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.

GAS TURBINE SERIES FLOW METER

DOCUMENT NUMBER: GAS TURBINE-MANUAL REV-B

Turbines, Inc.™

PO BOX 933 Highway 283 North - Altus, OK U.S.A. 73522
Ph:580-477-3071 Fax:580-477-3071 www.TurbinesIncorporated.com

Introduction

This document is the ***Installation, Operation, and Maintenance Manual*** pertaining to the Turbines, Inc. Gas Turbine Flow 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.

Please do not hesitate to contact an applications specialist at Turbines, Inc. should further information or clarification be necessary. 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

BASIC TURBINE METER PRINCIPLE OF OPERATION

The Turbines, Inc. Gas Turbine Flow Meter is a rugged, highly accurate volumetric flow measuring device designed to handle a broad range of gasses. The turbine flow meter consists of a magnetic rotor that is freely suspended in the flow stream. A magnetic pickup coil is positioned above the rotor. Fluid passing through the flow meter causes the rotor to rotate at an angular velocity proportional to the fluid velocity. 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 gas. The frequency of the pulses represents the flow rate and the accumulated pulses represent the total volume of flow.

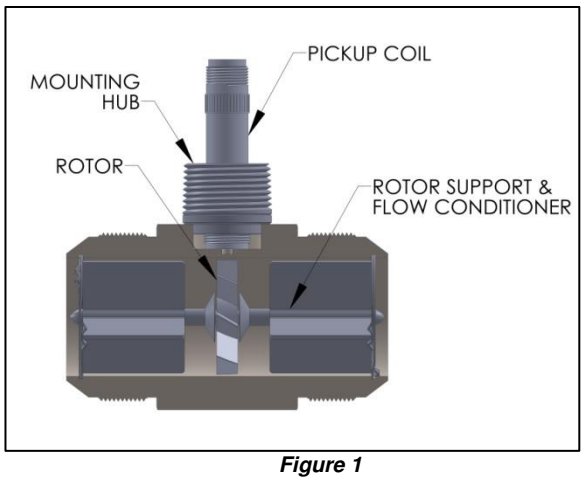

Figure 1

The Turbines, Inc. Gas Turbine Flow Meter can be configured with a variety of end arrangements including threaded, flanged, grooved, 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. Gas Turbine 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 turbine flow meter from the packaging carefully, 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 turbine 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

The turbine meter is sensitive to velocity profile disturbances in the flow stream. 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 to obtain an optimized velocity profile. (See Figure 2)

The upstream section may also include straightening vanes or other flow conditioners as required by the installation. The presence of a major flow disturbance such as pumps, valves or elbows may require longer straighter 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.

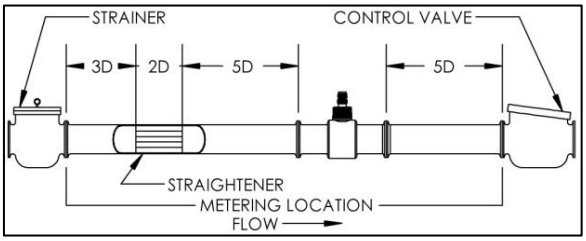

Figure 2

Figure 2 also illustrate the arrangement of the basket strainer upstream of the meter along with a control valve downstream. The purpose of the strainer is to protect the turbine flow meter from rotor damage by large foreign objects in the line fluid.

The control valve will permit the adjustment of flow rate.

GENERAL PIPING CONSIDERATIONS

As explained in earlier sections, the line fluid moving through the flow meter causes the rotor to rotate. Thus the rotational velocity of the rotor is a function of the line fluid velocity and the blade angle engagement. Since the calibration is performed under controlled flow conditions, swirl present in the line fluid stream can effectively change the angle of engagement between the fluid stream and the rotor blades and therefore result in a deviation from the calibrated k-factor supplied with the turbine meter. Proper installation as described elsewhere herein minimizes the harmful effects of fluid swirl.

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

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.

METER INSTALLATION

Meter Position- The turbine flow meter is calibrated horizontally. Therefore, to achieve the best correlation of calibration conditions to installed conditions, it is recommended that the turbine meter is installed in the same (horizontal) orientation. Meters may, however, be operated in any position.

Flow Direction- Although all Turbines, Inc. Gas Turbine Flow Meters are bi-directional, they are calibrated in the direction indicated by the flow arrow inscribed on the meter housing.

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 the connecting end fittings clamps. Consult the factory for specifications for your specific meter.

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. For pick-up coils with a lock nut, the lock nut should be tightened to approximately 25 lb-in.

Pickup coils for Turbines, Inc. Turbine Flow Meters are designed to mate with a two pin MS3106A-10SL-4S 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 ***magnetic pickup coil*** produces a low level sine wave output that ranges from 10mV to several volts peak-to-peak. A pulse amplifier may be required to convert the pick-up coil low level signal to a 10 V peak-to-peak pulse signal suitable for process instrumentation. Typical resistance of a magnetic pick-up coil is 1875 Ω ±20%.

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 to the ground contained inside the electronic instrument to prevent any ground-loop interference.

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

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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

In general, turbine flow meters remain linear when they are over ranged, and may not provide any indication that the instrument is being misused. The flow rate or output frequency should be monitored to insure maximum operating conditions is not exceeded. Under extreme conditions, the maximum operating flow rates can be exceeded for brief periods of time without meter damage. The maximum allowable over range capability is 150% of maximum flow.

UNDER RANGE

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

GAS FLOW CHARACTERISTICS

Accurate performance of gas turbine flow meters depend on a valid calibration that simulates the conditions in which the meter will operate. 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. Due to the nature of gases to be compressed, the volume of gas measured is dependent on the pressure and temperature as established by Boyle's and Charles' Law. Using this 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 Turbines, Inc. are 14.7 psia and 520 ºR (60 ºF) respectively.

The following equation is used to convert the actual volumetric flow rate (Q_A) in Actual Cubic Feet per Minute (ACFM) to the equivalent standard flow rate (Q_S) in Standard Cubic Feet per Minute (SCFM).

$$Q_S = Q_A * \left(\frac{P_A + 14.7}{14.7}\right) * \left(\frac{520}{T_A + 459.62}\right)$$

Where:
Q_S= Flow rate at standard condition (ft^3/min)
Q_A= Actual measured flow rate (ft^3/min)
P_A= Actual measured pressure upstream of meter (psig)
T_A= Actual measured temperature downstream of meter (ºF)

Equipment Specifications

PERFORMANCE SPECIFICATIONS

Accuracy & Linearity:	±1.0% of reading
Repeatability:	±0.1% of reading
Temperature Range:	-100ºF to 450ºF w/ standard coil

MATERIALS OF CONSTRUCTION

Turbines, Inc. offers the Gas Turbine Flow Meter line with the following standard material configuration:

Meter Body:	316 Stainless Steel
Rotor Support:	316 Stainless Steel
Shaft:	316 Stainless Steel
Rotor:	17-4 PH Stainless Steel
Bearing:	440C Stainless Steel Ball Bearing
Retaining Rings:	316 Stainless Steel

Optional materials of construction are available, consult factory.

PICKUP COILS

The following standard pickup coils are available:

100 Gauss Magnetic pickup coil to +450 ºF
(Standard for meters size 2" and smaller)

330 Gauss Magnetic pickup coil to +450 ºF
(Standard for meters size 3" and larger)

Optional pickup coil:

Magnetic pickup coil with preamplifier

STANDARD CALIBRATION

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

Standard Calibration: Gas calibrations at Turbines Inc. are performed using Nitrogen at ambient conditions. These conditions are typically 14.2 psia and 60 ºF. The standard calibration consists of 10 data points distributed over the normal range of the flow meter.

Non-Standard Calibration: Upon customers' request, Turbines, Inc. can calibrate gas flow meters at flow conditions that match the customer's application. Custom flow ranges and additional calibration points are also available. Additional calibration charges may apply.

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.

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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 ºF. 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. Gas Turbine 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 turbine flow meter, and shorten the useful service life of the equipment. Therefore piping and system components should be arranged to minimize pulsation entering the turbine meter. Pulsation should be kept below 10% of the current flow rate at the meter location.

WARNING: 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 SURGING DURING OPERATION MUST BE AVOIDED TO PREVENT OVER-SPEEDING.

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.

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.

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Equipment Maintenance

By observing proper maintenance procedures the useful service life of the Gas Turbine flow meter can be prolonged.

PERIODIC MAINTENANCE

Maintenance for Turbines, Inc. Gas Turbine Flow Meters consists of periodic inspection of the internal components; rotor supports, rotor, 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.

Complete sets of calibrated internal retro-fit kits are available if field repair and/or replacement is desired. Consult with factory for assistance.

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 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.

Disassembly and Assembly

An exploded view of the internal components is provided in Figure 3. Additional assistance, if required, may be obtained by contacting the factory.

DISASSEMBLY

Step 1
Prior to removing any flow element from the process line, VERIFY PRESSURE HAS BEEN RELIEVED FROM THE LINE and that no flow is present.

Step 2
Make sure that all power to any connected secondary device(s) has been disconnected. Remove any connections to the **Pickup Coil**. Remove **Pickup Coil** from the **Meter Housing**.

Step 3
Remove **Retaining Rings** from both ends of the **Meter Housing**.

Step 4
Remove **Upstream Rotor Support**, **Rotor**, and **Downstream Rotor Support** carefully by gently pushing entire assembly through the **Meter Housing**.

Step 5
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.

Step 6
If any components show signs of excessive wear, a factory calibrated replacement kit should be installed.

RE-ASSEMBLY

Step 1
Internal components must be reassembled in the same orientation as they were removed.

Step 2
Install a **Retaining Ring** into the upstream retaining ring groove in the **Meter Housing**.

Step 3
Install upstream and downstream **Bearings** into the **Rotor** bearing bores.

Step 4
Slide the **Rotor** and **Bearing** assembly onto the shaft of the **Upstream Rotor Support**. Check **Rotor** orientation by verifying the mark on the **Rotor** is facing the **Upstream Rotor Support**.

Step 5
Complete the internal assembly by mating the **Downstream Rotor Support** with the **Upstream Rotor Support**.

Step 6
Insert the internal assembly into the **Meter Housing** while aligning the **Upstream Rotor Support** with the **Anti-Rotation Humps** in the **Upstream Retaining Ring**.

Step 7
Install **Retaining Ring** the downstream retaining ring groove in the **Meter Housing**.

Step 8
Verify that the **Rotor** spins freely, without any disruption, bias or binding, and that the **Rotor Supports** do not rotate within the **Meter Housing**.

Step 9
Thread **Pickup Coil** into **Meter Housing**.

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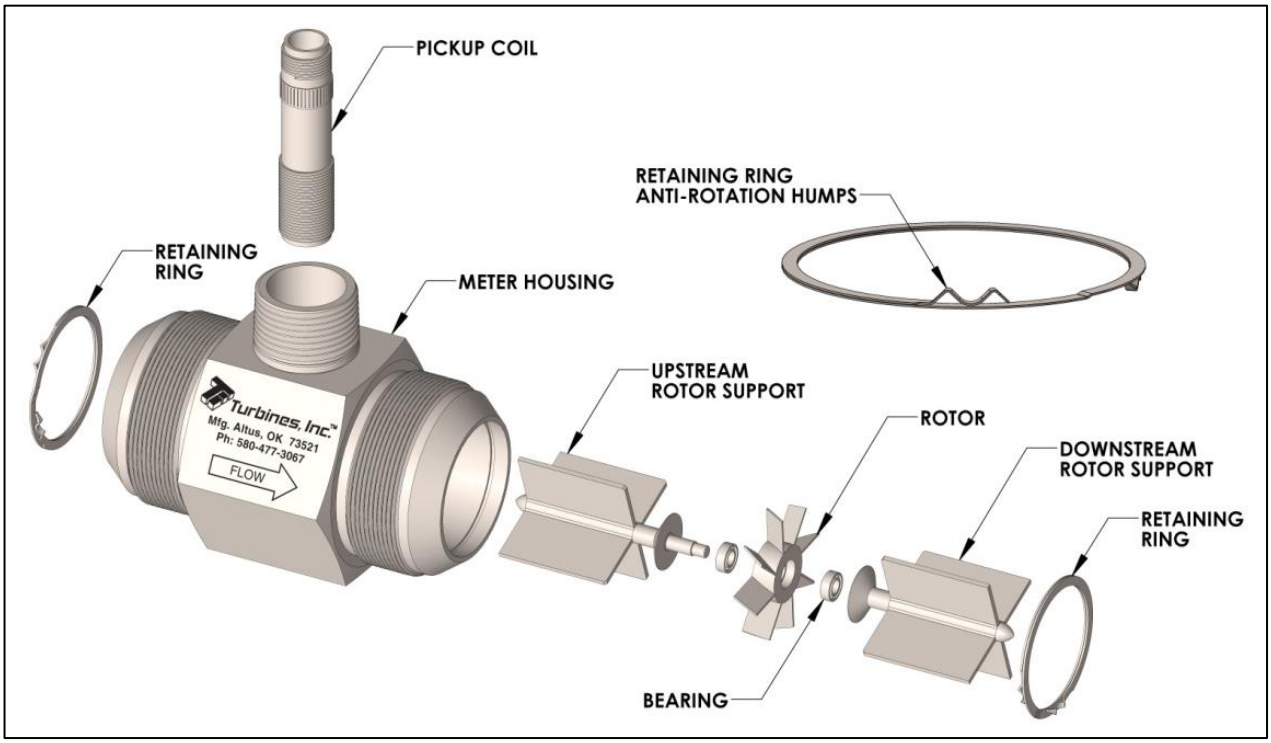

Figure 3

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