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# AccuTest™ Transfer Proving Turbine Meter

**Installation  
Operation  
Maintenance**



**AMC Quality System**  
QMI is Accredited by:



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Dutch Council for Accreditation



Measurement Engineers Since 1836



Figure 16 AE 5000 C/P Keypad



Figure 17



Figure 18

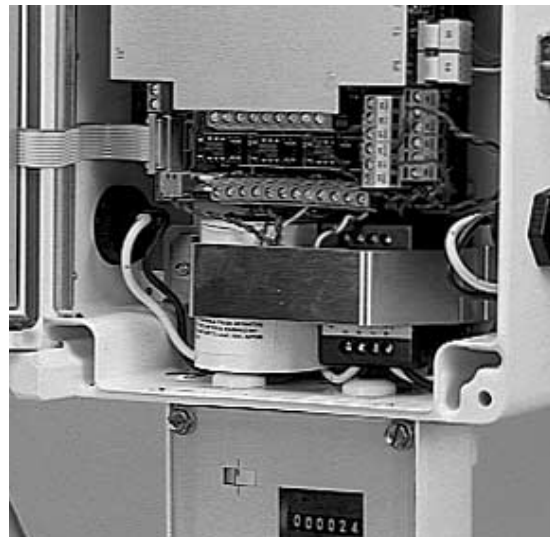


Figure 19

## OPERATION –

### Automatic Proving Mode

The EFC C/P automatically proves the meter at the preprogrammed interval, at whatever flow and line pressure exists at the time. Since changes in the turbine meter's friction level will generally have more effect at low flow rates, it may be advisable to program the proving cycle during overnight low flow periods. Recommended test flow rates for turbine meters are 10% to 15% of maximum capacity.

When the proving cycle is complete, the date, time, flow rate and meter accuracy are stored in memory in a proving file. This data can be downloaded into a laptop along with the base volume history file or remotely via a modem.

### Manual Proving Mode

Manual proving is conducted using the keypad inside the EFC C/P cover, Figure 16. The advantages of manual proving are: (a) it allows the meter flow rate to be adjusted to 10-15% of capacity (where bypass piping or multiple runs exist) to obtain good low end performance testing and (b) it allows the meter to be tested at more than one flow rate if desired.

#### Procedure:

1. Press "Ent" if the unit is asleep. If the unit enters the alarm mode, press "Ent" to clear the alarm or arrow down (↓) to skip. Press "Esc" to exit alarm mode without clearing alarms.
2. Press "Conf" to enter configuration mode.
3. Press "F5" to move to the Rate Trigger parameter.
4. Press "Edit", then press F1 to energize the sensors, and press "Ent".
5. Press "F6" to view the flow rate through the meter, Figure 17. The flow rate display updates every 4 seconds as the by-pass valve setting is changed.
6. When the desired flow rate is achieved, press "F8" to move to the Manual Proving Trigger parameter.
7. Press "Edit", then "F1" to set the trigger, and press "Ent".
8. The proving process begins – wait approximately 30 seconds.
9. Press "F7" to view the percent accuracy of the meter, Figure 18. The EFC C/P stores the test results in memory; percent accuracy, flow rate, time and date.

To conduct the accuracy test at another flow rate, repeat the steps above.

When completed, close the cover and lock the clasp. The unit returns to sleep after 2 minutes.

## SERVICE

The EFC C/P is normally battery powered, Figure 19. The life of the batteries will partly depend on the frequency of the proving process. The EFC C/P will show an alarm display when the battery needs to be replaced. The EFC C/P requires battery pack Part No. 40501 P002.

For any other service, including a periodic check of the P and T transducers, refer to the EFC operating manual.

## Introduction

General Description .....	4
Theory Of Operation .....	4

## Installation

AccuTest Meter .....	5
Optional Installations .....	5
AccuTest Laptop Proving System .....	7

## Operation

Conducting An AccuTest Meter Accuracy Test .....	8
EFC Corrector/Prover Proving System (EFC-C/P) ...	9
Automatic Proving Mode .....	10
Manual Proving Mode .....	10

## Service

Battery Replacement .....	10
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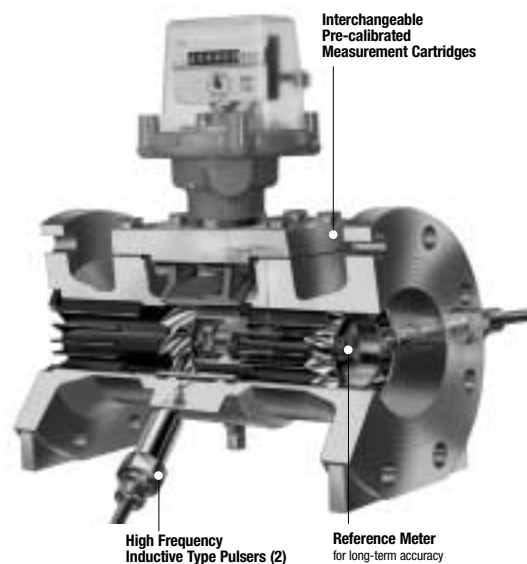


Figure 1

## GENERAL DESCRIPTION

The AccuTest meter is a new type of turbine meter that evaluates the meter's accuracy under actual operating conditions, using recognized transfer proving techniques. The meter is specially suited for evaluating the effects of mechanical friction or damage and installation effects or flow blockage causing swirl.

An AccuTest meter contains both a removable measurement cartridge and a master or reference meter in the outlet section, as shown in Figure 1. Inductive type proximity sensors create high frequency pulses as the blades of each aluminum rotor pass the sensors. Connecting these pulse outputs through a signal conditioner to a laptop computer or to a Corrector/Prover creates a transfer proving system for on-site, in-line proving (Figures 2 and 3).

## THEORY OF OPERATION

The accuracy of the measurement cartridge is calculated using Equation 1, which is similar to the standard transfer proving equation except that no delta P or delta T correction is required.

$$\text{Equation (1) ACCURACY} = \frac{F_{\text{main}}}{F_{\text{ref}}} \times \frac{K_{\text{ref}}}{K_{\text{main}}} \times A(m)$$

In the AccuTest equation, pulse frequencies are used instead of counting the number of pulses from the field and reference meters.

The second term, the ratio of K factors, is similar to the reference meter correction factor used with conventional transfer provers. These K factors are obtained from the meter calibration sheet at various flow rates and at (or near) the expected working pressure. A meter's K factors, by definition, are pulses per cubic foot or cubic meter that normalize the meter's electronic pulse output to zero error.

The final term in the equation is A(m), the mechanical output shaft accuracy listed at various flow rates on the calibration sheet. A(m) is used to calculate the accuracy of the meter's mechanical output drive. This term is *not* required when computing the meter's electronic output accuracy from pulse streams fed to a flow computer.

### Example:

The test certificate of a 4-inch AccuTest meter with a 30 degree rotor lists the main and reference rotor K factors at 15% of capacity as 178.65 and 135.40 pulses/cf, respectively. The mechanical drive output accuracy is 100.25% and is dependent on the output change gears selected.

The main and reference rotor pulse frequencies when factory tested at 15% of capacity are 171.20Hz and 129.75Hz.

Inserting these values into the equation:

$$\text{ACCURACY} = \frac{171.20}{129.75} \times \frac{135.40}{178.65} \times 100.25 = 100.25$$

(Term 1)   (Term 2)   (Term 3)

For a new meter, Term 1 x Term 2 will always equal 1.00. Term 3 accounts for the error related to the selection of change gears and will vary slightly with flow rate.

After an extended period of service the meter is field tested again at 15% of capacity. A build up of mechanical friction in the gear train now retards the main rotor rotation. As a result, the main rotor pulse



Figure 2



Figure 3

You may enter an elevated test pressure between P1 and P2. Example: If P1 is 60 psi and P2 is 100 psi and the actual meter pressure is 80 psi at the time of the test, enter 80 psi in the Ptest window. The program will interpolate the proper K-factor for that pressure and flow rate.

Click on the "Run" arrow to start the accuracy test, which takes 30 seconds.

Once the low flow rate test is complete, the test can be re-run at that same rate or at a different rate. Testing the meter at higher flow rates will detect installation effects. To retest at a different flow rate, return to the main menu and click on F3. (Or, just change the by-pass valve setting and wait for the flow rate display to change.)

Note: The laptop will abort the test if the flow rate through the meter changes by more than 5% during the 30-second proving cycle. A warning will also appear on the screen. Repeat the test until successful.

- F. Meter accuracy, flow rate, time and date may be saved to the laptop's hard drive or to a disk. (Install a blank disk into the A drive.) The program will ask for a directory to save the file. Type in a:\ for disk or c:\ for hard drive.

## EFC Corrector/Prover Proving System (EFC C/P)

### Installation

Mount the EFC C/P on the AccuTest meter so that the meter output shaft aligns with the EFC C/P input shaft and with the base plate gasket in place, Figure 15. Fasten the unit with (4) screws provided.

Connect the yellow cable exiting the *right* side of the EFC C/P case to the *downstream* (reference rotor) sensor. The left hand cable connects to the upstream (main rotor) sensor.

### Description

An EFC C/P Proving System allows the AccuTest meter to be proved both automatically and manually. To perform the proving function, the EFC C/P is built with an on-board signal conditioner/barrier to receive pulses from the meter sensors. The EFC C/P is programmed to calculate meter accuracy using Equation 1. (It includes the Am term for mechanical accuracy since the corrector is mechanically driven.) Energy to power the rotor sensors during the accuracy test is obtained from the EFC C/P power supply.

The EFC C/P is factory programmed and tested with the AccuTest meter as a system. In addition to the base condition programming, the EFC C/P is programmed with the meter accuracy values and K factors at six flow rates and at one or more test pressures. The EFC C/P will automatically interpolate for intermediate flow rates and pressures. The EFC prover programming can be changed on site using either a laptop with Meter Reader software or the EFC C/P internal keypad, Figure 16. Refer to the EFC C/P manual for instructions.

Other set-up parameters of the EFC C/P include a maximum allowable error limit between the main rotor and the reference rotor; the date and time of the automatic proving process such as daily, weekly, monthly, etc.; the maximum change in flow rate allowed during the proving cycle before the test aborts; the maximum allowable change in pressure before the proving cycle aborts; and the number of minutes and times between retests.

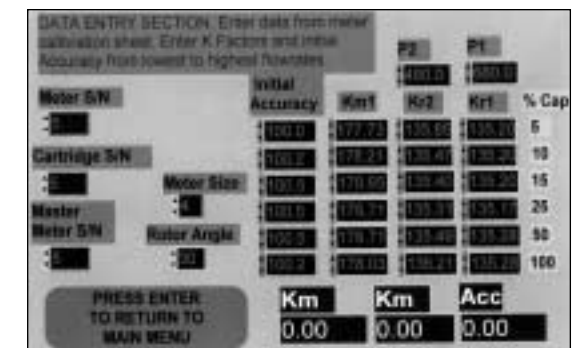


Figure 13 Data Entry Screen

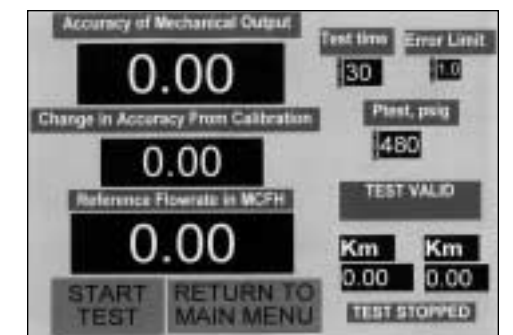


Figure 14 Accuracy Calculation Screen



Figure 15 AE 5000 Corrector/Prover

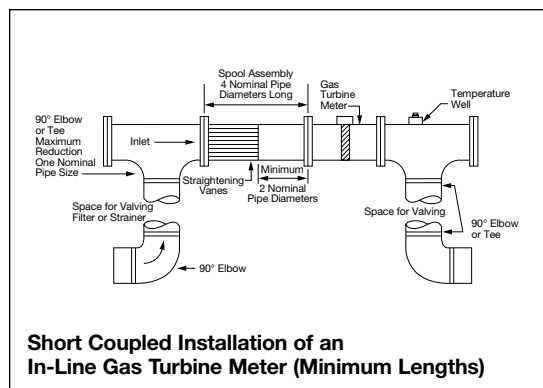


Figure 7

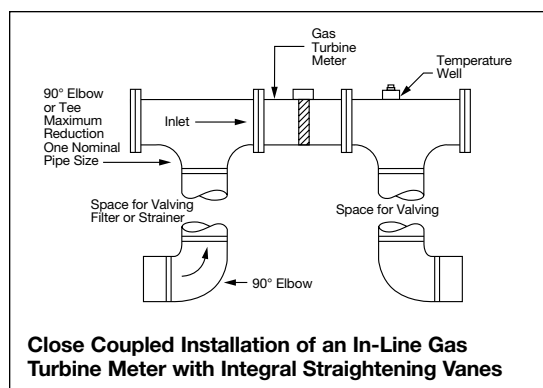


Figure 8

### Short Coupled Installation

This configuration uses a minimum of 4 pipe diameters ahead of the meter with straightening vanes a minimum of 2 pipe diameters from the meter inlet, Figure 7. The meter is connected to vertical risers using a standard tee, as shown, to minimize jetting.

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

### Close Coupled Piping

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

### Strainers or Filters – Caution

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

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

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

### Over-Range Protection

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

### By-Pass Piping

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

### Additional Installation Reminders

Minimize pipe stresses on the meter.

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

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

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

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

Lubricate the meter within the first six months of operation with the recommended oil – Anderol #401-D.

## INSTALLATION/SET-UP – AccuTest Laptop Proving System

The AccuTest Field Prover System consists of (a) two 20-foot sensor cables, (b) a signal conditioner case (which includes a battery pack to power the sensors), (c) a data acquisition (DAQ) card, (d) a computer interface cable that connects to the DAQ card, (e) a disk that contains the executable (proving) program, drivers and individual meter data such as the meter serial numbers, K-factors, etc., and (f) 11 disks containing the NIDAQ software needed to configure the DAQ card.

### Loading The AccuTest Software

Note: The AccuTest Proving System requires a laptop with a 486 drive or better, 12mB of memory, a PC card slot and a math co-processor. The operating system is Windows 3.1 or Windows 95.

1. From the Windows 95 or 3.1 file manager, install the NIDAQ software following the instructions given in the installation procedure provided. In most, but not all cases, all 11 disks will be requested during the installation. After installation, re-boot the computer and launch the NIDAQ software.

Windows 95 will automatically configure the DAQ card; however, Windows 3.1 requires that configuration parameters be set. To set parameters, open WDAQCONFIG and configure the DAQ card for the correct PCMCIA port.

Open NIDAQ configuration utility. Click on Device #1, toggle down to DAQ Cards, click, toggle to DAQ-700, click. Select Socket O and hit OK. Click on Configuration and Save. Click on Configuration and Return. Close NIDAQ Utility.

2. Next, install the disk containing the executable file (Serial#.ZIP), drivers (SERPDRV, DAQDRV, and LVDEVICE.DLL) and PKUNZIP.EXE. A suggested directory name is C:\ACCU. "Serial#.ZIP" is the serial number on the badge of the AccuTest meter *cartridge*.

Use PKUNZIP.EXE to inflate the executable by typing:

PKUNZIP Serial#.ZIP Serial.EXE.

Repeat Step 2 for each additional AccuTest meter disk; one per meter.

### Hardware Installation

3. Insert the DAQ card into the PC card slot.
4. Connect the cable to the flat connector of the signal conditioner/power supply box, as shown in Figure 9. Note the key in the strip connector for proper orientation.
5. Connect the 20-foot yellow cables from the meter to the signal conditioner box, being careful of the main and reference rotor positions. The reference rotor sensor is closest to the meter *outlet*.

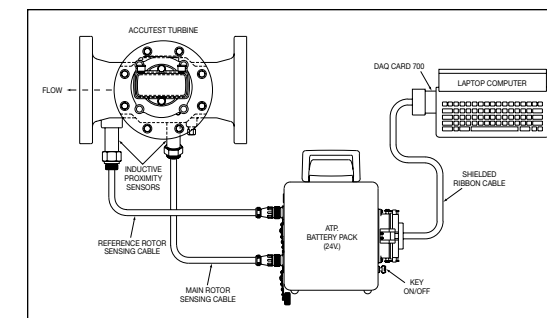


Figure 9 Laptop Proving Setup



Figure 10 Main Menu

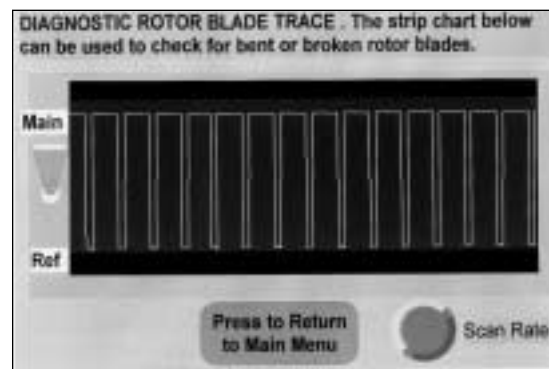


Figure 11 Display of Rotor Blade Traces

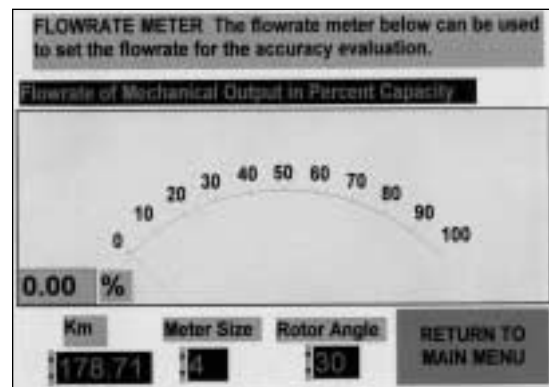


Figure 12 Flow Rate Display

## OPERATION – Conducting An AccuTest Meter Accuracy Test

- Turn on the laptop and the power switch of the signal conditioner box which energizes the rotor sensors. From the File Manager screen select the “Accu” directory and then the serial number of the meter to be tested. The executable Main Menu appears, Figure 10.
- Click on the left hand box, “Check For Bent or Broken Rotor Blades” or press F1. Figure 11 is a square wave trace that shows the condition of the rotor blades. Click on the icon at the left of the screen to toggle from the main rotor to the reference rotor. Each screen should show at least 14 blade traces. If not, adjust the display by using the “scan rate” icon. Place the pointer on the knob and adjust CW or CCW with the mouse until at least 14 blade traces are showing. On this screen, a missing trace (a blank space between traces) represents a bent or missing rotor blade. If no blade traces are missing, return to the main menu by pressing “Enter”.
- From the main menu screen, click on “Monitor Flow Rate” box or press F2. Figure 12 shows an analog display of flow rate in percent of capacity, which is updated every 2 seconds. A turbine meter accuracy test should be conducted at about 10% of capacity to detect any change in the meter’s friction level. Testing a turbine meter at 40% of capacity or greater will often mask any friction changes in the meter. Open the bypass valve until a flow rate of 10 to 15% is achieved. Return to the main menu.
- Click on “View Original Data” or press F4. This brings up the data entry screen which displays meter parameters such as K-factors for each rotor, the initial meter accuracy at various flow rates, meter size, serial numbers, etc., Figure 13. Check this data against the calibration sheet supplied with the meter.

The original factory test pressure(s) P1 and P2 are displayed in the upper right hand corner of the screen. They may be both atmospheric pressures, .2 psi (which means there was no elevated pressure test); both elevated pressures (example: 60 and 100 psi) or one at atmospheric pressure and the other at elevated pressure.

The K-factors shown at the bottom of this screen are values relating to the test flow rate selected in Step C above and are interpolated for any flow rate selected in Step C that is between the original test flow rates.

Return to the main menu.

- Click on “Check Meter Accuracy” or F3 to bring up the accuracy calculation screen, Figure 14. This screen will display the current meter accuracy, the change in accuracy from its original value and the flow rate in MACFH. Also displayed is a pass/fail indicator based on the error limit set on the meter data screen.

Note: The screen shows a “Ptest” display, the pressure at which the accuracy test is to be conducted. The default value shown is the pressure P2 on the Data Entry Screen, Figure 13, which is the meter operating pressure. If you are proving the meter at atmospheric pressure, enter .2 psi in the Ptest display using the mouse to click in the window and keying in the pressure. This will allow the laptop to use the atmospheric K-factors for this test, but does not lock in the Ptest value.

frequency decreases to 170.77, a change of 0.25%. Substituting this value into the Equation 1 and recalculating the output drive accuracy:

$$\text{ACCURACY} = \frac{170.77}{129.75} \times \frac{135.40}{178.65} \times 100.25 = 100.00\%$$

In this example, the speed of the main rotor is reduced by friction which reduces its pulse output frequency. The reference rotor, which is unaffected by the friction buildup, continues at a pulse frequency of 129.75. Since the ratio of frequencies has changed, the calculated accuracy changes. (Note: The K factors remain constants in the calculation and are only changed if the main and/or reference meters are rebuilt and retested.)

## Use Of The Equation With Flow Computers

In a flow computer application, the base volume calculation is not influenced by the mechanical output drive accuracy, but rather the high frequency pulse output. Therefore, the equation used by a flow computer does not include the A(m) term. In the above example, the accuracy calculation for the *electronic* output would change from 100.00% to 99.75% under the conditions given.

## INSTALLATION – AccuTest Meter

AccuTest meters in sizes from 4" through 8" have ANSI 150, 300 or 600 flanges, depending on the pressure rating and are designed for horizontal installations.

Recommended turbine meter installation requires a minimum of 10 pipe diameters upstream, with straightening vanes located 5 pipe diameters from the meter inlet as shown in Figure 4. A length of 5 pipe diameters is recommended downstream of the meter. Both inlet and outlet piping should be the same nominal size as the meter.

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

Jetting, shown in Figure 5, is non-uniform gas velocity within the pipe, and can be caused by an upstream regulator, a valve, an elbow or a misaligned flange gasket. Jetting will cause the meter to over-register since the rotor responds to the higher, not the average velocity, in the pipe. For this reason, temperature wells and pressure taps should be located in the downstream piping. Any pressure tap fitting in the upstream piping should be ground flush with the inside pipe wall.

Swirl, Figure 6, is a condition where the gas velocity is not totally parallel to the axis of the pipe, but has a spiral component. It may be caused by upstream valves, elbows or other fittings. Swirl in the direction of the rotor rotation will cause the turbine meter to over-register and vice-versa.

## Optional Installations

The following installations may result in some degradation in meter accuracy, and should only be used where space does not permit the recommended installation shown in Figure 4.

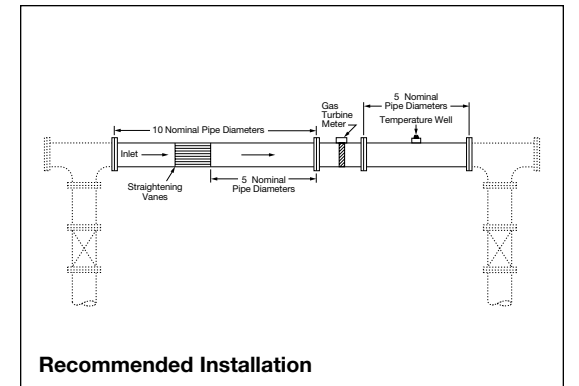


Figure 4

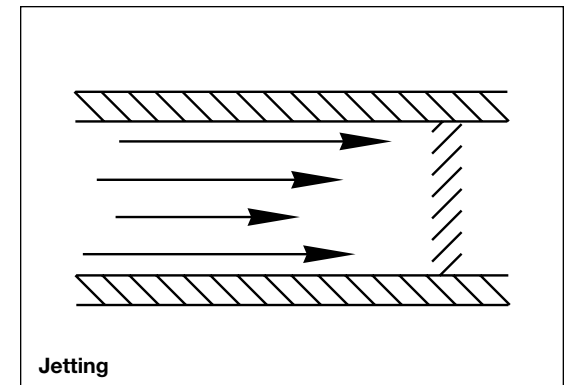


Figure 5

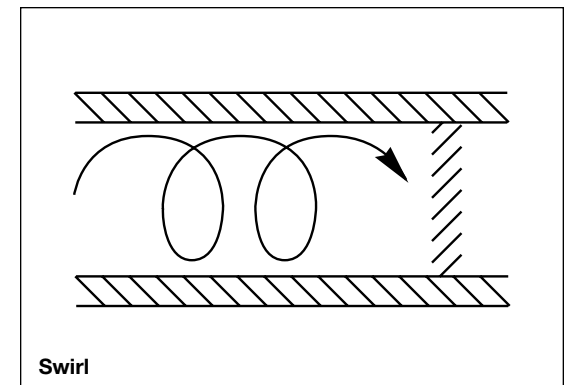


Figure 6