05
9,10,11	Ball Bearing Kit (Brg Code H)	1	86-17416-103	86-17416-103

Table 26 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT-24 & FT-32

ITEM	DESCRIPTION	QTY	FT-24	FT-32
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-86374-130	13-86374-133
	b. NE (NPT)		13-86374-131	13-86374-134
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-132 13-86374-210	13-86374-135 13-86374-215
	d. WF (Wafer)		13-86374-159	13-86374-160
2	Retaining Ring	2	57-31920-03	57-31920-04
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-51931-06	54-80972-01 *
	b. NE (NPT)		54-51931-06	54-80972-01 *
	c. Flanged		54-51931-06	54-80972-01 *
	d. WF (Wafer)		54-84031-01	54-85603-102
		Refer to:	Figure 16	Figure 17
7	Rotating Assembly, (Brg Code H)	1	53-61462-110	N/A
7A	Cones	2	55-11820-04	N/A
7B	Shaft	1	52-13152-2-17	52-13152-2-17
	Rotor Assembly (Brg Code H)	1	53-61457-105	53-61021-103
7C	Rotor	1	53-31171-18	53-31172-18
9,10,11	Ball Bearing Kit (Brg Code H)	1	86-17417-105	86-17417-105

* For FT-32 meters with S/N 3202339 and up. FT-32 meters with S/N below 3202339 consult factory.

Table 27 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT-40 & FT-48

ITEM	DESCRIPTION	QTY	FT-40	FT-48
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-86374-136	N/A
	b. NE (NPT)		13-86374-137	13-86374-139
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-138 13-86374-226	13-86374-140 13-86374-226
	d. WF (Wafer)		13-86374-161	13-86374-162
2	Retaining Ring	1	57-13038-225	57-13038-287
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-85632-101	54-85753-101
	b. NE (NPT)		54-85632-101	54-85753-101
	c. Flanged		54-85632-101	54-85753-101
	d. WF (Wafer)		54-85632-102	54-85753-102
		Refer to:	Figure 18	Figure 18
8	Cones	2	55-85631-01	55-85750-01
7	Shaft	1	52-85122-02	52-85122-04
	Rotor Assembly (Brg Code H)	1	53-61457-107	53-61457-108
6	Rotor	1	53-85741-01	53-85136-01
9,10,11	Ball Bearing Kit (Brg Code H)	1	86-17418-105	86-17419-102

Table 28 - Gas Service Turbine Flow meters Parts List Bearing Code H, FT-64

ITEM	DESCRIPTION	QTY	FT-64
		Refer to:	Figure 10
1	Housing, Flow meter	1	
	a. AE (AS4395)		N/A
	b. NE (NPT)		13-86374-141
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-86374-142 13-86374-248
	d. WF (Wafer)		13-86374-163
2	Retaining Ring	1	57-13038-387
3	Locknut, Pickoff	1	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101
6	Supports	2	
	a. AE (AS4395)		54-86099-101
	b. NE (NPT)		54-86099-101
	c. Flanged		54-86099-101
	d. WF (Wafer)		54-80539-103
		Refer to:	Figure 18
8	Cones	2	55-86100-01
7	Shaft	1	52-85122-04
	Rotor Assembly (Brg Code H)	1	53-61457-110
6	Rotor	1	53-85153-01
10,12,13	Ball Bearing Kit (Brg Code H)	1	86-17419-102

Table 29 - Gas Service Turbine Flow meters Parts List Bearing Code A, FT4-8

ITEM	DESCRIPTION	QTY	FT4-8
		Refer to:	Figure 10
1	Housing, Flow meter	1	
	a. AE (AS4395)		13-30837-03
	b. NE (NPT)		13-31314-46
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85778-101 13-85778-102
	d. WF (Wafer)		13-82869-03
2	Retaining Ring	2	57-11235-01
3	Locknut, Pickoff	1	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101
6	Supports	2	
	a. AE (AS4395)		54-11702-44
	b. NE (NPT)		54-11702-44
	c. Flanged		54-11702-44
	d. WF (Wafer)		54-11702-81
		Refer to:	Figure 11
7	Rotating Assembly, (Brg Code A)	1	53-84921-102
7A	Cones	2	55-11703-14
7B	Shaft	1	52-11234-03
	Rotor Assembly (Brg Code A)	1	53-61457-102
7C	Rotor	1	53-84219-02
9,10	Ball Bearing Kit (Brg Code A)	1	86-17413-102
8*	Spacers, support	2	41-84900-01

* FT4-8 flanged meters require support spacers between retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 11.

Table 30 - Gas Service Turbine Flow meters Parts List Bearing Code A, FT6-8 & FT8-8

ITEM	DESCRIPTION	QTY	FT6-8	FT8-8
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-30514-04	13-30514-06
	b. NE (NPT)		13-31314-16	13-31314-26
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85779-101 13-85779-102	13-85780-101 13-85780-102
	d. WF (Wafer)		13-82869-06	13-82869-06
2	Retaining Ring	2	57-31648-01	57-31648-02
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-11702-43	54-11702-40
	b. NE (NPT)		54-11702-43	54-11702-40
	c. Flanged		54-11702-43	54-11702-40
	d. WF (Wafer)		54-80956-06	54-80956-05
		Refer to:	Figure 12	Figure 12
7	Rotating Assembly, (Brg Code A)	1	53-84922-102	53-89860-112
7A	Cones	2	55-11703-01	55-11703-01
7B	Shaft	1	52-10907-14	52-10907-14
	Rotor Assembly (Brg Code A)	1	53-30896-119	53-30896-109
7C	Rotor	1	53-31166-35	53-31677-09
9,10	Ball Bearing Kit (Brg Code A)	1	86-17414-101	86-17414-101
8*	Spacers, support	2	41-84900-02	41-84900-03

* FT6-8 and FT8-8 and flanged meters require support spacers between retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 12.

Table 31 - Gas Service Turbine Flow meters Parts List Bearing Code A, FT-08

ITEM	DESCRIPTION	QTY	FT-08
		Refer to:	Figure 10
1	Housing, Flow meter	1	
	a. AE (AS4395)		13-31219-02
	b. NE (NPT)		13-31314-36
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85781-101 13-85781-102
	d. WF (Wafer)		13-82869-12
2	Retaining Ring	2	57-31648-03
3	Locknut, Pickoff	1	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101
6	Supports	2	
	a. AE (AS4395)		54-11702-41
	b. NE (NPT)		54-11702-41
	c. Flanged		54-11702-41
	d. WF (Wafer)		54-80956-04
		Refer to:	Figure 12
7	Rotating Assembly, (Brg Code A)	1	53-84924-102
7A	Cones	2	55-11703-01
7B	Shaft	1	52-10909-14
	Rotor Assembly (Brg Code A)	1	53-30896-110
7C	Rotor	1	53-31166-22
9,10	Ball Bearing Kit (Brg Code A)	1	86-17414-101
8*	Spacers, support	2	41-84900-04

* FT-08 flanged meters require support spacers between retaining rings and rotor supports to properly position rotor in housing. Refer to Figure 12.

Table 32 - Gas Service Turbine Flow meters Parts List Bearing Code A, FT-10 & FT-12

ITEM	DESCRIPTION	QTY	FT-10	FT-12
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-30884-02	13-30877-02
	b. NE (NPT)		13-51275-02	13-51044-03
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85782-101 13-85782-102	13-85783-101 13-85783-102
	d. WF (Wafer)		13-82869-15	13-82869-18
2	Retaining Ring	2	57-11728-03	57-11728-03
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-31660-04	54-31333-08
	b. NE (NPT)		54-31660-04	54-31333-08
	c. Flanged		54-31660-04	54-31333-08
	d. WF (Wafer)		54-31660-09	54-31333-13
		Refer to:	Figure 13	Figure 13
7	Rotating Assembly, (Brg Code A)	1	53-89860-113	53-89860-114
7A	Cones	2	55-31334-02	55-31334-02
7B	Shaft	1	52-10182-09	52-10182-09
	Rotor Assembly (Brg Code A)	1	53-30888-102	53-30895-102
7C	Rotor	1	53-31167-03	53-31168-12
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17415-101	86-17415-101

Table 33 - Gas Service Turbine Flow meters Parts List Bearing Code A, FT-16 & FT-20

ITEM	DESCRIPTION	QTY	FT-16	FT-20
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-80024-02	13-80023-02
	b. NE (NPT)		13-80024-04	13-80023-04
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-88335-01 13-85784-102	13-85785-101 13-85785-102
	d. WF (Wafer)		13-82869-21	13-82869-24
2	Retaining Ring	2	57-31920-05	57-31920-06
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-31194-20	54-31623-10
	b. NE (NPT)		54-31194-20	54-31623-10
	c. Flanged		54-31194-20	54-31623-10
	d. WF (Wafer)		54-31194-21	54-31623-11
		Refer to:	Figure 14 – FT4-8, FT6-8, FT8-8, & FT-08 Gas Bearing Code H	Figure 13
7	Rotating Assembly, (Brg Code A)	1	53-84927-102	53-89860-115
7A	Cones	2	55-11710-02	55-11710-02
7B	Shaft	1	52-13152-1-13	52-13152-1-13
	Rotor Assembly (Brg Code A)	1	53-30023-105	53-30947-103
7C	Rotor	1	53-31169-22	53-31170-05
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17416-101	86-17416-101

Table 34 - Gas Service Turbine Flow meters Parts List Bearing Code A, FT-24 & FT-32

ITEM	DESCRIPTION	QTY	FT-24	FT-32
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-51892-02	13-51871-02
	b. NE (NPT)		13-51930-02	13-51870-03
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85786-101 13-85786-102	13-85787-101 13-85787-102
	d. WF (Wafer)		13-82869-27	13-82869-30
2	Retaining Ring	2	57-31920-03	57-31920-04
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6*	Supports	2		
	a. AE (AS4395)		54-51931-06	54-80972-01 *
	b. NE (NPT)		54-51931-06	54-80972-01 *
	c. Flanged		54-51931-06	54-80972-01 *
	d. WF (Wafer)		54-84030-01	54-85603-102
		Refer to:	Figure 13	Figure 17
7	Rotating Assembly, (Brg Code A)	1	53-84929-102	N/A
7A	Cones	2	55-11820-04	N/A
7B	Shaft	1	52-13152-2-17	52-13152-3-21
	Rotor Assembly (Brg Code A)	1	53-30037-102	53-61021-102
7C	Rotor	1	53-31171-18	53-31172-18
9,10,11	Ball Bearing Kit (Brg Code A)	1	86-17417-103	86-17417-103

* For FT-32 meters with S/N 3202339 and up. FT-32 meters with S/N below 3202339 consult factory.

Table 35 - Gas Service Turbine Flow meters Parts List Bearing Code A, FT-40 & FT-48

ITEM	DESCRIPTION	QTY	FT-40	FT-48
		Refer to:	Figure 10	Figure 10
1	Housing, Flow meter	1		
	a. AE (AS4395)		13-86223-01	N/A
	b. NE (NPT)		13-85738-101	13-85754-101
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85788-101 13-85788-102	13-85789-101 13-85789-102
	d. WF (Wafer)		13-82869-50	13-82869-49
2	Retaining Ring	1	57-13038-225	57-13038-287
3	Locknut, Pickoff	1	46-10036-01	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101	15-89515-101
6	Supports	2		
	a. AE (AS4395)		54-85632-101	54-85753-101
	b. NE (NPT)		54-85632-101	54-85753-101
	c. Flanged		54-85632-101	54-85753-101
	d. WF (Wafer)		54-85632-102	54-85753-102
		Refer to:	Figure 18	Figure 18
8	Cones	2	55-85631-01	55-85750-01
7	Shaft	1	52-85122-02	52-85122-04
	Rotor Assembly (Brg Code A)	1	53-85744-102	53-61457-111
6	Rotor	1	53-85741-01	53-85136-01
10,12,13	Ball Bearing Kit (Brg Code A)	1	86-17418-102	86-17419-101

Table 36 - Gas Service Turbine Flow Meters Parts List Bearing Code A, FT-64

ITEM	DESCRIPTION	QTY	FT-64
		Refer to:	Figure 10
1	Housing, Flow meter	1	
	a. AE (AS4395)		N/A
	b. NE (NPT)		13-85798-101
	c. C1 (150# ANSI Flange) C2 (300# ANSI Flange)		13-85790-101 13-85790-102
	d. WF (Wafer)		13-82869-39
2	Retaining Ring	1	57-13038-387
3	Locknut, Pickoff	1	46-10036-01
4	Connector, W/Boot, MS Pickoff	1	15-89515-101
6	Supports	2	
	a. AE (AS4395)		54-86099-101
	b. NE (NPT)		54-86099-101
	c. Flanged		54-86099-101
	d. WF (Wafer)		54-80539-103
		Refer to:	Figure 18
8	Cones	2	55-86100-01
7	Shaft	1	52-85122-04
	Rotor Assembly (Brg Code A)	1	53-61457-109
6	Rotor	1	53-85153-01
10,12,13	Ball Bearing Kit (Brg Code A)	1	86-17418-102

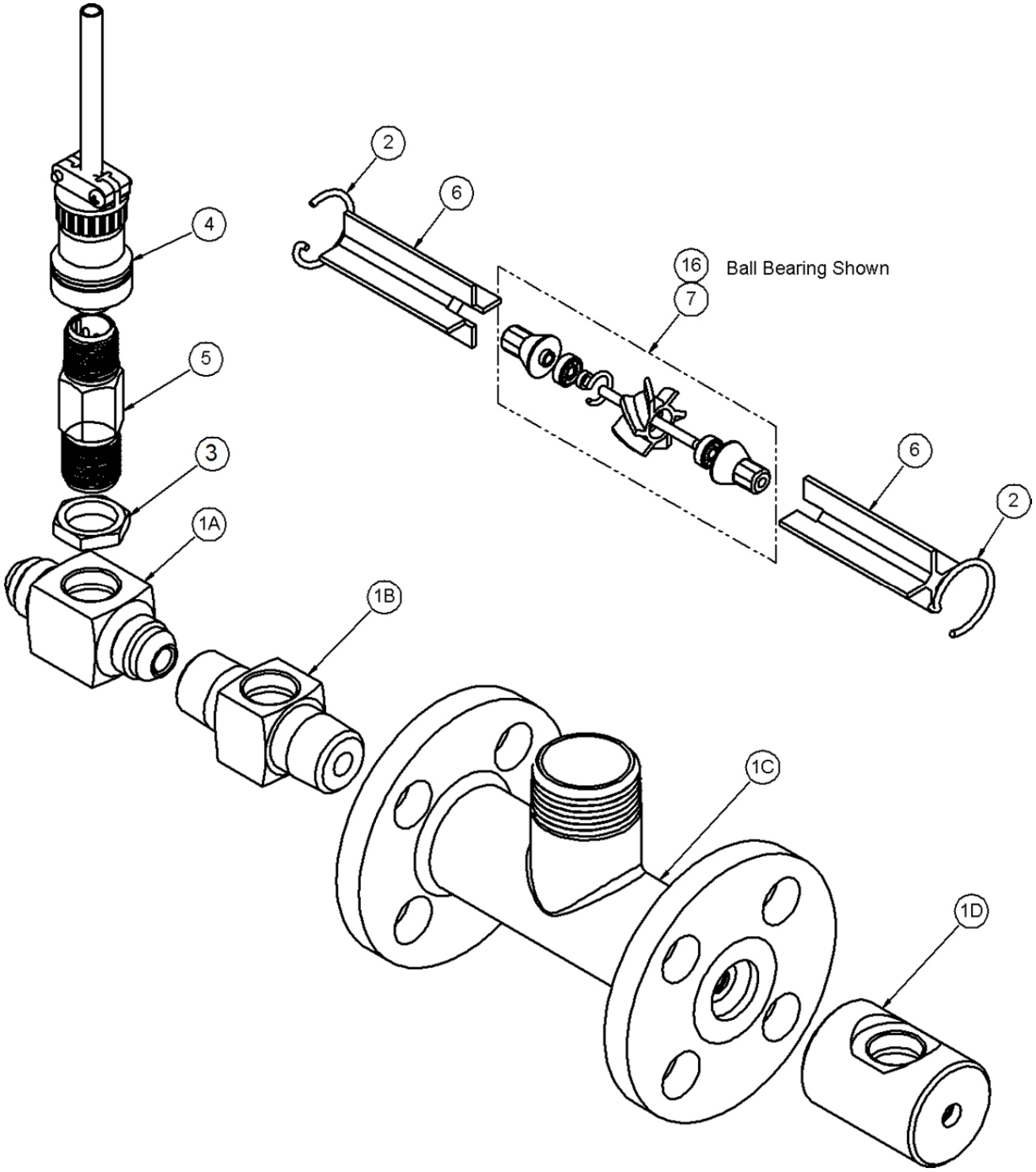


Figure 10 - Illustrated Parts Breakdown

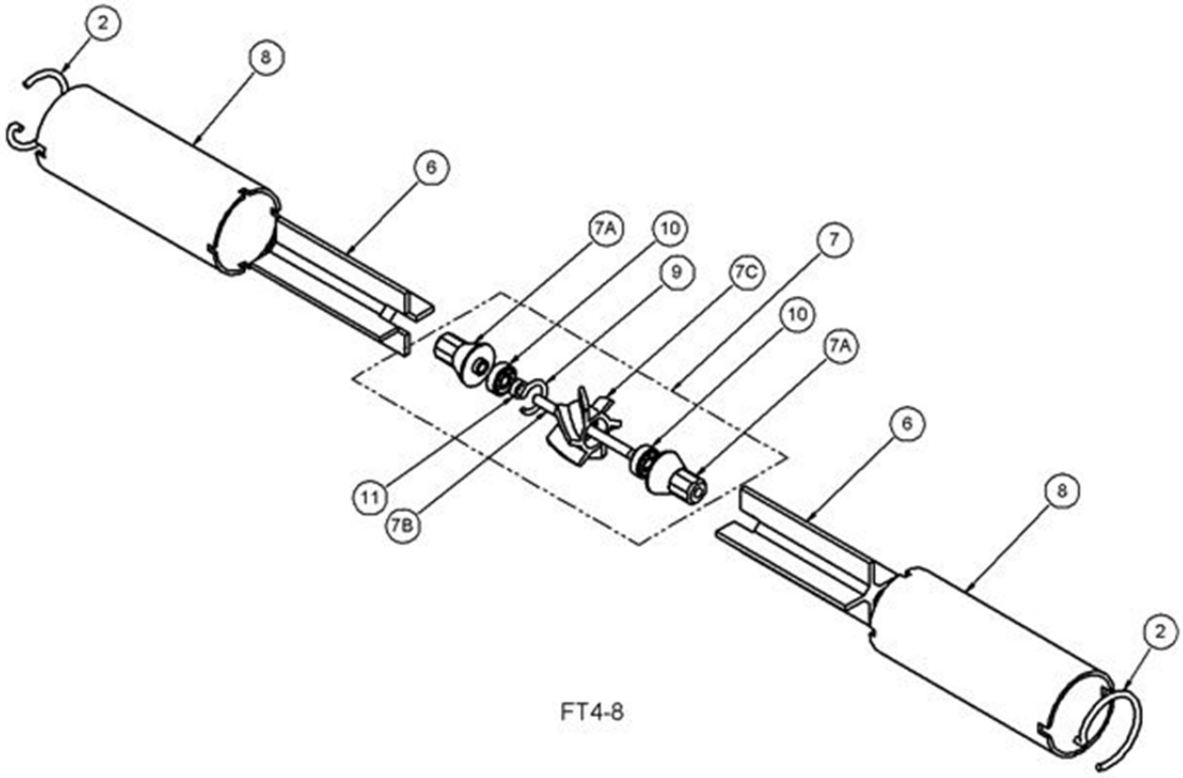


Figure 11 – FT4-8 Liquid Bearing Code A & B, Gas Bearing Code A

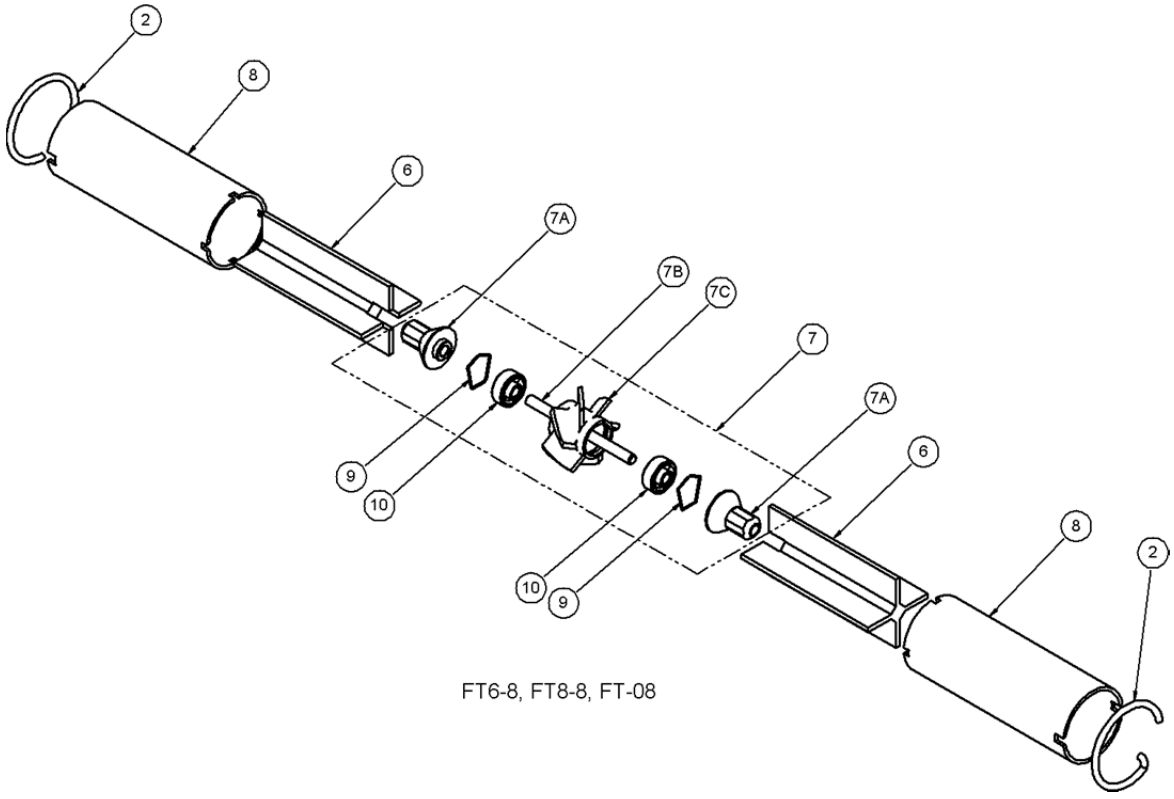


Figure 12 – FT6-8, FT8-8, & FT-08 Liquid Bearing Code A & B, Gas Bearing Code A

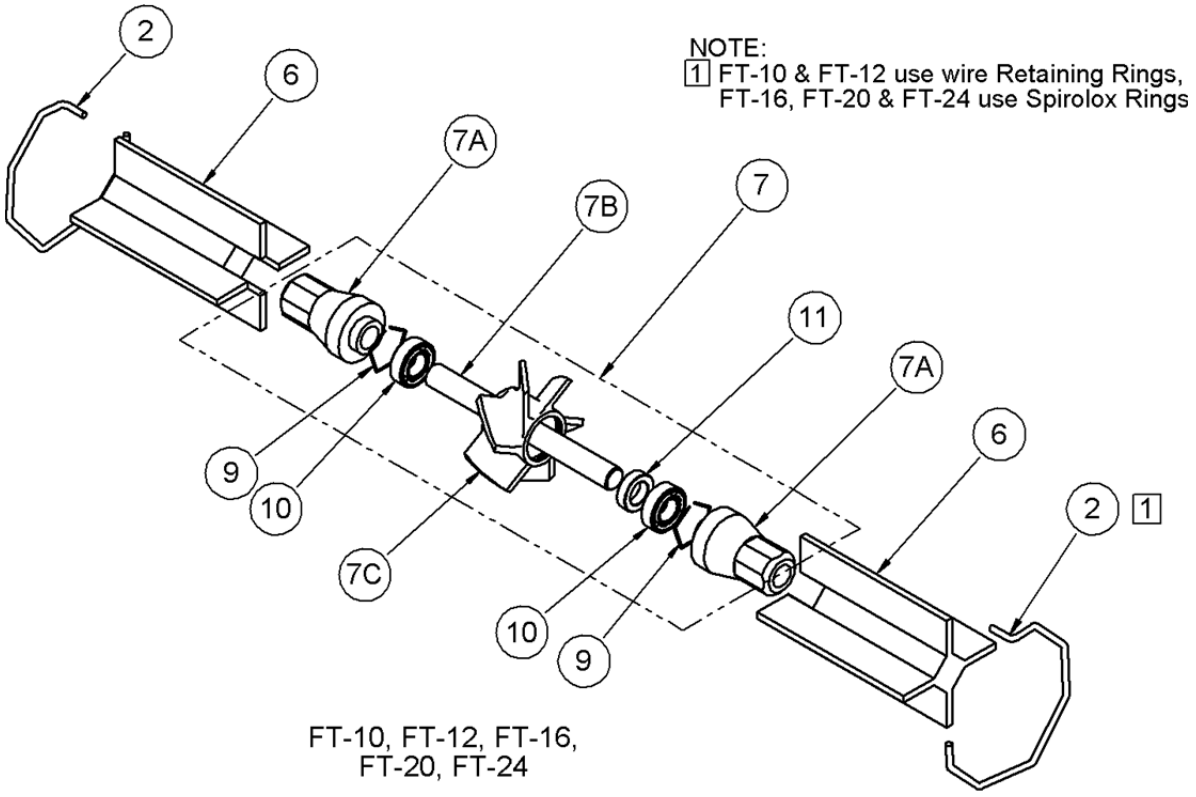


Figure 13 – FT-10, FT-12, FT-16, FT-20, & FT-24 Liquid Bearing Code A & B, Gas Bearing Code A

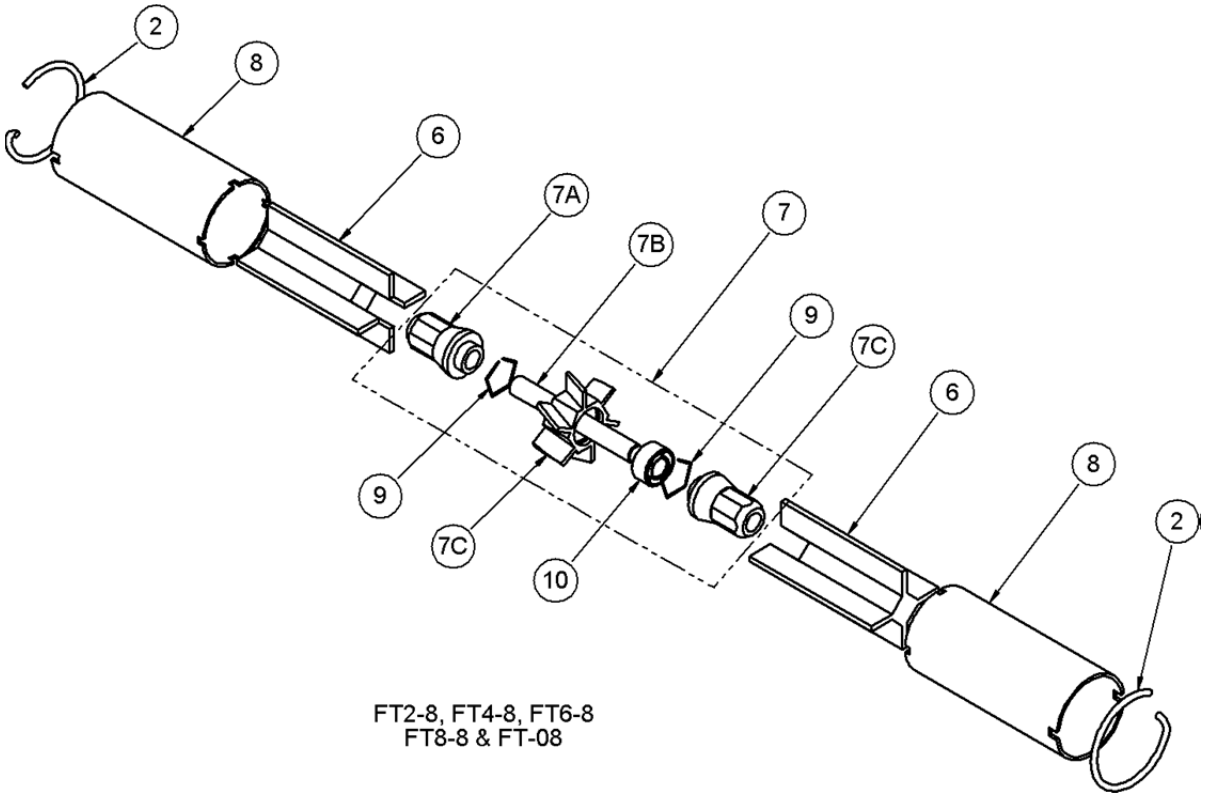


Figure 14 – FT4-8, FT6-8, FT8-8, & FT-08 Gas Bearing Code H

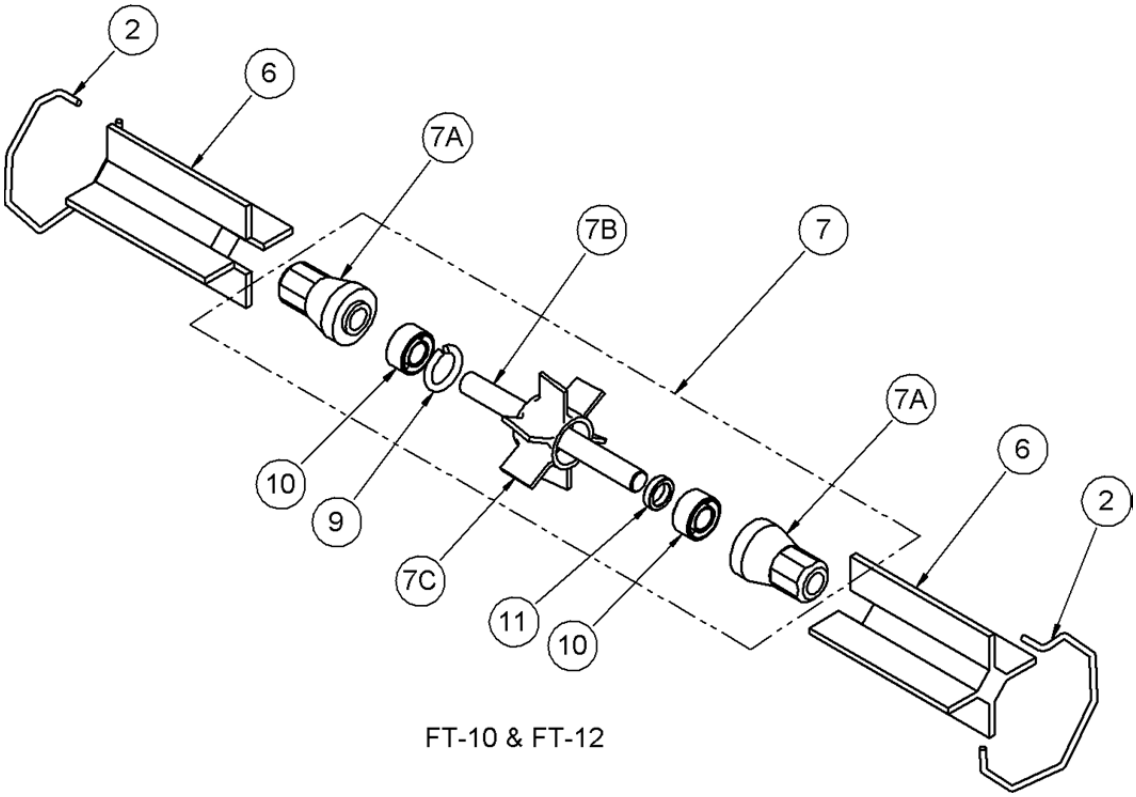


Figure 15 – FT-10 & FT-12 Gas Bearing Code H

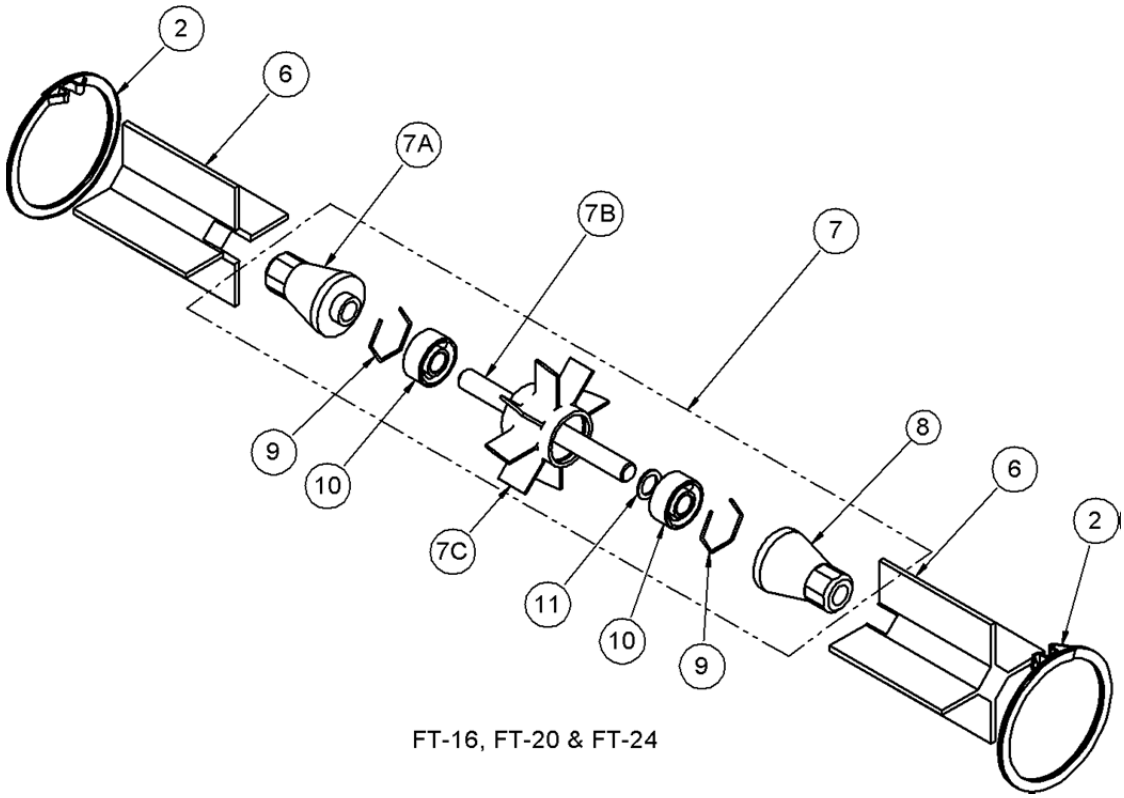


Figure 16 – FT-16, FT-20, & FT-24 Gas Bearing Code H

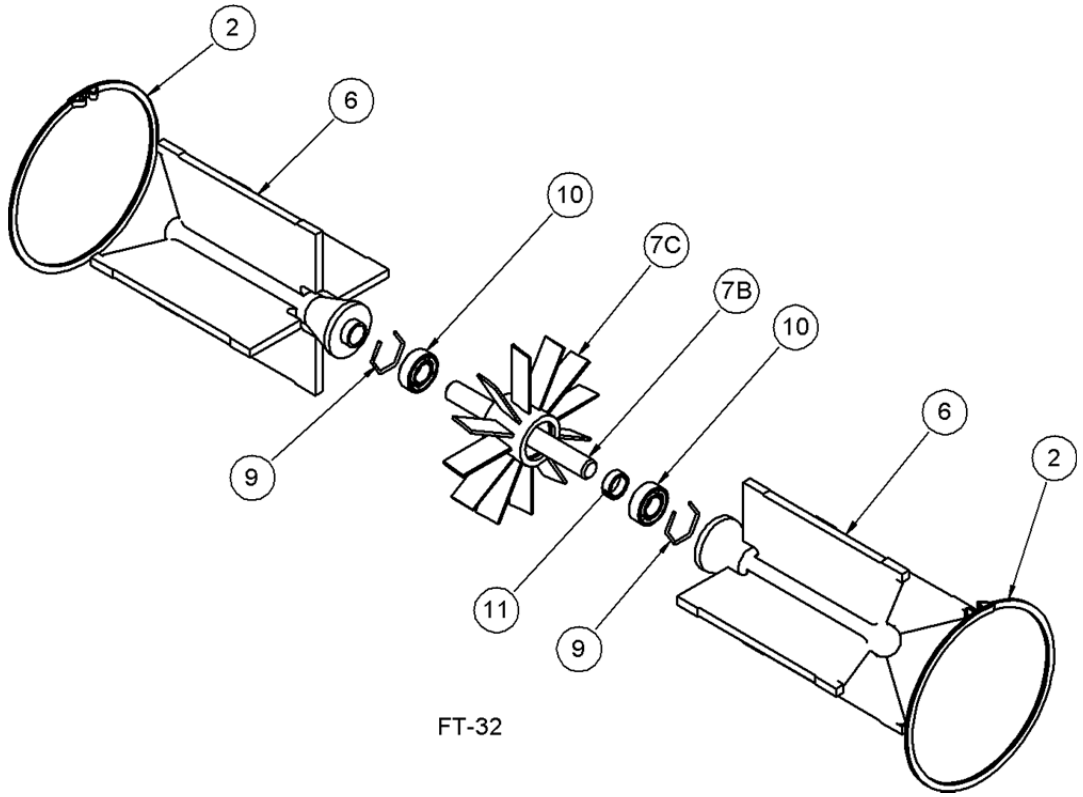


Figure 17 – FT-32 Liquid Bearing Code A & B, Gas Bearing Code A & H

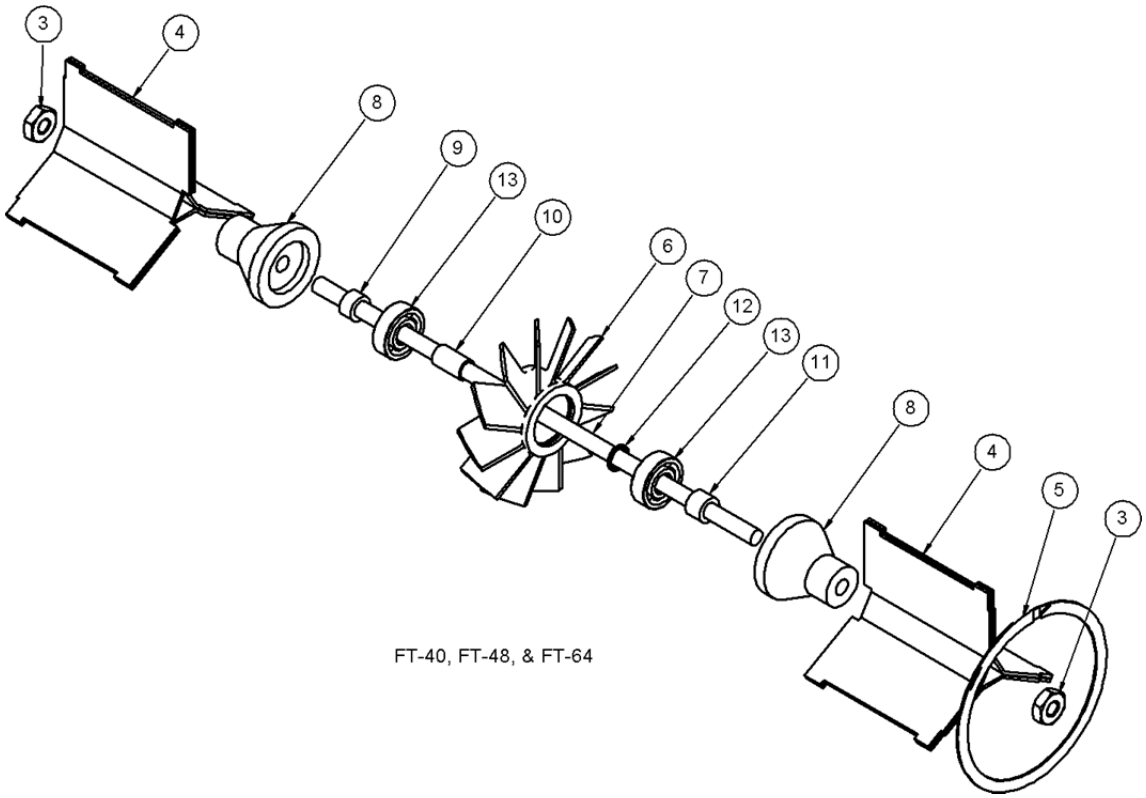


Figure 18 – FT-40, FT-48, & FT-64 Liquid Bearing Code A & B, Gas Bearing Code A & H

Appendix A Model Number Break Down

FT*aaa bb cc d e f g hh jjj*

aaa Flow Meter Size

4-8 (1/2”) through -64 (4”). See Table 4 through Table 6 for sizing information.

bb End Fitting

AE = 37° flare per AS4395
BE = British Standard external pipe threads 1/2" to 4"
NE = NPT external threads, 1/2" to 6"
HB = Hose Barb
WF = Wafer type serrated surface
C1 = 150# Raised Face Flange
C2 = 300# Raised Face Flange
C3 = 600# Raised Face Flange
C4 = 900# Raised Face Flange
C5 = 1500# Raised Face Flange
C6 = 2500# Raised Face Flange
J1 = 150# Ring Joint Flange
J2 = 300# Ring Joint Flange
J3 = 600# Ring Joint Flange
J4 = 900# Ring Joint Flange
J5 = 1500# Ring Joint Flange
J6 = 2500# Ring Joint Flange
D1 = DIN Flange PN16
D2 = DIN Flange PN40
D3 = DIN Flange PN100
D4 = DIN Flange PN160
D5 = DIN Flange PN250
D6 = DIN Flange PN400
FS = O-Ring Face Seal per SAE J1453

cc Calibration

KA = 3 Point, K-factor average, in Air
KW = 3 Point, K-factor average, in Water
KS = 3 Point, K-factor average, in Solvent
KB = 3 Point, K-factor average, in Oil Blend
NA = 10 Point, normal 10:1 range, in Air
NW = 10 Point, normal 10:1 range, in Water
NS = 10 Point, normal 10:1 range, in Solvent
NB = 10 Point, normal 10:1 range, in Oil blend
XA = 10 Point, extended range, in Air

XW = 10 Point, extended range, in Water
XS = 10 Point, extended range, in Solvent
XB = 10 Point, extended range, in Oil blend
TA = 20 Point, normal 10:1 range, in Air
TW = 20 Point, normal 10:1 range, in Water
TS = 20 Point, normal 10:1 range, in Solvent
TB = 20 Point, normal 10:1 range, in Oil blend
YA = 20 Point, extended range, in Air
YW = 20 Point, extended range, in Water
YS = 20 Point, extended range, in Solvent
YB = 20 Point, extended range, in Oil blend
GA = 30 Point, extended range, in Air
GW = 30 Point, extended range, in Water
GS = 30 Point, extended range, in Solvent
GB = 30 Point, extended range, in Oil blend
U2 = Universal Viscosity Curve, 2 viscosities
U3 = Universal Viscosity Curve, 3 viscosities
R1 = Reynolds # Calibration, 10 Point 1 Pressure
R2 = Reynolds # Calibration, 10 Point 2 Pressure
R3 = Reynolds # Calibration, 10 Point 3 Pressure
E1 = Reynolds # Calibration, 20 Point 1 Pressure
E2 = Reynolds # Calibration, 20 Point 2 Pressure
E3 = Reynolds # Calibration, 20 Point 3 Pressure
BA = Bidirectional, 1 Pickoff, 10 points each direction, Air
BW = Bidirectional, 1 Pickoff, 10 points each direction, Water
BS = Bidirectional, 1 Pickoff, 10 points each direction, Solvent
BB = Bidirectional, 1 Pickoff, 10 points each direction, Oil blend
CA = Bidirectional, 2 Pickoff, 10 points each direction, Air
CW = Bidirectional, 2 Pickoff, 10 points each direction, Water
CS = Bidirectional, 2 Pickoff, 10 points each direction, Solvent
CB = Bidirectional, 2 Pickoff, 10 points each direction, Oil blend

d Units of Measure

– = Standard Units of Measure
U = To signify required units of measure other than GPM
R = To signify special calibration flow range other than normal 10:1 or extended range
B = to signify both changes in units and special flow range

e Service

L = Liquid
G = Gas
P = Gas with pressure tap

f Materials of Construction

E = 316 Housing, 430F Rotor
G = 316 Housing, 316 Rotor
H = 316 Housing, 17-4 Rotor
N = Hast C Housing, Hast C Rotor

g Bearings

A = 440C Ball Bearings
D = Carbide Journal - Carbide Shaft and Bearing.
E = Graphite Journal - 316 SST Shaft and Graphite Bearing
G = Ceramic Journal - Ceramic Shaft and Bearings
H = 440C Ball Bearings, Polymer retainer (FT-64 & smaller gas meters)

Table 37 - Bearing Temperature Limits

CODE	SERVICE	BEARING TEMPERATURE RATING
A	Liquid or Gas	-450°F to 300°F
D	Liquid	Up to 1200°F
E	Liquid	Up to 500°F
G	Liquid	Up to 1200°F
H	Liquid or Gas	-450°F to 300°F

Meter temperature rating may be limited by the pickoff temperature rating

hh Pickoff

See Table 38

Table 38 - Pickoff Codes

Code	Type	Connection	Max Temp (°F)
–1	RF	MS Connector	350
–2	MAG	MS Connector	350
–3	MAG	Leads EP	350
–5	RF	Leads EP	350
–6	MAG	MS Connector	750
–7	MAG	MS Connector EP	750
S8	RF (F & P)	MS Connector	350
–L	RF	MS Connector	750
–M	RF	NPT Threaded	750
–U	MAG	MS Connector	350
–X	RF	MS Connector	350
PP	MAG	Leads	350
SS	RF	Leads	350
TT	MAG	Leads/ Threaded Connection	350
XX	RF	Leads/ Threaded Connection	350
S1	MAG, Amplified	MS Connector	185
S2	MAG, Amplified	Leads	185
S3	MAG, Amplified	NPT Threaded	185
S4	RF, Amplified	MS Connector	185
S5	RF, Amplified	Leads	185
S6	RF, Amplified	NPT Threaded	185
X3	MAG, QPS XP	Leads, Threaded conn	Ta 158
X5	RF, QPS XP	Leads, Threaded conn	Ta 158
R3	MAG/RTD, QPS XP	Leads, Threaded conn	Ta 158
R5	RF/RTD, QPS XP	Leads, Threaded conn	Ta 158

jjj Special Code

Special meter configurations will not be addressed in this manual. Please contact the factory for a description of the special code.

Appendix B Declaration of Conformity

QPS Evaluation Services Inc
Testing, Certification and Field Evaluation Body
Accredited in Canada, the USA, and Internationally

File
LR 1275

CERTIFICATE OF COMPLIANCE
(ISO TYPE 3 CERTIFICATION SYSTEM)

Issued to	FTI Flow Technology Inc.
Address	8930 South Beck Ave. Suite 107 Tempe, AZ 85284 USA
Project Number	**LR 1275-1**
Product	Flow Meters (Transmitters with pickoff sensors)
Model Number	LA-*-*-***F-*** or LAT-*-**-***F-*** or ID-*-***-*** LA-*-*-**F1-*** or LAT-*-**-***F1-***
Ratings	Class I, Div 1, Group BCD, T6/T5 Ex d IIC T6/T5 Class I, Zone 1, AEx d IIC T6/T5 Tamb = -40°C to +70°C/+85°C V= 10 – 32 Vdc; Imax= 110 – 200 mA
Applicable Standards	CAN/CSA 60079-0: 2011, CAN/CSA 60079-1: 2011, CSA C22.2 No. 30: 1986, CSA C22.2 No. 142: 1987 UL 1203 4th ed., UL 508 17th ed., ISA/ANSI 60079-0: 2009, ISA/ANSI 60079-1: 2009
Model Number	LA-*-*-***9-*** or LAT-*-**-***9-***
Ratings	Class I, Div 1, Groups ABCD, T6/T5 Tamb = -40°C to +70°C/+85°C V= 10 – 32 Vdc; Imax= 110 – 200 mA
Applicable Standards	CSA C22.2 No. 30: 1986, CSA C22.2 No. 142: 1987 UL 1203 4th ed., UL 508 17th ed.
Factory/Manufacturing Location	Same as Above

Statement of Compliance: The products identified in this Certificate and described in the Report covered under the above referenced project number have been investigated and found to be in compliance with the relevant requirements of the above referenced standards. As such, they are eligible to bear the QPS Certification Mark shown below, in accordance with the provisions of QPS's Service Agreement.

CERTIFIED
ELECTRICAL SAFETY

Issued By: **Rob Kohuch, P. Eng.**
Senior Engineer, Hazardous Locations

Signature: Rob Kohuch Date: July 23, 2013

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