Turbine Flow Meter

B142 Gas QuikSert

Blancett
Turbine Flow Meters

Blancett®
RACINE, WI USA

FLOW

MODEL XXX-XXX
S/N XXXXXXXX
CI I DIV 1 GP C,D
MAX. WP/T
2220 PSI
15.3 MPa
350°F
SINGLE SEAL

21503S
W/ B111113 INSTALLED
Vmax = 10V Imax = 3mA
Ci = 0µF Li = 1.65H

CLASSIFIED
MET
ELECTRICAL SAFETY
E112860

Badger Meter

User Manual

CONTENTS

INTRODUCTION

The B142 gas turbine flow meter is designed with wear resistant moving parts to provide a long service life with very low maintenance. Should the B142 meter be damaged, the turbine is easily replaced in the field with a drop-in repair kit rather than replacing the entire flow meter (see *Replacing Turbine Cartridges on page 15* for repair kit information). Repair parts are constructed of stainless steel alloy and tungsten carbide.

THEORY OF OPERATION

Gas moving through the turbine flow meter causes the rotor to turn at a speed proportional to the flow rate. The rotor blade cuts the magnetic field that surrounds the magnetic pickup, which in turn generates a frequency output signal that is directly proportional to the volumetric flow rate (see *Figure 1*). The signal is used to represent flow rate and/or totalization of a gas passing through the turbine flow meter and is always expressed as the number of electric pulses that the meter produces per cubic foot. This value, called the K factor, is constant over each flow meter's range and is unique to the meter.
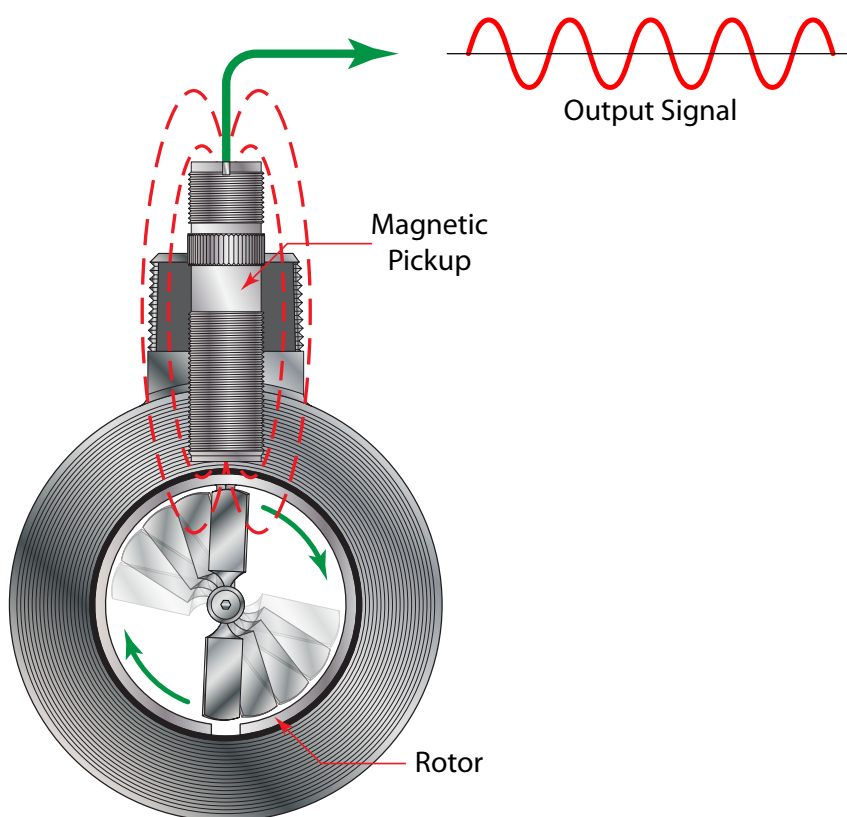

Output Signal

Magnetic Pickup
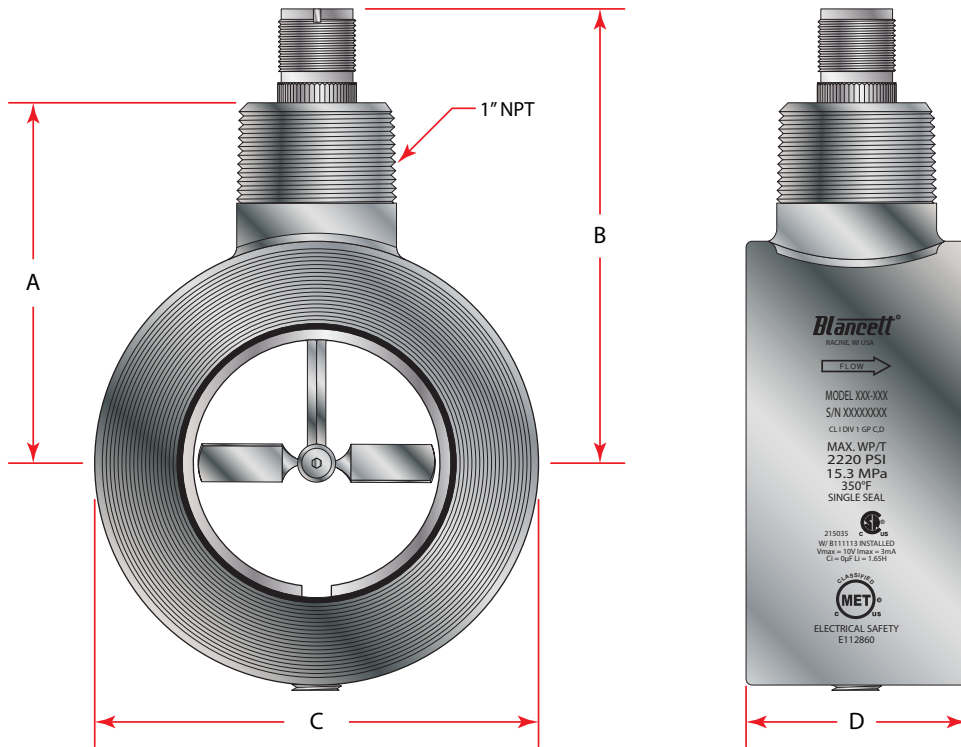
Rotor

Figure 1: B142 turbine flow meter

Figure 2: Dimensions

A	B	C	D
2.95 in. (74.9 mm)	3.12 in. (79.2 mm)	3.61 in. (92.0 mm)	1.80 in. (45.7 mm)
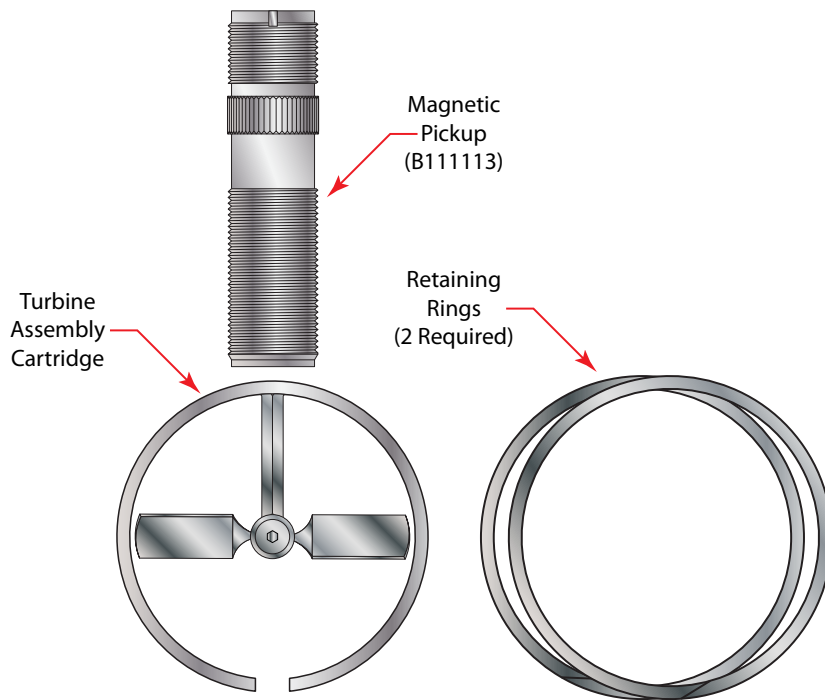
Figure 3: Parts identification

SPECIFICATIONS

Physical	
Installation	Mounts between 2 inch ANSI raised face flanges. Horizontal or vertical mounting
Flow Range/Nominal K Factors	See pressure drop graphs
Low Range	7…70 acfm (10…100 mcfd)/365 pulses per acf (12,900 pulses per m^3)
Mid Range	14…210 acfm (20…300 mcfd)/190 pulses per acf (6710 pulses per m^3)
High Range	35…350 acfm (50…500 mcfd)/85 pulses per acf (3000 pulses per m^3)
Working Pressure	Vacuum to 2220 psig (15.3 MPa)
Pressure Drop	3 inches of water column (7.5 mbar) at maximum rated flow (dry air)
Pressure Port	1/8 inch NPTF (plugged)
Temperature	–40…330° F (–40…165° C)
Electrical	
Output Voltage	100 mVp-p minimum when used with Blancett B111113 magnetic pickup
Accuracy	
Linearity	± 2% of reading over the specified measurement range
Uncertainty	± 1% of reading (when calibration data is entered into an intelligent Blancett monitor/transmitter)
Repeatability	± 0.5%
Certifications	
Intrinsically Safe	Class I Division 1 Groups C, D
	Entity parameters with Blancett B111113 magnetic pickup installed for US and Canada. Complies with UL 913 and CSA 22.2 No. 157-92
	V_{max} = 10V
	I_{max} = 3 mA
	Ci = 0 µF
	Li = 1.65 H
Explosion Proof	Class I Division 1 Groups C, D. Complies with UL1203 and CSA C22.2 No. 30-M1986
Single Seal	Complies with ANSI/ISA 12.27.01-2003
Construction	
Body and Cartridge	316/316L stainless steel
Bearing Mounts	304 stainless steel
Set Screws – Pressure Port Plug	316 stainless steel
Bearings and Rotor Shaft	Tungsten carbide
Rotor	410 stainless steel
Connections	
Pickup	Mates with AN3106A-10SL
Conduit	1 in. NPT (25.4 mm)

INSTALLATION

Before installation, the flow meter should be checked internally for foreign material and to be sure that the rotor spins freely. Gas lines should also be cleared of all debris. The flow meter must be installed with the flow indication arrow, etched on the exterior of the meter body, pointing in the correct direction of flow. The preferred mounting orientation is to have the meter installed in horizontal piping, with the pickup facing upward. However, the meter will function in any position.

While the flow meter body and magnetic pickup are sold as separate items, in most instances they are ordered at the same time and come assembled from the factory. If the magnetic pickup was not ordered with the meter body or replacement of the magnetic pickup becomes necessary, all that is needed to install it is to thread the pickup into the pickup port until it is bottomed out. Finger tightening is all that is required for proper installation.

The gas that is to be measured must be free from any large particles that may obstruct the rotor from turning. If particles are present, a filter of at least 60 mesh (0.0092 clearance) should be installed upstream before operation of the flow meter.

The preferred plumbing setup is one containing a bypass line (see *Figure 3*) that allows for meter inspection and repair without interrupting flow. If a bypass line is not used, it is important that all control valves be located downstream of the flow meter (see *Figure 5*).
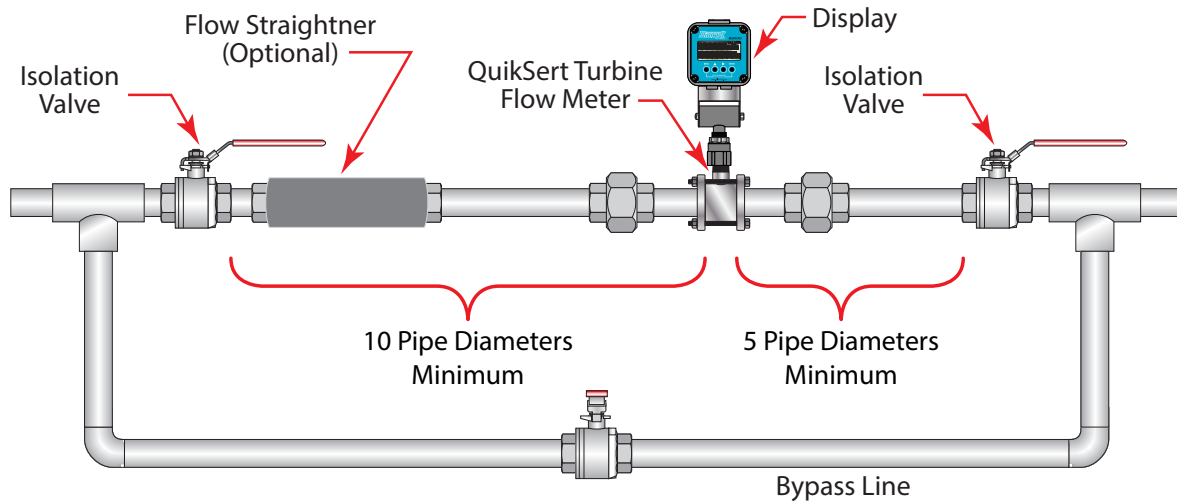

Figure 4: Bypass line installation

It is recommended that a minimum length, equal to ten (10) pipe diameters of straight pipe, be installed on the upstream side and five (5) diameters on the downstream side of the flow meter. Otherwise meter accuracy may be affected. Piping should be the same size as the flange size. If adequate straight runs of pipe are not available or if erratic flow readings are experienced, place a bundled-tube flow straightener upstream of the flow meter installation.
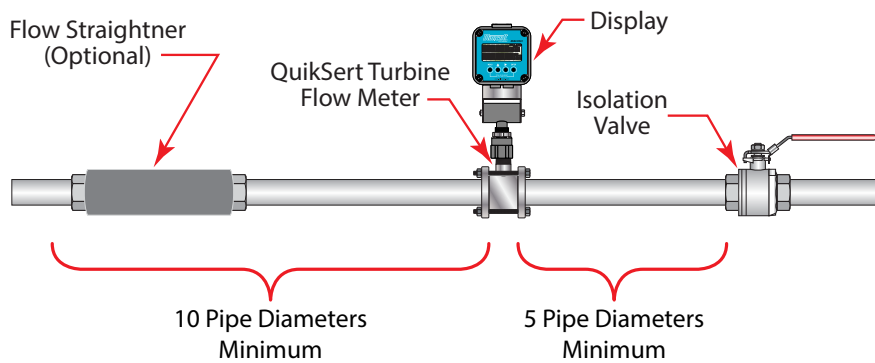

Figure 5: Installation without bypass line

Other Factors Affecting Performance

Do not locate the flow meter or connection cable close to electronic motors, transformers, sparking devices, high voltage lines, or place connecting cable in conduit with wires furnishing power for such devices. These devices can induce false signals in the flow meter coil or cable, causing the meter to read inaccurately.

Severe pulsation and/or severe mechanical vibration will affect accuracy and shorten the life of the meter. Steps should be taken to remedy these conditions if they are present.

NOTE: Incompatible gases will deteriorate internal parts and cause the meter to read inaccurately.

Mounting

The B142 turbine meter is supplied with two "centering rings" that make installation straightforward. Gaskets and either bolts or threaded rods supplied by the customer are also required. See *Figure 4*.

1.   Insert the bottom two bolts between the mounting flanges and install the nuts loosely.
2.   Place the centering rings on the outside diameter of the B142 meter and align the bolt notches.
3.   Place the centering rings with the B142 meter installed on the two bottom bolts between the flanges.
4.   Insert and center the face gaskets.
5.   Insert the remaining bolts and nuts.
6.   Tighten the nuts to the flange manufacturer's specifications.

If problems arise with the flow meter or monitor, consult the *Troubleshooting Guide on page 14*. If further problems arise, consult the factory. If the internal components of the turbine flow meter are damaged beyond repair, order replacement turbine cartridges.
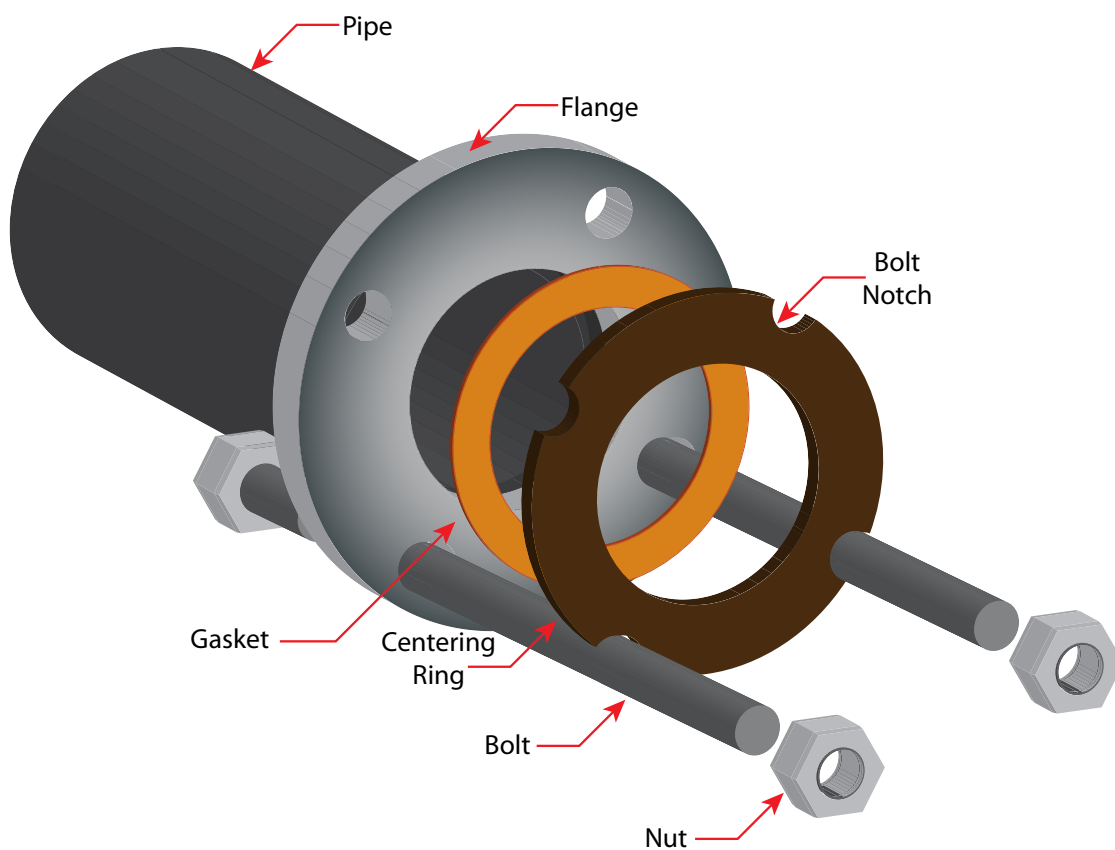

Figure 6: Installation using centering rings

Operational Startup

The following practices should be observed when installing and starting the meter.

⚠WARNING

MAKE SURE THAT GAS FLOW HAS BEEN SHUT OFF AND PRESSURE IN THE LINE RELEASED BEFORE ATTEMPTING TO INSTALL THE METER IN AN EXISTING SYSTEM.

1. After meter installation, close the isolation valves and open the bypass valve.
2. Open the upstream isolating valve slowly to eliminate hydraulic shock while charging the meter with gas. Open the valve to full open.
3. Open the downstream isolating valve to permit the meter to operate.
4. Close the bypass valve to a full off position.
5. Adjust the downstream valve to provide the required flow rate through the meter.

NOTE: The downstream valve may be used as a control valve.

CALIBRATION

The meter is calibrated on clean, dry air at the factory and tagged with a K factor (pulses per cubic foot). All attached electronics have been calibrated to match the flow meter's K factor. Ensure that the mating factory display is configured to the proper operating pressures and temperatures of your application. The B142 meter can be re-calibrated by any conventional meter proving processes used to calibrate standard meters.

The following graphs show how the capacities of the flow meters vary with pressure variations. Separate graphs are provided for high, medium and low flow ranges.
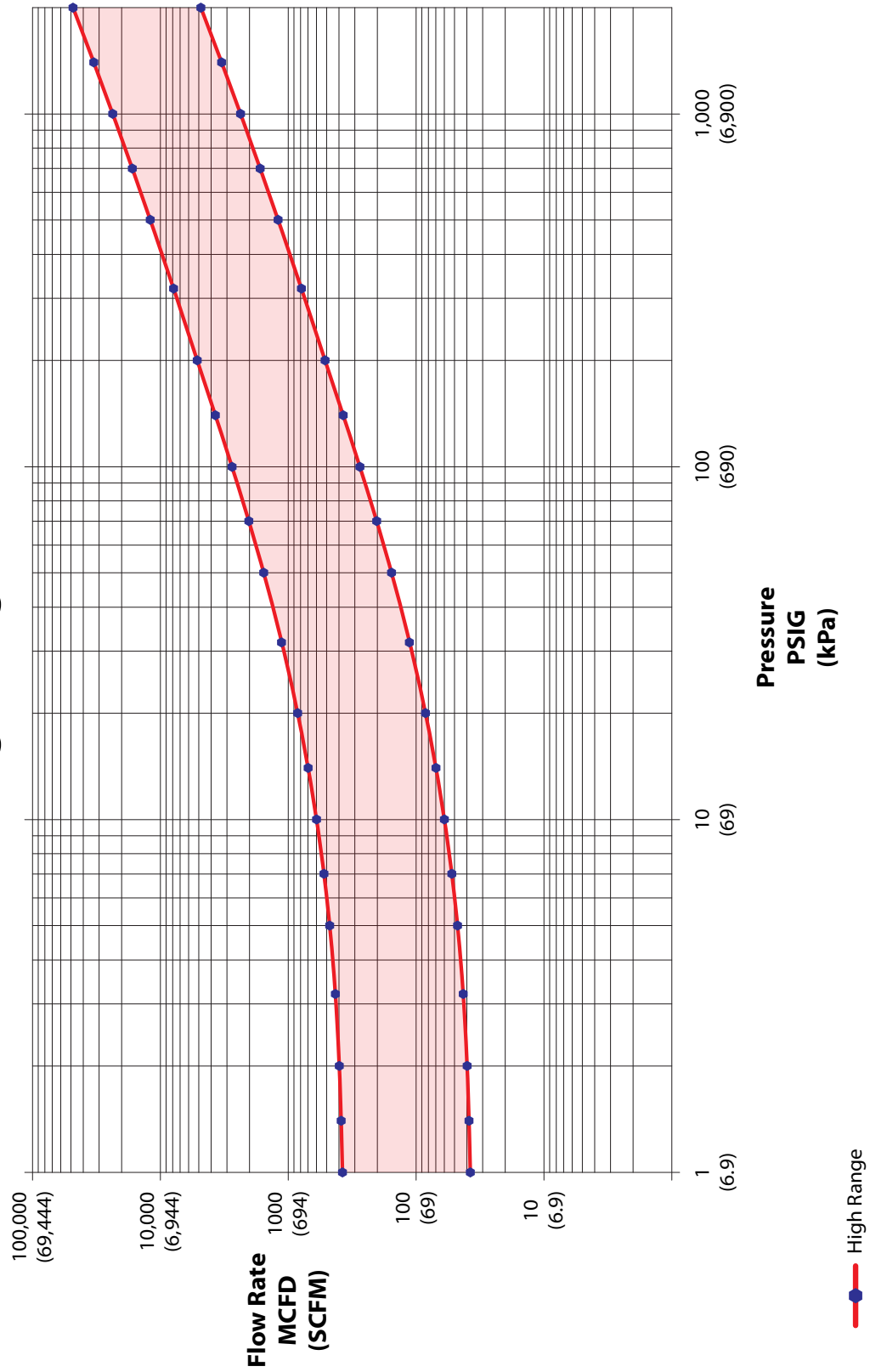
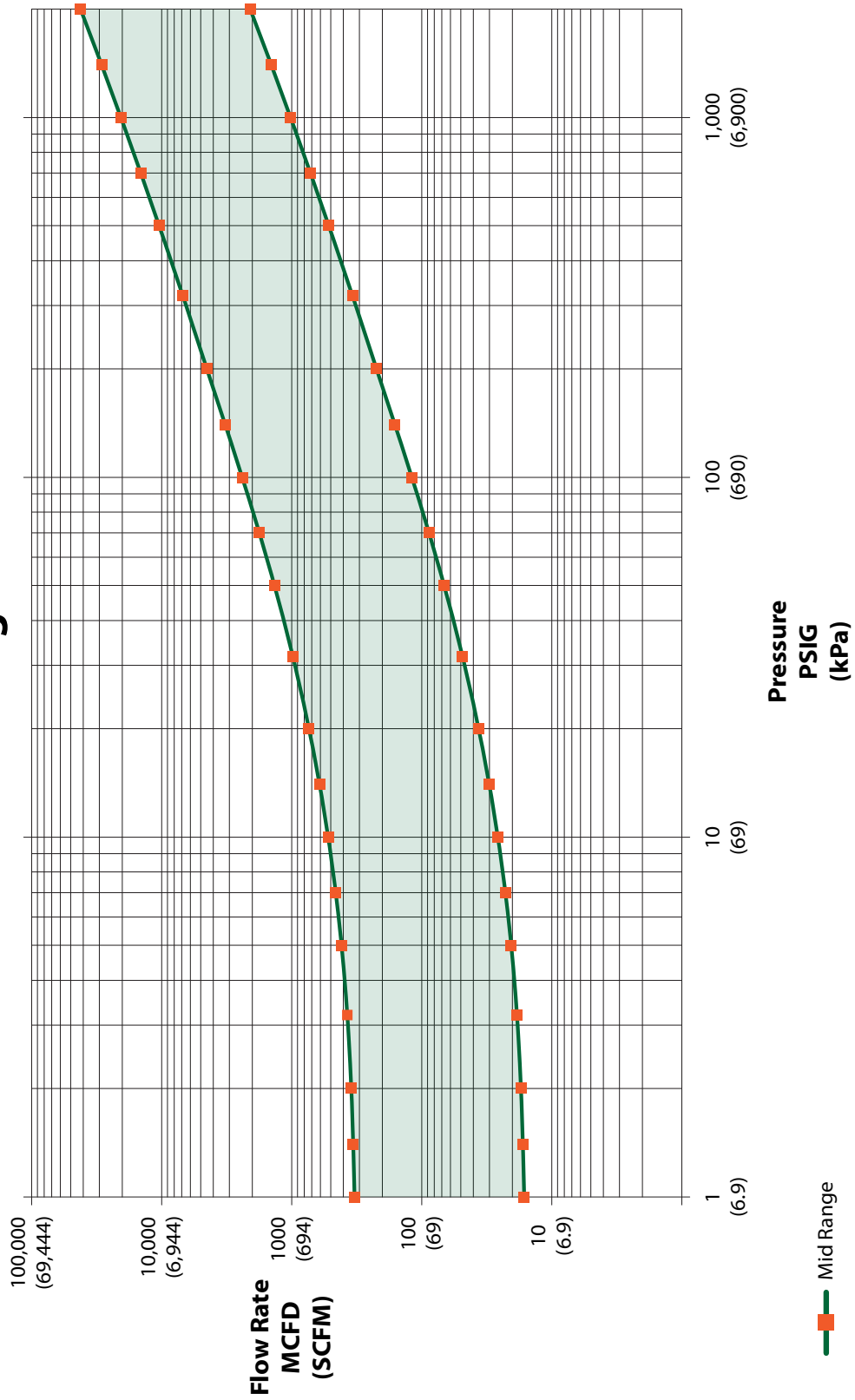*Figure 7: High range flow rates*

Figure 8: Mid range flow rates

**Measuring Range vs. System Pressure
Low Range**
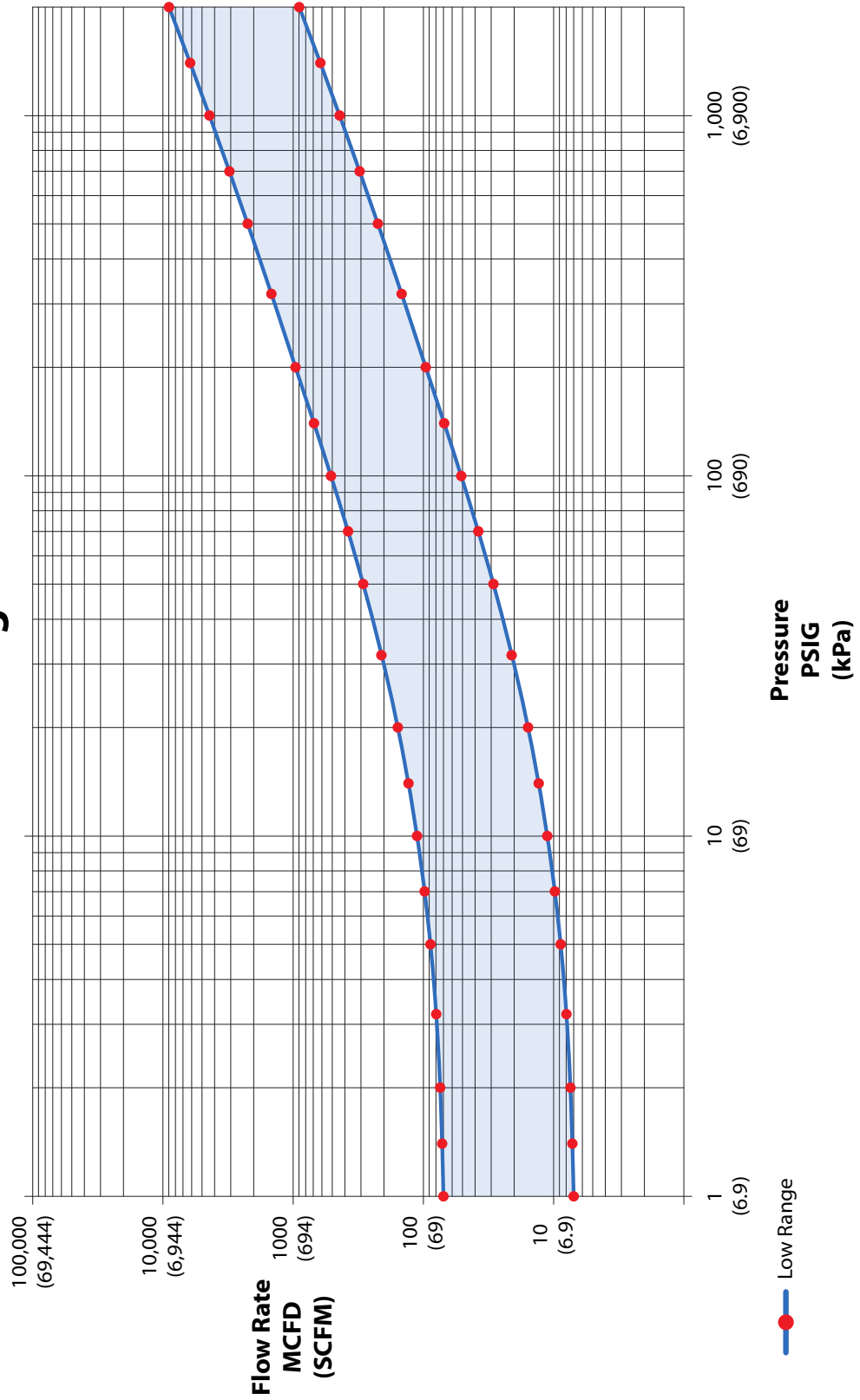
Figure 9: Low range flow rates

TROUBLESHOOTING GUIDE

Trouble	Possible Cause	Remedy
Meter indicates higher than actual rate	Incorrect K factor entry	Correct K factor
	Debris on rotor support	Clean meter
	Buildup of foreign material on meter bore	Clean meter
Meter indicates lower than actual flow rate	Incorrect K factor entry	Correct K factor
	Wrong magnetic pickup	Use only B111113 pickup
	Incorrect or missing pressure and/or temperature entries	Correct pressure and/or temperature entries
	Debris on rotor	Clean meter and add filter
	Worn bearing	Replace rotor and add filter
Erratic system indication, meter alone works well (remote monitor application only)	Ground loop in shielding	Ground shield one place only. Look for internal electronic instrument ground. Reroute cables away from electrical noise.
Indicator shows flow when shut off	Mechanical vibration causes rotor to oscillate without turning	Isolate meter
Erratic indication at low flow, good indication at high flow	Rotor has foreign material wrapped around it	Clean meter and add filter
No flow indication	Rotor not turning	Clean rotor or replace rotor cartridge
	Faulty pickup	Replace pickup
	Broken wire in cable between flow sensor and receiving electronics	Repair or replace cable
System works perfect, except indicates lower flow over entire range	Bypass flow, leak	Repair or replace bypass valves, or faulty solenoid valves

Table 1: Troubleshooting

NOMINAL K FACTOR VALUES

Gas		
Meter	**Flow Range**	**Nominal K factor**
Low	7…70 acfm (10…100 mcfd)	365
Medium	14…210 acfm (20…300 mcfd)	190
High	35…350 acfm (50…500 mcfd)	85

Table 2: Gas K factors

REPLACING TURBINE CARTRIDGES

If a turbine is damaged and it becomes necessary to service the meter, repairs are easily accomplished in the field using slide-in replacement cartridges.

Cartridge replacement kits come complete with the turbine cartridge and two retaining rings.

Size	Part Number
Low Flow Cartridge	B142-20L-Kit
Mid Flow Cartridge	B142-20M-Kit
High Flow Cartridge	B142-20H-Kit

Replacement Procedure

1. Using a knife edge or a small flat bladed screwdriver, remove both retaining rings. With the retaining rings absent, the old turbine cartridge should be easily removed.
2. Clean any foreign materials from the bore of the meter body that may restrict sliding the new turbine cartridge into place.
3. Replace the downstream retaining ring with one of the new retaining rings supplied in the kit.
4. With the meter body on a flat surface and the downstream end facing down, the direction arrow on the outside of the meter body should also be facing down. Place the turbine cartridge at the opening of the meter body with the arrow on the turbine cartridge facing the same direction as the arrow on the meter body.
5. Rotate the turbine cartridge so that the gap in the cartridge lines up with the magnetic pickup, then squeeze the cartridge to reduce the gap until the cartridge slides into the meter body.

NOTE: In a properly aligned cartridge the pressure port at the bottom of the meter body will also line up with the round hole at the bottom of the turbine cartridge.

6. Install the inlet retaining ring.

Gas Compensation Considerations

Gaseous fluids measured by the B142 gas turbine meter are compressible and are also affected by temperature changes, as illustrated by the ideal gas law equation:

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

This equation allows the calculation of gas volumes when the pressure and/or temperature values vary from standard conditions. Standard conditions are generally assumed to be 0 psig and 60° F.

Because pressure and temperature have a large impact on the mass of gas moving through the flow meter, both values must be entered into the receiving electronics for accurate gas readings to occur.

Absolute Pressure and Temperature

The ideal gas law equation shows that the volume of gas is determined by the specific pressure and temperature applied to the gas under running conditions.

In this equation, the pressure (P) is absolute pressure, that is, the observed gauge pressure plus the atmospheric pressure. The commonly used domestic unit of measure for absolute pressure is pounds per square inch absolute (psia). Atmospheric pressure is considered to be 14.73 psi. Therefore, Absolute pressure (psia) is the sum of the gage pressure plus 14.73.

$$\text{Absolute Pressure} = \text{Gage Pressure (psig)} + 14.73$$

The absolute temperature in the equation (T) is expressed in degrees Rankine, which is calculated by adding 459.67 to the temperature in ° F.

$$\text{Absolute Temperature} = \text{Observed Temperature (°F)} + 459.67$$

Effects of Changing Pressures

For applications where the pressure does not remain constant and "Standard" units of measure must be determined, the degree to which changing pressures affect readings must be known. Relatively small changes in pressure can produce large errors in the calculation of standard volumes, especially at low ambient temperatures.

NOTE: The effect of changing pressure is much greater than the effect of changing temperature. The overall effect of changing temperature and pressure is the algebraic sum of the individual effects.

Effects of Changing Temperatures

For applications where the temperature does not remain constant, it may be desirable to compensate for large fluctuations in temperature. In many applications, temperature changes will not produce serious measurement errors and can be disregarded. In situations where temperature changes are more extreme, for example seasonal temperature changes from winter to summer, reading accuracy can be adversely affected if the measurement is not adjusted for temperature effects.

Fixed Pressure and Temperature Conversions

Generally, gas volumes are reported in standard cubic feet but are measured in actual cubic feet.

NOTE: Standard cubic feet and actual cubic feet are equivalent for gases at standard conditions of 0 psi and 60° F.

Simple conversions between Actual and Standard measurements are easy if the system pressure and temperature are known. The general conversion formulas are:

$$\text{Standard Cubic Feet} = \frac{\text{Actual Cubic Feet} \times P_a \times T_s}{P_s \times T_a}$$

$$\text{Actual Cubic Feet} = \frac{\text{Standard Cubic Feet} \times P_s \times T_a}{P_a \times T_s}$$

Where:

P_a = system pressure in psia (14.73 + gage pressure)

P_s = standard pressure in psia

T_a = system temperature in ° R (system temperature in ° F + 459.67)

T_s = standard temperature in ° R (standard temperature in ° F + 459.67) = 519.76° R

Example 1

One actual cubic foot at a pressure of 90 psig and 85° F is equivalent to how many standard cubic feet?

$$\text{Standard Cubic Feet} = \frac{1 \times (90+14.73) \times 519.67}{14.73 \times (85 + 459.67)} = \frac{104.73 \times 519.67}{14.73 \times 544.67} = \frac{54,425}{8,023} = 6.784$$

This example shows that there are 6.784 standard cubic feet of gas in 1 actual cubic foot of gas at a running pressure of 90 psig and 85° F.

K factor Calculation in Standard Cubic Feet

If the running conditions are held constant, the K factor adjustment for converting actual cubic feet to standard cubic feet will also remain constant. In applications where a direct readout in standard cubic feet is desirable the following formula can be used to determine the K factor for any given set of operating conditions:

$$\text{Adjusted K factor} = \frac{\text{Factory K factor x } P_s \text{ x } T_a}{P_a \text{ x } T_r}$$

Example 2

A 2 inch B142 gas turbine meter has a factory K factor of 190 pulses per actual cubic foot and is installed in an application operating at 100 psig at 80° F. Calculate the adjusted K factor that will allow the downstream electronics to display flow in standard cubic feet.

Where:

Factory K factor = the K factor from the factory supplied in pulses per acf (actual ft^3).

P_a = system pressure in psia (14.73 + gage pressure)

P_s = standard pressure in psia

T_a = system temperature in °R (system temperature in ° F + 459.67)

T_s = standard temperature in °R (standard temperature in ° F + 459.67) = 519.76° R

$$\text{Adjusted K factor} = \frac{190 \text{ x} 14.73 \text{ x } (80 + 459.67)}{(100 + 14.73) \text{ x } (60 + 459.67)} = \frac{190 \text{ x } 14.73 \text{ x } 539.67}{114.73 \text{ x } 519.67} = \frac{1{,}510{,}375}{59{,}622} = 25.333$$

NOTE: If a Blancett readout such as the B3000 is being used, entering the operating pressure (Op Pres) and operating temperature (Op Temp) will allow the readout to calculate the adjusted K factor automatically, eliminating the need to do manual conversions.

In this example, as long as the pressure and temperature stay at 100 psig and 80° F, a K factor of 25.33 will allow the downstream electronics to display rate and total in scfm.

Dynamic Systems

In systems where pressure and/or temperature vary constantly, the alternative to extracting scf from acf data is to use of a flow computer and discrete pressure and temperature transducers.
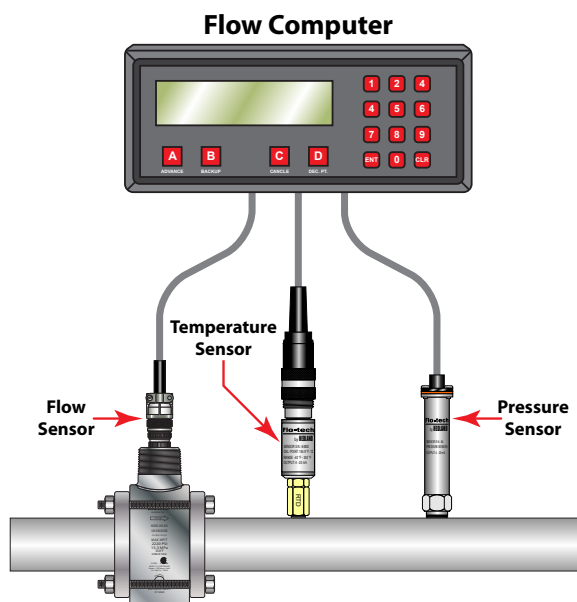

Figure 10 Typical flow computer inputs

SYMBOL EXPLANATIONS

⚠CAUTION

REFER TO ACCOMPANYING DOCUMENTS.

⚠WARNING

EXPLOSION HAZARD - SUBSTITUTION OF COMPONENTS MAY IMPAIR SUITABILITY FOR CLASS I, DIVISION 2.

⚠WARNING

DO NOT CONNECT OR DISCONNECT EITHER POWER OR OUTPUTS UNLESS THE AREA IS KNOWN TO BE NON-HAZARDOUS.

IMPORTANT
Not following instructions properly may impair safety of equipment and/or personnel.

Electrical Symbols					
Function	Direct Current	Alternating Current	Earth (Ground)	Protective Ground	Chassis Ground
Symbol	⎓	∿	⏚	⏚	⏛

CSA INTERNATIONAL

CERTIFICATE OF COMPLIANCE

Certificate:	1667574		**Master Contract:**	215035
Project:	2428682		**Date Issued:**	**July 19,2011**
Issued to:	**Racine Federated Inc.**			

8635 Washington Ave
Racine, WI 53406
USA
Attention: William Roeber

The products listed below are eligible to bear the CSA Mark shown with adjacent indicators 'C' and 'US' for Canada and US or with adjacent indicator 'US' for US only or without either indicator for Canada only.

C   US

Edward Foo

Issued by: Edward Foo, C.E.T.

PRODUCTS

CLASS 2258 04	**- PROCESS CONTROL EQUIPMENT -Intrinsically Safe, Entity -For Hazardous Locations**
CLASS 2258 84	**- PROCESS CONTROL EQUIPMENT -Intrinsically Safe, Entity --For Hazardous Locations -Certified to US Standards**

Class I, Div. 1, Groups C and D; Class II, Div. 1, Groups E, F and G:
• Model 280605, Battery Powered B2800 Series Flow Monitor. Intrinsically safe when installed per Drawing NO.B280001 and using Duraeell 1.5 V D-cell (p/n MN 1300) or Energizer 1.5 V (p/n E95). Opto-isolated entity parameters are Vmax = 30 V, Imax = 100 mA, Ci = 0 µF, Li = O. Output to Turbine Flow Meter having Entity Parameters of Voc = 3.5V ; Isc = 1.8mA ; Ca = 15µF ; La = 1.65H. Temperature code T3C at maximum Ambient 70 °C. Enclosure Type 4X.

• Model B280606, Loop Powered B2800 Series Flow Monitor. Intrinsically Safe when installed per Drawing No. B280002. Opto-isolated entity parameters are Vmax = 30 V, Imax = 100 mA, Ci = 0.0 µF, Li = 0. 4-20 rnA Current loop entity parameters are Vmax = 30 V, Imax = 100 mA, Ci = 0.5 µF, Li = O. Output to Turbine Flow Meter having Entity Parameters of Voe = 3.5V ; Isc = 1.8mA ; Ca = 15µF ; La = 1.65H. Temperature code T3C at maximum Ambient 70°C. Enclosure Type 4X.

DQD 507 Rev. 2009-09-01   Page: 1

CSA INTERNATIONAL

Certificate:	1667574	**Master Contract:**	215035
Project:	2428682	**Date Issued:**	July 19,2011

• Turbine Flow Meter, Models BII00 and Bl30 QuikSert, Intrinsically Safe with Entity Parameters Vmax = l0V, Imax = 7mA, Ci = 0µF, Li = 0.9H. "Single Seal", MWP 5000 PSI (34.5MPa), 350° F.

• Gas Turbine Flow Meter, Model Bl42 Series, Intrinsically Safe with Entity Parameters Vmax = l0V, Imax = 3mA, Ci = 0µF, Li = 1.65H. "Single Seal", MWP 5000 PSI (34.5MPa), 350° F.

<u>APPLICABLE REQUIREMENTS</u>

CAN/CSA C22.2 No. 0-M91 (R2001) - General Requirements - Canadian Electrical Code, Part II

CSA C22.2 No. 142 - Ml987 - Process Control Equipment

CSA-C22.2 No. 157-92 - Intrinsically Safe and Non-Incendive Equipment for Use in Hazardous Locations

CSA-C22.2 No. 94-M91 - Special Purpose Enclosures

UL Std No. 913 -7th Ed. - Intrinsically Safe Apparatus and Associated Apparatus for Use in Class I, II and III, Division 1, Hazardous Locations

UL No. 50 - 12th Ed. - Enclosures for Electrical Equipment, Non-Environmental Considerations

UL No. 50E - 1st Ed. - Enclosures for Electrical Equipment, Environmental Considerations

UL No. 746C - 6th Ed. - Polymeric Materials - Use in Electrical Equipment Evaluations

ANSI/ISA-12.27.01-2003 - Requirements for Process Sealing Between Electrical Systems and Flammable or Combustible Process Fluids

CSA INTERNATIONAL

Supplement to Certificate of Compliance

Certificate: **1667574**   **Master Contract:**   **215035**

*The products listed, including the latest revision described below, are
eligible to be marked in accordance with the referenced Certificate*

Product Certification History

Project	Date	Description
2428682	July 19, 2011	Update to include alternative Gas Turbine Flow Meter, Model B142 Series.
2388024	March 15, 2011	Update to cover Turbine Flow Meters Entity Certification.
2392258	February 16, 2011	Update to report 1667574 to include additional private label.
2302190	July 30, 2010	Update to include "Single Seal Device" Marking.
2284108	March 26, 2010	Update to Report 1667574 to include an alternate Battery Holder and Battery Bracket assembly.
2131250	March 31, 2009	Update of report to add humidity vent and revise model code scheme (including multiple listing).
1921676	July 19, 2007	Update Report 1667574 for alternate construction.
1667574	October 4, 2005	1. Transfer Contents of MC 185535 (Legacy 105056) to MC 215035 & cancel MC 185535 (Legacy 105056);

History

1439967	2003/10/08	Original certification of Model B2800 Flow Monitor (battery and loop powered) as intrinsically safe for Class I, Groups C, D; Class II, Groups E, F, G.

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www.badgermeter.com