INSTALLATION & OPERATION MANUAL

This document contains the recommended installation, operation and maintenance regimen authorized and approved by Turbines, Inc., the manufacturer of the referenced equipment. No substitutions of specified components, improper handling or installation procedures, or use that is abusive or outside the specified range or capability specifications of the referenced equipment is permitted hereunder, and may, if evident or present, serve to void any warranties that might otherwise be operative or effective.

In the event installers or end users require additional assistance and/or clarification in any respect, contact the manufacturer at the address indicated below. Technical questions must be accompanied by proper product model number and serial number of subject equipment.

LF SERIES
LOW FLOW TURBINE METER

DOCUMENT NUMBER: LF-MANUAL REV-A

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Introduction

This document is the ***Installation, Operation, and Maintenance Manual*** pertaining to the Turbines, Inc. Low Flow Series Liquid Turbine Meter. This manual will provide all information necessary to insure a successful metering installation.

Users unfamiliar with this equipment are strongly recommended to thoroughly familiarize themselves with the contents of this manual.

If you require further information or clarification, please contact an applications specialist at Turbines, Inc. Be sure to have the model and serial number of the subject equipment ready when you call or contact us via e-mail.

WARNING: GAS AND LIQUID TURBINE FLOW METERS ARE NOT INTERCHANGEABLE. SEVERE DAMAGE TO THE EQUIPMENT MAY RESULT.

Thank you for choosing Turbines, Inc. for your equipment needs.

Table of Contents

Description of the Equipment

LF SERIES PRINCIPLE OF OPERATION

The Turbines, Inc. Low Flow Series Turbine Meter is a highly accurate volumetric flow measurement device designed to handle a broad range of line fluids. The flow meter consists of a magnetic rotor that is freely suspended in the fluid stream. An internal orifice directs the fluid past the rotor causing it to rotate at an angular velocity proportional to the fluid velocity (Figure 1). A magnetic pickup coil is positioned above the rotor. As the rotor rotates, each rotor blades pass though the magnetic field produced by the pickup coil, generating an electrical pulse. Each pulse represents a discrete volume of fluid. The pulse frequency represents the flow rate, and the accumulated pulses represent the total volume of flow.

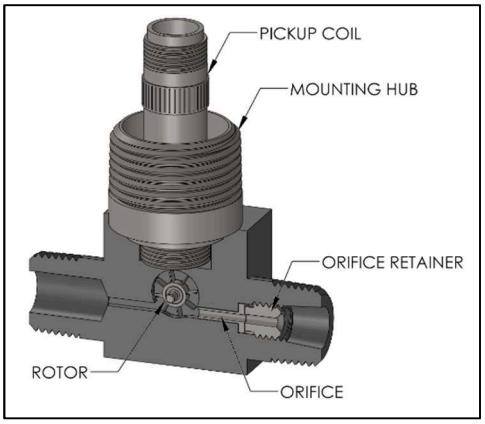

Figure 1

The LF Series Flow Meter can be configured with a variety of end arrangements including NPT, flanged, AN flare, or other means specified by the customer. The basic operating principles governing the installation, operation and maintenance remain essentially the same.

CALIBRATION AND K-FACTOR

Every turbine flow meter manufactured by Turbines, Inc. is factory calibrated in order to provide a unique K-factor. The K- factor provided with each meter is the reference value used to configure the accompanying flow monitor in order to achieve the specified accuracy in service.

The unique K-factor is an expression of the number of output pulses recorded by the pickup coil per unit of volume flow passing through the meter.

Installation of the Equipment

Various elements that must be considered in order to obtain a proper turbine flow meter installation are provided in this section.

PRE-INSTALLATION INSPECTION

The Turbines, Inc. LF Series Flow Meter is a high-quality measuring instrument capable of providing high precision metering performance over an extended period of time. It should be treated with care and not subjected to rough or abusive handling.

Unpack the flow meter from the packaging carefully and verify the information on the packing list for Model Number and Serial Number. Remove the end-fitting protectors from the turbine meter housing. The turbine meter should be inspected to verify that no damage, either external or concealed has been sustained during transit. Insure that the internal parts are clean and completely free of any packing materials, debris or foreign matter. The rotor should spin freely.

DO NOT USE HIGH PRESSURE AIR TO CLEAN OR TEST ROTOR FOR ROTATION. THIS MAY DAMAGE THE FLOW METER.

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Immediately report any visible damage to the seller. Do not discard the packaging materials in the event damage claim and/or product return is indicated.

Upon confirming that the flow meter is in good condition and free of any damage, replace the end-fitting protectors and return the meter to its original packing if the intention is to the store the unit until subsequent installation.

METER RUN ARRANGEMENT

Turbines, Inc. recommends the following flow metering piping configuration to obtain optimum metering performance (Figure 2). This includes a strainer upstream of the meter along with a control valve downstream.

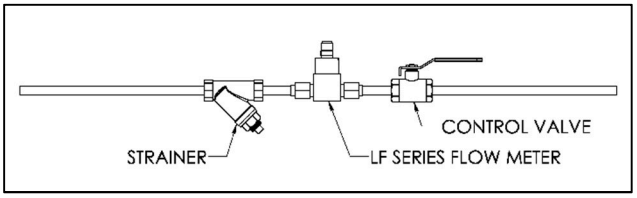

Figure 2

The purpose of the strainer is to protect the turbine flow meter from rotor damage by particulate matter in the line fluid. The recommended strainer size is 100 mesh for the LF Series Flow Meter.

The control valve will permit the adjustment of flow rate as well as apply the proper amount of back pressure for the turbine meter.

GENERAL PIPING CONSIDERATIONS

Meter By-Pass - When possible, it is advisable to include a valved by-pass around the "metering location" (Figure 3). This foresight will allow the turbine flow meter to be removed without interrupting the operation of the line.

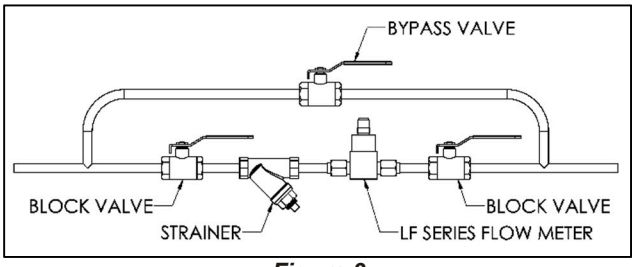

Figure 3

Line Purge - In a new or revised piping system, the line should be flushed prior to the installation of the turbine flow meter to minimize damage from foreign materials otherwise present in the line.

Air-Bleed - In liquid turbine applications, air should be bled from the line fluid prior to start up.

METER INSTALLATION

Meter Position- The LF Series Flow Meters are calibrated horizontally, with the pickup coil in the vertical position. To achieve the best correlation of calibration conditions to installed conditions, it is recommended that the meter is installed in the same (horizontal) orientation. Meters may, however, be operated in any orientation.

Flow Direction- All Turbines, Inc. LF Series Flow Meters are calibrated in the direction indicated by the flow arrow inscribed on the meter housing. The meter must be installed in the direction indicated by the flow arrow to ensure accurate and reliable operation.

Meter Location- When intermittent flow conditions are anticipated, the flow meter should not be mounted at the lowest point of the piping system. Accumulation of sedimentary deposits or congealing of susceptible fluids may occur at this point. The consequences may include reduced meter performance or damage to the meter internal components.

The meter should be installed in such a way that it remains full of line fluid even when no flow occurs. If a meter is left in a line that is partially or fully drained, bearing corrosion may occur. If feasible, the turbine meter should be removed, cleaned and properly stored when out of service for any length of time.

Tolerance to Electrical Interference-In order to obtain optimum electrical signal output, consideration must be given to the isolation of the turbine flow meter from any source of ambient electrical interference such as nearby motors, transformers, or high voltage power transmission lines.

Maximum Allowable Working Pressure (MAWP) – The maximum safe working pressure of the turbine flow meter is determined by the meter size and type of end connection. Consult the factory for specifications for your specific meter.

System Pressure- A minimum operating pressure should be maintained to reduce the possibility that two-phase flow may occur within the flow meter. The minimum operating pressure is a function of the line fluid vapor pressure and the presence of other undissolved gases. Maintaining the proper back pressure serves to prevent cavitation and fluid separation.

Calculation of the required back pressure for liquid line fluid applications is calculated as follows:

$$\boldsymbol{BP = (2 * \Delta P) + (1.25 * VP)}$$

where: $\boldsymbol{BP = Back\ Pressure(psig)}$
$\boldsymbol{\Delta P = Meter\ Pressue\ Drop\ @Max\ Flow(psig)}$
$\boldsymbol{VP = Fluid\ Vapor\ Pressure\ @Max\ Temp(psia)}$

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PICKUP COIL INSTALLATION

Pickup coils should be inserted into the threaded hub of the turbine flow meter, with the electronic connector end of the pickup coil facing out. This component should be finger tightened to approximately 4 in-lb.

Pickup coils for Turbines, Inc. Flow Meters are designed to mate with a two pin MS3106A-10SL-4S style connector.

Precaution should be taken when installing or removing the pickup coil from the turbine flow meter. Turbines, Inc. warranty does not cover physical damage to the coil.

The following must be observed to obtain proper operating performance:

Use a twisted and shielded cable (Belden 8761 or equivalent) to carry the signal. The shield should only be connected at one end. This will prevent a ground loop.

Do not mount the meter/pickup close to electrical noise generating equipment (motors, relays, etc.)

The conduit for the pickup cable must not be shared with other service(s).

Operation of the Equipment

Proper performance of the equipment is dependent upon correct installation and proper operating procedures. The operating procedures described below are necessary and must be carefully observed.

OVER RANGE

The greatest hazard to any turbine flow meter is over ranging of the meter. If the flow rate present through the meter exceeds the specified flow range for the meter, the meter is said to be “over ranged.”

When over ranging occurs, the performance of the turbine meter will generally remain linear. However, the pressure drop will increase and the angular velocity of the rotor will exceed its design limits, quite likely resulting in permanent damage due to over speeding of the bearings.

In liquid applications, over speed usually occurs during startup when air is present in the metering line. Air should be bled from meter line prior to a startup operation to prevent over ranging.

UNDER RANGE

As suggested by the nomenclature, under ranging is defined as operating the turbine flow meter below the minimum flow rate for which the meter is rated. While this will not cause physical damage to the equipment, operating beneath the minimum rated range limit of a turbine flow meter will cause the performance to become non-linear.

LIQUID FLOW CHARACTERISTICS

Each LF Series flow meter has a unique k-factor, as derived by calibration wherein a known volume of liquid is passed through the meter in a known span of time.

Ideally, the k-factor would remain constant across the entire range of the flow meter, but in reality, the k-factor changes slightly over the flow range. This variation of the k-factor across the range is referred to as meter linearity. Conventional metering systems use an average k-factor over the flow range to calculate flow rate or total. This technique results in an error approximately equal to the linearity error of the flow meter. This error can be significantly reduced through an electronic technique called linearization.

Linearization is accomplished by utilizing a meter factor curve rather than an average k-factor. The meter factor curve is developed by proving the flow meter at various flow rates and determining the k-factor at each flow rate.

The LF Series flow meter can be combined with electronics that have linearization capabilities to track the flow rate within ±0.25% of reading.

If the application line fluid differs from water (the calibration medium) the k-factor provided with the turbine flow meter may not accurately reflect the actual performance that will obtain. In order to achieve high accuracy in connection with given non-water liquid installation, it is recommended that the turbine meter be proved in place.

Equipment Specifications

PERFORMANCE SPECIFICATIONS

Repeatability:	±0.25% of reading
Temperature Range:	-70^{0}F to 450^{0}F w/ standard coil

MATERIALS OF CONSTRUCTION

Turbines, Inc. offers the LF Series Flow Meter with the following standard material configuration: Optional materials of construction are available, consult factory.

Meter Body and Retainer:	316 Stainless Steel
Bearing Cup:	316 Stainless Steel
Shaft:	316 Stainless Steel
Orifice and Orifice Retainer:	316 Stainless Steel
Rotor:	17-4 PH Stainless Steel
Ball Bearing:	440C Stainless Steel
O-Ring:	Buna-N

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PICKUP COILS

The following standard pickup coils are available for LF Series Flow Meters:

Magnetic Pickup Coil: produces a low-level AC sine wave output and requires an amplifier to convert the signal to 0 to 10-volt peak to peak pulse signal suitable for common process instrumentation.

Modulated Carrier (RF) Pickup Coil: pickup has the required amplifier built into the pickup producing a 0 to 10-volt peak to peak pulse.

CALIBRATION

Turbines, Inc. offers the following calibration options for LF Series Flow Meters. The selected option must be specified at the time of order placement.

Standard Calibration: A standard calibration consists of 20 data points covering the stated flow range using water as the line fluid. All Turbines, Inc. LF Series flow meters are factory calibrated based on this calibration procedure in order to determine the applicable k-factor.

Non-Standard Calibration: For an additional charge, Turbines, Inc. offers custom calibrations upon request. Options include additional data points, customer defined flow range, or alternative calibration fluids.

Turbines, Inc. also offers periodic re-certification and calibration of turbine flow meters. Contact the company for additional information or instructions on how to obtain calibration services.

FLOW MONITORS-TOTALIZERS

Turbines, Inc. offers several proprietary flow monitor/totalizer units as well as a number of OEM units. Operation and maintenance literature for these units are provided separately.

Generally, monitor/totalizers offer Nema 4X enclosures with LCD read-out configured to units of measure suitable to the user's application. Such units can be directly mounted onto the hub of the turbine flow meter, or remote mounted using additional cable set. Local indication can be augmented by the addition of 4 - 20 mA output features.

Options include: explosion proof, intrinsically safe design, as well as certification to various industry standards depending upon application requirements.

Monitor/totalizer equipment can be expanded to handle batching, control, reporting, and other functions. Consult factory for further information and applications support.

Operating Limitations Notes

INSTALLATION

To achieve stated accuracy, the flow directional arrow on the body of the turbine flow meter must coincide with the direction of flow of the process line fluid.

TEMPERATURE

Do not subject the meter electronics (monitors/totalizers, etc.) to temperatures in excess of 160 ^{0}F. Do not subject the meter or electronics to temperatures below the freezing point of the process line fluid.

Unless a high temperature pickup coil is selected and secondary electronics are remotely mounted, temperatures exceeding the rated maximum may cause irreparable damage.

Lower temperatures can cause the electronic display(s) to cease functioning until acceptable temperature is restored.

PRESSURE

Never exceed the pressure rating of the turbine meter. Excessive pressure may result in the rupture or explosion of the flow element.

When pressurizing an empty line, gradually increase pressure incrementally until line pressure is achieved. Line pressure must be compliant with rated pressure of the flow element(s). Do not quickly approach full pressurization.

Damage to the turbine flow meter due to failure to comply with the foregoing shall immediately void any warranty otherwise operative.

WARNING: DO NOT REMOVE METER FROM A PRESSURIZED LINE.

CORROSION

The standard design for Turbines, Inc. LF Series Flow Meters consists of stainless steel internal components. It is essential that the user confirms that these materials are compatible with the process line fluid. Incompatible process line fluids may cause premature deterioration of meter components, and lead to inaccurate meter registration and eventual failure.

If the compatibility of an intended process line fluid is unknown, contact the factory for application assistance. Alternate and/or non-standard materials selections can be utilized resulting in flow elements that will be fully compatible with process fluids.

PULSATING FLOW ISSUES

Severe pulsation of flow will affect the accuracy of the flow meter, and shorten the useful service life of the equipment.

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VIBRATION AND SHOCK

Severe mechanical shock and/or vibration may decrease the useful service life of the meter. Excessive mechanical shock and/or vibration may cause structural failure of the connection between meter and secondary equipment (monitor/totalizer).

CONTROL OR THROTTLING VALVE(S)

Throttling valves should be installed downstream of the turbine flow meter only.

FILTRATION

A strainer should be installed upstream of the turbine flow meter. Suspended particles and/or foreign matter may damage rotor and/or other internal components. The recommended strainer size is 100 mesh for the LF Series Flow Meter.

LINE FLUID-FLOW CONDITIONS

Never introduce air or gaseous substances or flow into a liquid turbine flow meter.

The turbine flow meter should be operated within the specified rated range of the meter. Don not run below the minimum limit of the flow range as it will result in inaccuracies. Do not exceed the maximum limit of the flow range as this may damage the turbine flow meter.

Equipment Maintenance

By observing proper maintenance procedures, the useful service life of the LF Series flow meter can be prolonged.

PERIODIC MAINTENANCE

Maintenance for the LF Series Flow Meter consists of periodic inspection of the internal components; rotor, shaft, and bearings. Excessive wear, physical damage, or clogging must be identified promptly. Should evidence of such conditions be present, it is recommended that the meter be returned to the factory to be rebuilt.

INSPECTION

In order to inspect or clean the turbine flow meter, the internal components must be removed. Detailed disassembly and assembly instructions are included below.

As components are removed from the housing, inspect each part for visible corrosion, wear, or damage. A severely worn bearing may allow the rotor to contact the housing. This condition will immediately affect the performance of the meter and, if left uncorrected, permanently damage the meter housing.

One of the primary sources of turbine meter failure is the bearing wear caused by foreign material build-up. A large number of process line fluids will leave residue that severely degrades the free motion of the rotor, resulting in permanent damage.

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Disassembly and Assembly

An exploded view of the internal components is provided in Figure 4. Additional assistance, if required, may be obtained by contacting the factory.

DISASSEMBLY

Prior to removing any flow element from the process line, VERIFY PRESSURE HAS BEEN RELIEVED FROM THE LINE and that no flow is present. Make sure that all power to any connected secondary device(s) has been disconnected. Remove any connections to the Pickup Coil.

Step 1
Remove **Pickup Coil** from the meter **Housing**.

Step 2
Remove **Retainer** from the **Housing** with a large flat bladed screwdriver.

Step 3
Remove the **Rotor**, **Bearings**, **Bearing Cup** (LF020-LF090 models only) and **Shaft** (LF100-LF175 models only) from the **Housing**.

Step 4
For LF020-LF090 models, remove the **Orifice Retainer** and **Orifice** from the **Housing** by unscrewing the **Orifice Retainer** with a flat blade screwdriver.

Thoroughly inspect all internal components for evidence of wear, degradation, corrosion, foreign debris entanglement, and physical damage. Nicks, dents, misalignment of blades, or build up on the Rotor can cause the turbine flow meter to register incorrectly. If any components show signs of wear or damage, return the meter to a Turbines, Inc. service office for repair and recalibration.

RE-ASSEMBLY

Internal components must be reassembled in the same orientation as they were removed.

Step 1 (LF020-LF090)
Install the **Orifice** and secure in place by threading the **Orifice Retainer** into the upstream bore of the **Housing**.

Step 2
Install **Bearing Cup** into the internal cavity of the **Housing**.

Step 3
Place a **Bearing** on each end of the **Rotor** and guide **Rotor** assembly into the **Housing**. Verify that the inboard **Bearing** fits into the bore of the **Bearing Cup**.

Step 4
Install **O-Ring** onto the groove of the **Retainer** and thread the **Retainer** into the **Housing** to secure the internal components.

Step 5
Thread **Pickup Coil** into meter **Housing.**

Step 1 (LF100-LF175)
Place a **Bearing** in each **Rotor** bore and Slide **Rotor** and **Bearing** assembly over the **Shaft**.

Step 2
Guide the **Rotor** and **Shaft** assembly into the internal cavity of the **Housing**. Verify that the **Shaft** fits into the bore located at the back of the **Housing** cavity.

Step 3
Install **O-Ring** onto the groove of the **Retainer** and thread the **Retainer** into the **Housing** to secure the internal components.

Step 4
Thread **Pickup Coil** into meter **Housing**.

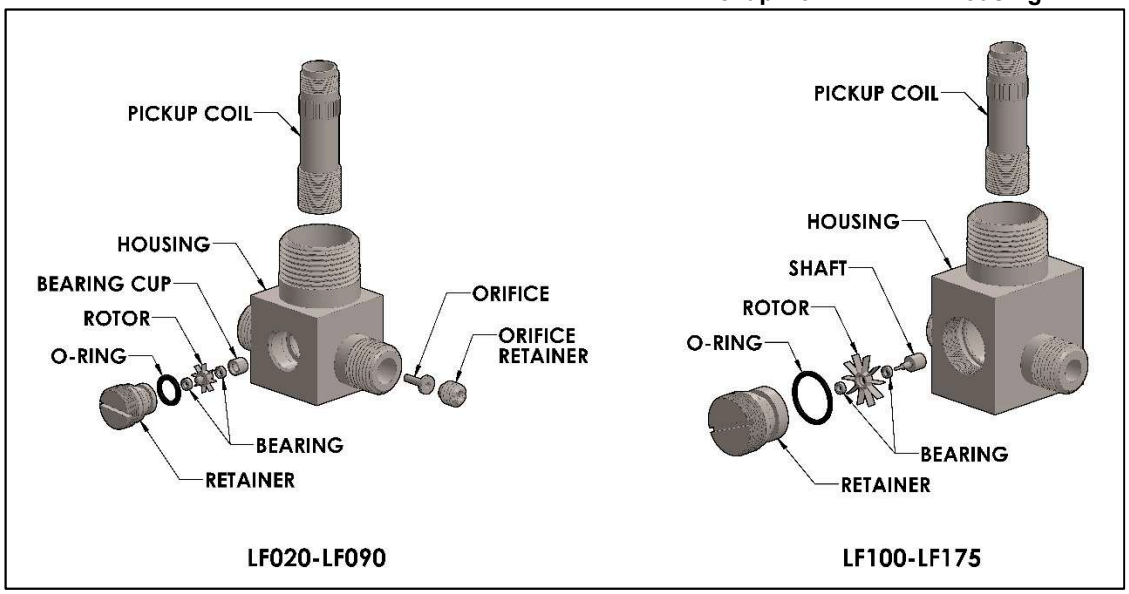

Figure 4

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