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FPT-6100, FPT-6200 AND FPT-6300

High Accuracy Pitot Tubes

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HIGH ACCURACY PITOT TUBES
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Operator's Manual

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FPT-6000 SERIES: Selection and Sizing

Vibration Calculations (Step VII)

Natural frequency or resonant vibration can inhibit performance. Checks are to be made during sizing. The checks will guide you to the proper probe with resonant vibration range outside the anticipated operating flow range. VIBRATION CHECKS MUST ALWAYS BE MADE FOR LIQUID, GAS OR STEAM FLOW.

Natural frequency vibration is caused by a force created as vortices are shed by the probe. At a critical point (which is a function of probe geometry, probe material and velocity of the flowing fluid) a destructive natural frequency vibration is created which can lead to probe failure.

To an extent, we can adjust the point at which destructive vibration occurs by using various probe diameters or by improving the probe's resistance to vibration by using a second mounting support. Ideally, the destructive vibration range should be above the maximum anticipated flow rate. This removes the vibration concern from the flow application. A tube can also be used if the vibration range is well below the anticipated operating flow range. The process flow rate can pass through the vibration range but should not be allowed to flow within the vibration range continuously.

The equations below will give a flow rate range which must be avoided when selecting. The calculated flow range is representative of the point of natural frequency vibration for the probe and a ±20% safety factor. If operated continuously within the calculated range, probe failure may result.

AVOID VELOCITY RANGE OF...

$$Vel_{\text{lower limit}} = \frac{5252.7 \times M \times Pr \times DIA}{L^2} \quad \text{to} \quad Vel_{\text{upper limit}} = \frac{7879.0 \times M \times Pr \times DIA}{L^2}$$

where:

Vel = fluid velocity, feet per second
M = mounting factor
M = 3.52 for single mount
M = 15.4 for double mount
Pr = probe factor, see below
DIA = probe diameter, inches
L = unsupported probe lengths

Probe Factor

PROBE DIAMETER	Pr
3/8"	0.185
1/2"	0.269
3/4"	0.372
1"	0.552
2 3/8"	1.300

Unsupported Probe Length

Single Mount Series	Double Mount Series	Probe Dia.	Flange Rating	Single Mount L, Inches	Double Mount L, Inches
Standard	Optional	3/8"	N/A	I.D. + Wall + 1.25	Single Mount L + 0.94
		3/4"	N/A	I.D. + Wall + 1.56	Single Mount L + 1.25
		1/2"	N/A	I.D. + Wall + 1.50	Single Mount L + 1.25
		1"	N/A	I.D. + Wall + 1.94	Single Mount L + 1.62
		1/2"	150#	I.D. + Wall + 3.62	Single Mount L + 1.25
		1"	150#	I.D. + Wall + 3.62	Single Mount L + 1.62
		ALL	N/A	CONSULT OMEGA	N/A
		ALL	N/A	CONSULT OMEGA	N/A

The upper and lower limit velocities calculated define the destructive vibration range. Convert velocity into Actual Cubic Feet per Minute (ACFM) or Standard Cubic Feet per Minute (SCFM) using the equations shown on the right. Then compare the calculated vibration range to your anticipated operating flow range and refer to the bottom of this page for interpretation of your results.

$ACFM = Vel \times I.D.^2 \times 0.3272$
$SCFM = ACFM \times 35.37 \times P/T$
$PPH = ACFM \times p \times 60$

where:

ACFM = Actual Cubic Feet per Minute at flowing conditions
SCFM = Standard Cubic Feet per Minute at 14.7 PSI and 60°F
PPH = Pounds Per Hour
Vel = Velocity, feet per second
I.D. = pipe Inside Diameter, inches
P = inlet Pressure, PSIA
T = inlet Temperature, °R (°R = 460 + °F)
p = density, pounds per cubic foot

COMPARISON OF VIBRATION RANGE TO OPERATING FLOW RANGE

A. Vibration range greater than operating flow range...selection is OK.

B. Vibration range is within operating flow range...Rerun vibration check using double mount, larger probe diameter or both as necessary.
- If check is OK, then the new selection is OK. Re-check requirements of STEP I through VI.
- If vibration range is still within 70% of the minimum operating flow, try a smaller probe and see "C" at right.

C. Vibration range less than 30% of minimum operating flow range selection is OK provided: (1) flow rate is not allowed to remain within calculated vibration range. (2) requirements of STEP I through VI are satisfied.

NOTES:

HIGH ACCURACY PITOT TUBES
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SECTION 1. INTRODUCTION

1.1 General Description

The FPT-6000 Series Pitot Tubes are a highly accurate averaging Pitot Tube which generates a pressure differential between its upstream (stagnation) ports, and its downstream (static) ports, that is proportional to the flowrate squared (Q). The 6100 are for low pressure applications; the 6200 for high pressure applications.

Many types of readout instrumentation can be used to measure the differential pressure developed by the Pitot Tube. The most common type are manometers, dial gauge indicators, electronic transmitters/transducers (such as the OMEGA PX 760) or electronic gauges. Each type has its own installation and operational characteristics. Certain types of instruments are sensitive to mounting position which can affect zero indication (See Section 3, "Installation"). In this case the zero setting should be adjusted after installation.

The FPT-6000 Series Pitot Tubes can be used to measure clean liquids, gases and steam in a variety of piping systems and pipe sizes up to 72 inches and above on special order.

The FPT-6000 Series Pitot Tube offers many advantages over the orifice plates. The Pitot Tube is easier and less expensive to install since only one small coupling is welded into place vs. two large flanges for the orifice plates. Furthermore, the Pitot Tube offers much lower permanent pressure loss, low maintenance and good resistance to wear.

To provide superior durability, the FPT-6000 Series Pitot Tubes have a double "D" tube within the sensing tube. Its bidirectional flow measurement (See Section 4, "Operation") is standard and with a special double-mount construction, the flow ranges can be extended to up to four times.

The FPT-6300 averaging Pitot Tube is similar to the FPT-6100 in performance, but features a wet-tap assembly which permits its installation and removal of the sensor in pressurized lines without process shutdown.

The FPT-6300 Pitot Tube is ideal for retrofits on critical flowstreams.

1.2 Features

The FPT-6100 Series Pitot Tubes are made of a 316 stainless steel shaft, with packing and head in brass, a carbon steel weld coupling, two SAE flair brass valves and a Delrin (polyacetal) ferrule. The FPT-6200 Series Pitot Tubes are identical except that they are equipped with two 1/2" FNPT carbon steel block valves instead of flair brass valves.

On the other hand, the FPT-6300 Series Pitot Tubes are equipped with a carbon steel weld coupling and pipe fittings, brass ball valves and packing, and a Delrin (polyacetal) ferrule.

SECTION 2. INSTALLATION

2.1 Unpacking

Remove the Packing List and check off actual equipment received. If there are any questions about the shipment, please call OMEGA Customer Service Department.

Upon receipt of shipment, inspect the container and equipment for any signs of damage. Take particular note of any evidence of rough handling in transit. Immediately report any damage to the shipping agent.

NOTE

The carrier will not honor any claims unless all shipping material has been saved for their examination. After examining and removing contents, save packing material in the event reshipment is necessary.

2.2 Location and Positioning

The installation of the Pitot Tubes in locations where significant pipe vibrations exist must be avoided. Where vibration is a concern, double mounted style Pitot Tubes are recommended.

Selection of the proper location and position of the Pitot Tube within the piping system is important.The first consideration is to locate the Pitot Tube with proper upstream and downstream straight pipe runs. This is required to assure a fully developed symmetrical flow profile at the Pitot Tube. Accuracy can be affected if sufficient piping is not provided. Table 2-1 shows recommended straight run requirements with various types of upstream flow disturbances.

TABLE 2-1
RECOMMENDED STRAIGHT RUNS OF PIPE

UPSTREAM FLOW DISTURBANCE	UPSTREAM LENGTH IN TERMS OF INTERNAL DIAMETER OF PIPE (SEE NOTES)		
	WITH STRAIGHTENING VANES	WITHOUT STRAIGHTENING VANES-IN-PLANE	WITHOUT STRAIGHTENING VANES-OUT-PLANE
ONE ELBOW OR TEE	6-8	8-10	10-12
TWO 90° BEND IN SAME PLANE	8-10	8-10	12-15
TWO 90° BENDS IN DIFF. PLANES	10-12	18-22	24-28
REDUCERS OR EXPANDERS	8-10	8-10	8-10
ALL VALVES (SEE NOTE 3)	10-12	24-28	24-28

NOTES

1. Downstream straight run of pipe should be a minimum of 4 to 5 internal diameters.
2. The values listed in Table 2-1 are acceptable for most applications. Additional lengths are recommended where precise measurements are desired.
3. Recommendations for valve disturbances are for non-throttling (fully open) position only. The Pitot Tube should not be located downstream of a throttling valve.
4. Straightening vanes (where used) shall be installed 2 diameters downstream of the upstream flow disturbance.
5. Deviations from the above recommendations will normally not affect repeatability of the flow signal.

Proceed by determining the position of the Pitot Tube and indicating instrument with respect to the pipe. Selection of the entry location (i.e., in from top or bottom, etc.) is determined by the media in the pipe. Sections 2.2.1 through 2.2.3 give general requirements for Pitot Tube position and installation, and specific recommendations for each general category of fluid.

2.2.1 Liquid Flow Metering

With liquid flow the readout instrument is normally located below the Pitot Tube. This prevents air entrapment in the instrument lines. Figures 2-1 through 2-4 show recommended orientation for liquid flow. Refer also to 2.2.4 General Interconnection Requirements.

Instrument lines must be properly sloped (1/2" per foot) without high points that may cause air entrapment. If this is not possible, air vent valves must be placed at any high points in piping. Trapped air is a frequent cause for measurement error with liquids. Refer to Figures 2-1 through 2-4.

2.2.1 Liquid Flow Metering (Continued)

The air vent valves should be bled on a regular basis during normal operation and upon restart after a system shutdown.

2.2.2 Gas Flow Metering

Few restrictions apply to system arrangement in gas flow. Any arrangement shown in Figures 2-1 through 2-6 may be used. Figures 2-1, 2-2 and 2-5 are recommended for simplicity in installation.

In installations where condensation or entrained liquids can accumulate in the instrument piping, it is recommended that the instrument be mounted above the Pitot Tube or install the Pitot Tube in the top portion of the line. If mounting below the Pitot Tube is necessary, then sediment traps and/or drain valves should be used as in Figure 2-6.

2.2.3 Steam Flow Applications

As in liquid flow, the indicator shall be located below the Pitot Tube. Figure 2-1 shows the recommended configuration. This configuration allows condensate to collect in the instrument lines and finds its natural level within the Pitot Tube.

An installation in a vertical pipe should only be performed when a horizontal line location is not available. This installation should be as in Figure 2-2 for upward flow. For downward flow a special "rotated head" Pitot Tube is normally used. This permits the side port connection to point to the side of the pipe and allow installation similar to Figure 2-2. Refer also to 2.2.4 General Interconnection Requirements.

The indicator must be placed far enough away from the Pitot Tube to prevent thermal damage from line heat. Allow 1 ft. of instrument piping for every 100° F of process temperature.

2.2.3 Steam Flow Applications (Continued)

Slope the instrument lines up to probe 1/2" /foot to prevent air entrapment.

Fill the instrument lines with water before connecting the Pitot Tube. This can be accomplished after making the connection if the line is not under pressure. In this case, the water is introduced to flow up lines to the Pitot Tube. Allow approximately 1/2 hour after system startup for condensate level to stabilize.

2.2.4 General Interconnection Requirements

Instrument lines to the Pitot Tube shall be as large as possible in liquid and steam applications. The length of the instrument lines does not affect accuracy. Long lines can, however, dampen the indicator response time. For Pitot Tubes with 1/2" NPT connections, 1/2" pipe or tubing is recommended. Pitot Tubes with 1/8" NPT connections should use 1/4" pipe or tubing.

The use of the optional instrument shutoff valves at the Pitot Tube head is recommended. Also, the use of a 3-valve manifold is recommended at the indicator to aid system startup and ease indicator maintenance and calibration.

Where instrument piping slopes are required, use 1/2" per foot minimum.

Test the system for leaks after connecting instrumentation. It is essential to assure that no leaks exist.

In situations where accumulation of sediment or condensation within the piping is possible, a system drain or pressure blowdown should be performed on a regular basis. Valves are recommended for indicators/transmitters without drain valves/plugs.

SYSTEM ORIENTATION RECOMMENDATION (Figures 2-1 through 2-6)

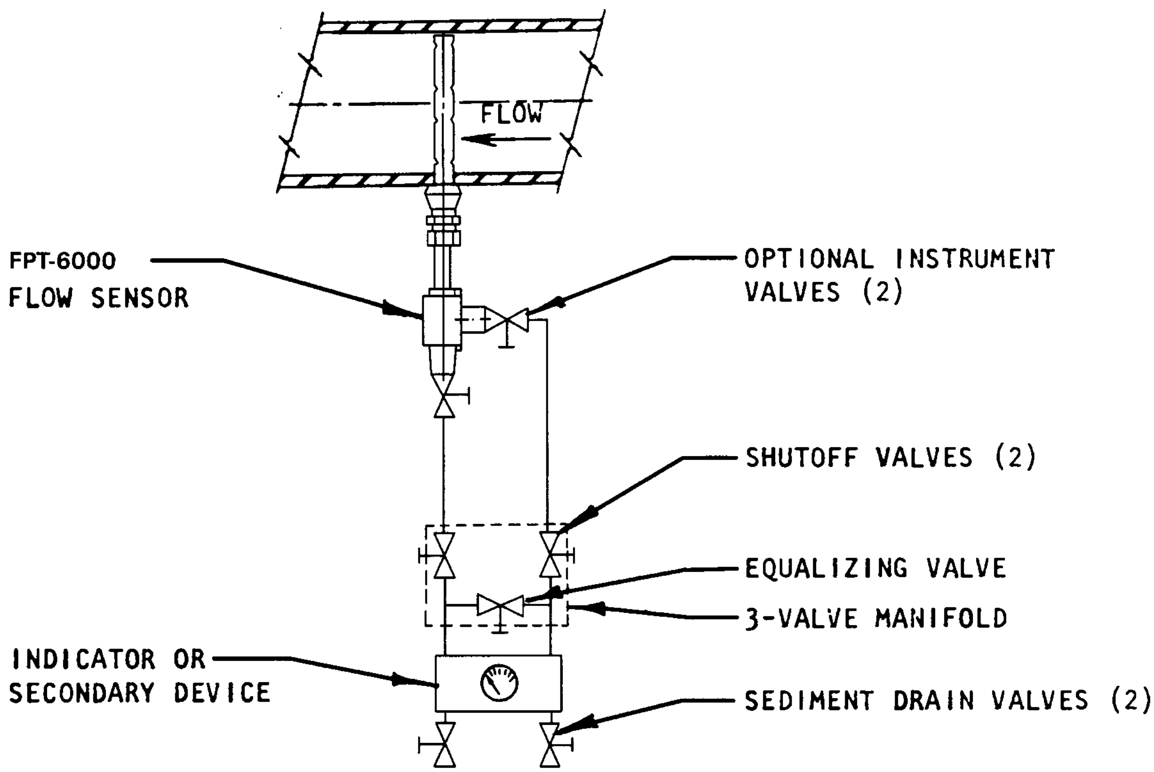


Figure 2-1. Steam, Liquid, and Dry Gas Horizontal Lines
(Bottom Entry)

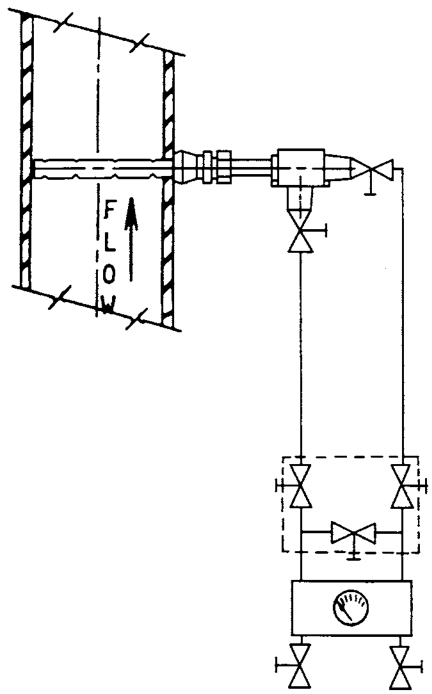


Figure 2-2. Steam, Liquid, and Gas Vertical Lines

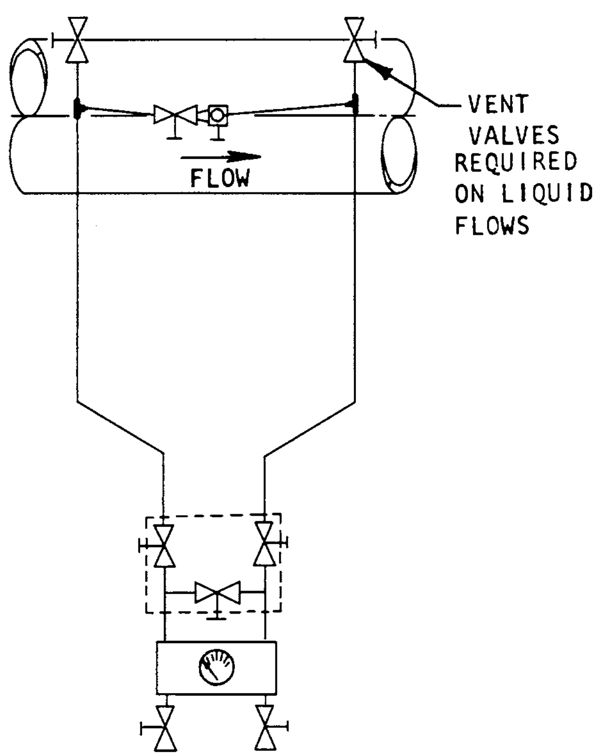


Figure 2-3. Liquid, and Gas Horizontal Lines (Side Entry)

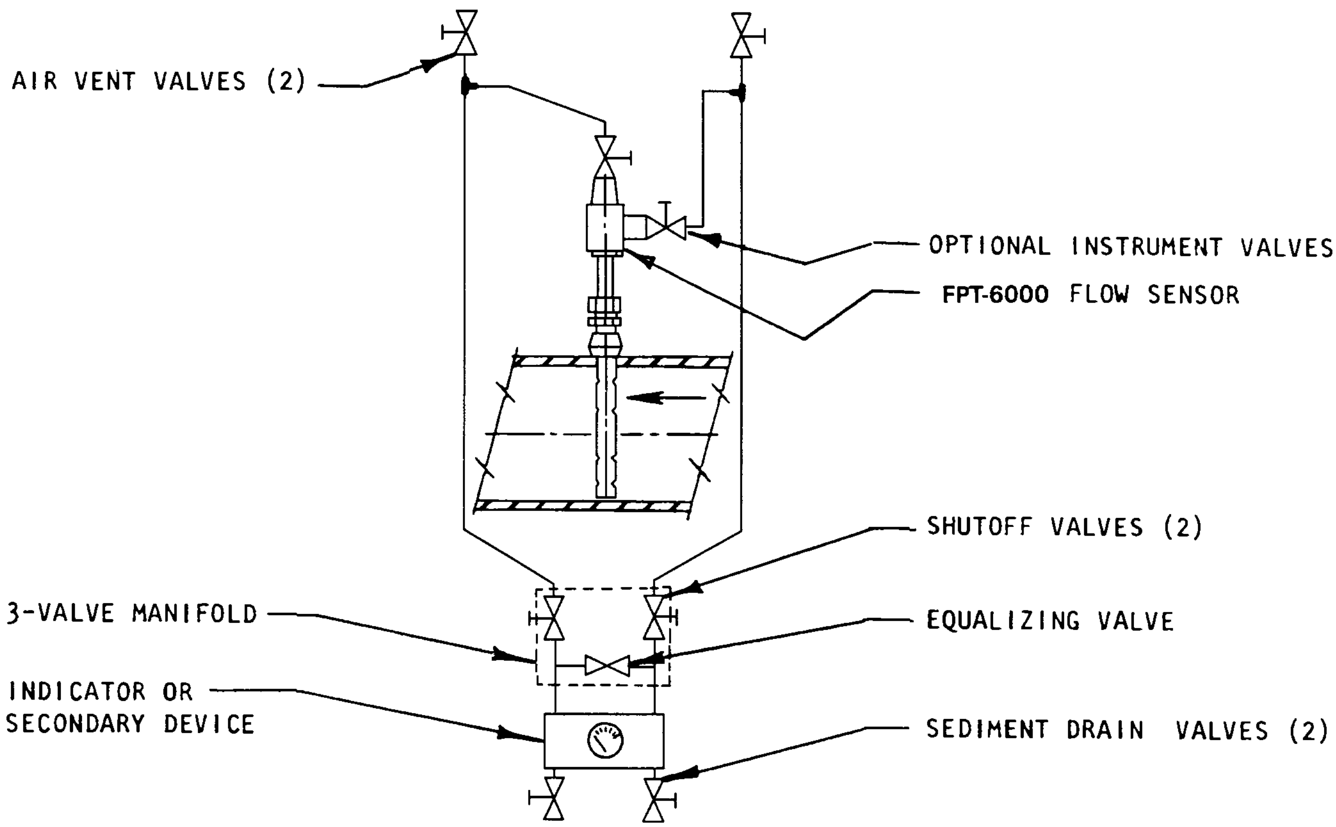


Figure 2-4. Liquid Horizontal Lines (Top Entry)

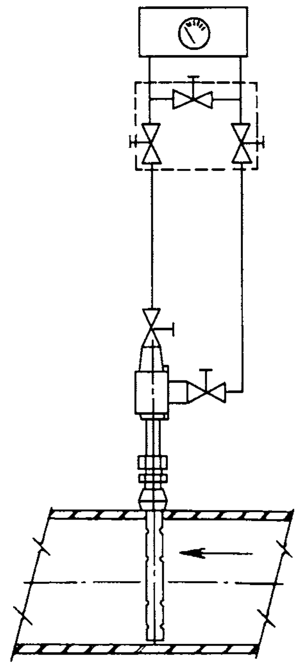


Figure 2-5. Gas Horizontal Lines (Top Entry)

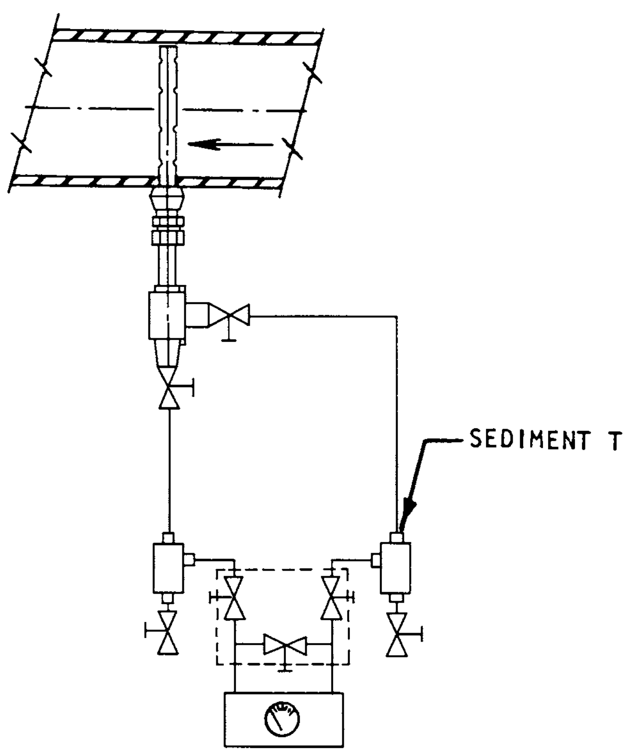


Figure 2-6. Gas Horizontal Lines (Bottom Entry)

2.3 Installation Procedure

2.3.1 General Requirements

1. Prepare the surface of the pipe or duct where the Pitot Tube is to be mounted. Proper preparation involves removal of scale, rust, paint and grease for proper welding of the threaded coupling.

2. Drill or burn a hole through the pipe at the mounting location. The size of the hole should be 1/16" to 1/8" larger than the probe diameter as identified in Table 2-2.

TABLE 2-2
RECOMMENDED DRILL SIZES

Probe Diameter	Recommended Drill Sizes
3/8	1/2
1/2	9/16
3/4	7/8
1	1-1/16

3. Double support type sensors require a second hole on the opposite side of the pipe. Location of this hole is important as it establishes proper alignment of the probe with respect to the flow. A common method of locating the opposite support hole is by wrapping a piece of string totally around the pipe, with the string crossing the center line of the existing drilled hole at each end, and running square to the pipe. The position can be marked at 1/2 the total length of the string.

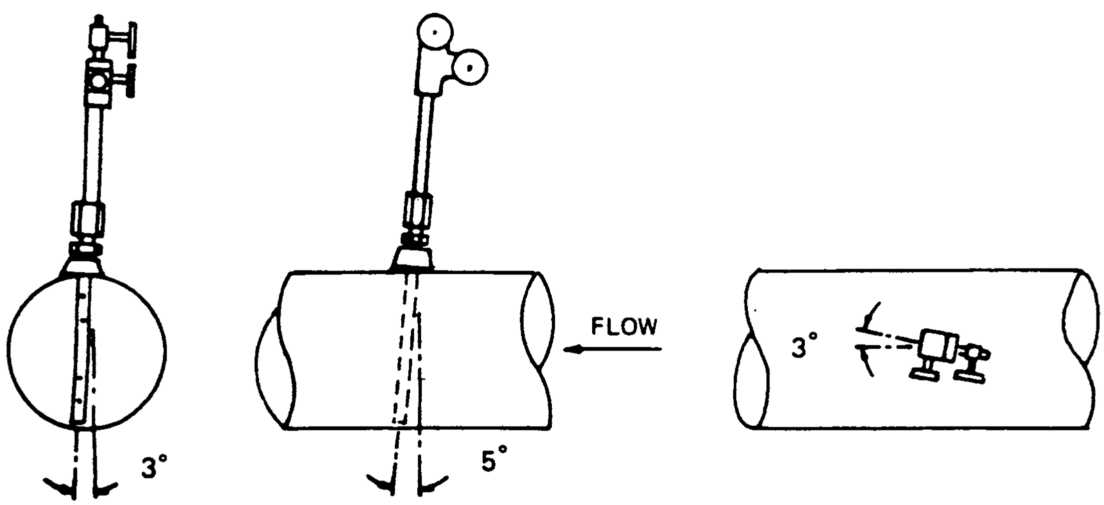
4. Center the threaded weld coupling over the hole and tack weld in place.

2.3.1 General Requirements (Continued)

5. Thread the packing gland fitting in place (compression type), and insert the probe into the pipe. Observe the position of the probe assuring that it is perpendicular within the tolerances shown in Figure 2-7. If adjustments are required, remove the probe and packing, and thread a pipe into the threaded fitting a few feet long. With the leverage of the pipe, force the threaded fitting into the proper position.

> **NOTE**
> Do not try to use the Pitot Tube as a lever. Damage to the probe and/or packing can result!

6. Once alignment is verified, perform a final weld of the threaded fitting.



7. Re-assemble the packing and insert the Pitot Tube as described in Section 2.2.3.

2.3.2 FPT-6100 (Low Pressure) and FPT-6200 (High Pressure) Pitot Tubes

1. Perform the general preparation steps as outlined in Section 2.2.1.

2. Slide the fitting nut onto the probe with the threaded end facing the tip of the probe.

3. Slide the ferrule onto the probe such that the angle of the taper slopes downward toward the probe tip.

4. With the fitting body already assembled and tightened onto the threaded coupling, insert the probe into the line.

5. Slide the ferrule into the fitting body.

6. Thread the nut onto the fitting body fingertight.

7. Properly position the probe so that the high pressure connection (side connection) is pointing upstream within the tolerances as shown in Figure 2-7.

8. Withdraw the probe tip from the opposite end of the pipe 1/16" for line sizes 12" and smaller, and 1/8" for larger lines sizes. This measure properly locates the sensing port holes and allows for thermal expansion of the probe.

9. Tighten the nut with a wrench an additional number of turns as follows. Hold the fitting body with a second wrench to prevent the body from turning. It is helpful to mark the nut to facilitate counting the number of turns.

CAUTION
Do Not Overtighten.

Sealing turns from handtight required
Stainless steel fitting on probe
3/8" through 1" O.D. . . . . .1-1/4 turns
Brass fittings on probe diameters
3/8" and 3/4" .2-1/4 turns

10. For maximum number of remakes, mark the fitting and nut (scribe or ink) before disassembly. Remake by tightening until marks line up again. A slight torque rise will be felt indicating the ferrule is being resprung into sealing position. Only after several remakes may it become necessary to advance the nut slightly past original position. This advance need only be 10°-20° (less than 1/3 of a hex flat).

11. The FPT-6100/6200 Pitot Tube is now prepared for instrument connection and operation.

2.3.3 Low Pressure Wet Tap, FPT-6300 Pitot Tube

1. Verify that the operating pressure and temperature are within the published limit of the Pitot Tube, probe valves, and mounting assembly. Refer to Table 3-1 in Section 3, "Operation."

2. Prepare the pipe surface for welding and tack weld the Thred-O-Let to the pipe. Verify alignment of the Thred-O-Let and finish the weld (see Section 2.2.1).

2.3.3 Low Pressure Wet Tap, FPT-6300 Pitot Tube (Continued)

3. Assemble the support nipple (on 3/4" probes only) and the insertion valve. Pipe sealant/dope is recommended on all pipe threads on the mounting assembly. Be sure that the insertion valve is in the fully open position.

4. Assemble the packing gland fitting onto the valve. The fitting need only be hand tightened and the ferrule need not be in place at this time.

5. Slide the guide punch through the fitting until it touches the pipe (diameter of the guide punch must be the same diameter as the Pitot Tube).

6. Impact the punch to leave the impression on the pipe to aid in starting the drill.

7. Remove the punch and the packing gland fitting from the insertion valve.

8. Insert the drill through the insertion valve and reassemble the packing ferrule and nut around the drill shank.

> **NOTE**
> The taper end of the ferrule slips into the packing gland fitting body.

9. Lightly wrench tighten the nut in place. Double check that all connections are tight and the insertion valve is fully open.

10. Mount the drill motor onto the drill and penetrate the pipe. The mounting assembly is now pressurized.

2.3.3 Low Pressure Wet Tap, FPT-6300 Pitot Tubes (Continued)

11. Retract the drill bit until it stops against the packing gland fitting and disassemble the drill motor from the drill bit.

12. Close the valve.

13. Slowly loosen the packing gland fitting to vent any pressure. Remove the drill bit.

14. Assemble the reducing bushing (on 3/4" probe only) and cage pipe onto the insertion valve.

15. Assemble the pipe coupling onto the end of the cage pipe.

16. Assemble the packing gland fitting onto the pipe coupling. Be sure that the ferrule is in place with the taper end into the body of the fitting and the nut loose on the fitting body. All other joints should be wrench-tight.

17. Insert the Pitot Tube probe into the packing gland fitting and slide down until the tip meets the insertion valve.

18. Lightly wrench tighten the compression nut onto the Pitot Tube probe.

19. Attach the safety chain to the head of the Pitot Tube probe and to the chain hook located on the bottom side of the insertion valve. There should be little slack in the chain. This chain is an imperative safety measure to prevent the Pitot Tube probe from accidently being forced out of the assembly under pressure.

20. Verify that both instrument valves are fully closed.

2.3.3 Low Pressure Wet Tap, FPT-6300 Pitot Tubes (Continued)

21. Open the insertion valve fully. The entire system is again pressurized including the Pitot Tube probe. Any leakage at the compression gland fitting can be corrected by further tightening the packing gland nut.

22. Manually push the probe in through the mounting assembly until the tip touches the opposite wall of the pipe line.

23. Retract the probe 1/16" on line sizes 12" and less, and 1/8" for larger line sizes. This measure properly locates the sensing port holes and allows for thermal expansion of the probe. Align the probe so that the side head connection points into the flow.

24. Tighten the nut on the packing gland fitting two turns form the handtight/light wrench position for final sealing/holding capability.

CAUTION

Do not overtighten! Probe damage can result from overtightening.

25. Readjust the chain position so that the chain is taut in this fully inserted position.

26. Verify the alignment of the probe head with respect to the pipe line. The side pressure port should point directly upstream. Refer to Figure 2.7.

27. The Pitot Tube is now ready to be placed into operation.

2.3.4 FPT-6300 Pitot Tube Probe Removal

1. Close the high and low pressure instrument valves.

2. Disconnect or modify line connections to head to allow probe removal.

3. As a precaution, hold the probe in place and adjust the safety chain to allow 2 links of slack.

4. Still holding the probe loosen the packing gland fitting nut slowly until the probe can be withdrawn.

5. Withdrawn the probe until the chain tightens. Retighten the packing nut.

6. Gently attempt to close the insertion valve. If the probe prevents it from closing, adjust the chain to allow 2 additional links of slack. Remove the probe further and again attempt to close the valve. Repeat this as necessary.

7. With the valve closed, there is still residual pressure in the upper portion of the assembly. This can be relieved by venting either or both of the valves on the Pitot Tube head.

8. The probe can now be fully removed.

2.3.5 Special Applications

(a) Ducts
The mounting technique for circular and rectangular ducts is most frequently the same as used for pipe in which a threaded coupling is welded in place. In instances where the duct wall is too thin to permit welding, a sheet metal

2.3.5 Special Applications (Continued)

flange option is available for bolt mounting. The flange is to be used with a user provided gasket or sealant between the flange and the duct. The surface of the duct where the gasket lays must be cleaned prior to application. All other standard instructions remain unchanged. This type of mounting is limited to pressures below 3 PSI.

(b) Saddle Clamps
Saddle clamps are used in applications where welding is not desired or possible. Saddle clamp mounting is accomplished by preparing the area around the hole that has been drilled. The gasket on the saddle clamp is placed around the hole and the unit is then bolted in place. It is important to bolt the saddle clamp as tightly as possible without damage to the pipe. All other instructions for the standard models apply.

SECTION 3. OPERATION

3.1 Operational Considerations

The Pitot Tube flow sensor is a bi-directional flowmeter; it can measure flow in either direction. The Pitot Tube head is labeled High and Low pressure as observed for normal flow directions. With reverse flow, the High pressure signal will occur at the Low pressure port and vice versa. Reverse flow measurement is as precise as forward flow. This unique feature allows measurement of flow which changes direction. Special consideration should be given to the indicating instrument. Instruments which allow positive and negative (zero center) differential pressure readings are best applied here.

Pitot Tube probes have limits as to the maximum flow rate that can be tolerated without risking damage to the sensor. The limits are defined as the maximum allowable differential pressure (Refer to Specifications).

3.2 Field Operational Preparation

Once the Pitot Tube is installed in the proper location and the instrument lines are installed to the indicator, the unit is prepared for operation. Operation of the Pitot Tube involves setting valves in the proper sequence. Refer to Figure 3-1 in the following steps.

1. Verify that the operating pressure and temperature are within the Pitot Tube and valve limitations (see Table 3-1).

2. Close Pitot Tube valves A and B and start up the system.

3. Open valves, C, D and E on the three valve manifold (the indicator should read zero).

3.2 Field Operational Preparation (Continued)

4. Open valves A and B.

5. Close valve E.

6. For liquid applications, open and bleed off air at any points where vent valves have been included.

7. The Pitot Tube is now in operation. In most cases the system can be shut down and turned on again without performing the startup sequence. For liquid applications, air venting should be done on a regular basis and also upon system restarts. On steam installations, a stabilization period of 1/2 hour may sometimes be required.

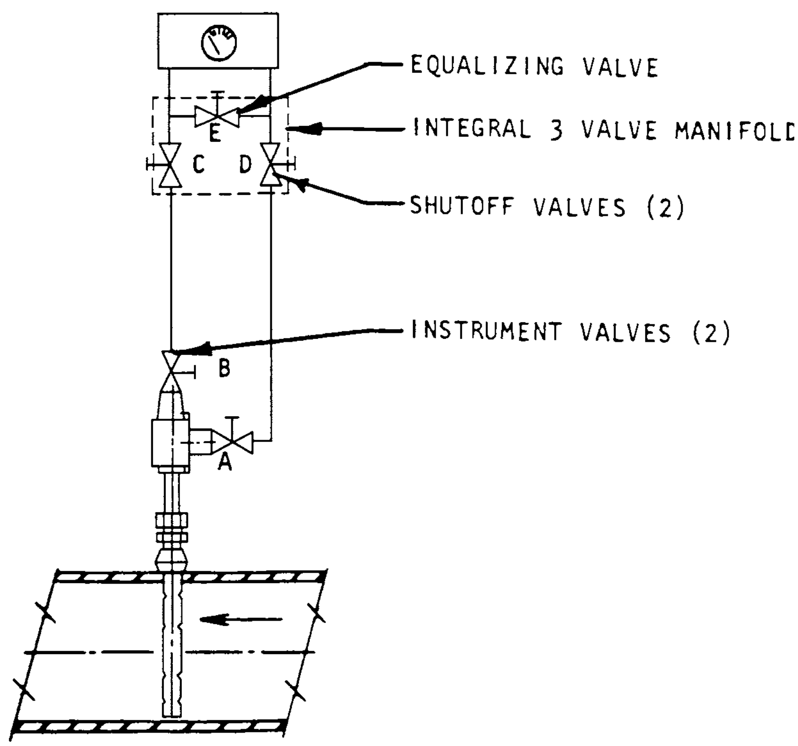


Figure 3-1. Pitot Tube Typical Valve Arrangement

TABLE 3-1
PITOT TUBE PRESSURE AND TEMPERATURE LIMITATIONS

FPT-6000 Series	Maximum Allowable Pressure PSIG	At	°F[1] Temperature
FPT-6100	150		200
FPT-6200	1500		500
FPT-6300[2]	150		190

(1) Consult factory where pressure or temperature exceeds either allowable maximum.

(2) Wet tap assembly rating is also limited by insertion valve rating.

SECTION 4. SERVICE INFORMATION

4.1 Interchangeability

The Pitot Tubes can be conveniently interchanged between different measuring points.

4.1.1 Functional Versatility

The Pitot Tubes can be used to measure any type of fluid (liquid, gas and steam). The fluid must be compatible with the probe material and must be single phase. Multi-phase fluids such as gases with a significant amount of entrained liquids or liquids with significant entrained gases may not be accurately measured.

Any Pitot Tube can be interchanged between pipe lines as long as the inside diameters are the same and the pressure rating of the probe and/or valves are not exceeded. The sensing port spacings are designed for specific inside pipe diameter. Use of the Pitot Tube in pipe with the inside diameter different from its designed inside diameter will result in measurement errors.

4.1.2 Packing Fitting Reusability

The packing gland fitting can be made and remade a number of times, however, the compression ferrule becomes permanently crimped onto the Pitot Tube probe shaft after the first assembly. The ferrule is not removable. The ferrule can be assembled into different fitting bodies of the same make.

4.2 Maintenance

4.2.1 Cleaning

Pitot Tube performance is generally not sensitive to dirt and film buildup. However, if contamination can build up to the point where internal or port hole blockage is threatened, then precautions must be taken to prevent this.

One method commonly used is occasional probe removal for thorough cleaning. Purging systems are also used which on regular intervals inject air or fluid through the probe into the pipe line system, thus flushing out the probe interior. A pressure source, and a system of control valves are required to do this.

4.2.2 Troubleshooting

Should measurement problems occur with the pitot Tube probe, the following is a check list of possible causes with their corresponding corrective actions.

Probable Cause	Corrective Action
Probe position	Verify orientation of probe as stated in Section 2.1
Upstream/Downstream piping configuration	Verify straight pipe run is as recommended in Section 2.1, Table 2.1
Pipe internal diameter	Verify the inside diameter is nominally the same as that for which the probe is designed (standard product is Schedule 40 on 20 inches line size and less, and standard weight in larger line sizes).

4.2.2 Troubleshooting (Continued)

Probable Cause	Corrective Action
Flow magnitude and direction	Verify that the reference source for expected flow is accurate.
Indicator calibration	Verify indicator accuracy.
Indicator scale	In installations where the scale is calibrated in flow units for specific flowing conditions, verify operating conditions agree with scale design conditions. Corrections factors may be necessary.
Air entrapment	In liquid and steam applications, air trapped in high pockets of instrument piping can cause erratic/erroneous signals.
Blockage	Internal blockage will give an incorrect or no flow indication. Check the probe for obstruction (See Section 4.2.1, "Cleaning").

4.2.3 Replacement Parts

Pitot Tube probes are completely welded sealed units for greatest integrity and reliability. No parts within the probe are replaceable. Mounting hardware and accessory parts can be obtained from OMEGA as replacement parts.

SECTION 5 SPECIFICATIONS

Accuracy:	Up to 1% of rate (Accuracy stated is for use in Schedule 40 pipe). Add 1% to accuracy if used in Schedule 80 pipe or request special construction.
Repeatability:	±0.1% of rate.
Max. Temperature:	FPT-6100: 200° F FPT-6200: 400° F FPT-6300: 190° F
Max. Pressure:	FPT-6100: 150 PSIG FPT-6200: 1500 PSIG FPT-6300: 100 PSIG DURING INTERSECTION 150 PSIG OPERATING
Unrecoverable Pressure Drop ("H_2O):	DP x (CP/D) Where: DP = generated differential pressure (inches H_2O) CP = pressure loss coefficient: .296 for 3/8" diameter probe .387 for 1/2" diameter probe .757 for 3/4" diameter probe .945 for 1" diameter probe D = inside pipe diameter (inches)
Wetted Parts:	For Model FPT-6100: 316SS shaft, brass packing and head, carbon steel weld coupling, 1/4" flair brass valve, and Delrin (polyacetal) ferrule. For Model FPT-6200: 316SS shaft, packing and head, carbon steel weld coupling, 1/2" FNPT carbon steel block valves, and Delrin (polyacetal) ferrule. For Model FPT-6300: Carbon steel welded coupling and pipe fittings, brass ball valve and packing, and Delrin (polyacetal) ferrule. For 316SS construction, consult engineering.

Dimensions:

For Model FPT-6100:
Add 4-7/8" to line size to determine overall length without valves.
Add 7-1/2" to line size to determine clearance required to install unit.

For Model FPT-6300:
Add 8-1/4" to line size to determine overall length without valves. Add 11-1/2" to line size to determine clearance required to install unit.

Model No. (Low Press.)	Nominal Line Size	Probe Dia.	Max. Differential Press. (inches H_2O)*	Max. GPM (Liquids)	K	Wt. (lb.)
FPT-6110	1"	3/8"	1200	115	.517	0.68
FPT-6112	1 1/4"	3/8"	833	179	.583	0.69
FPT-6115	1 1/2"	3/8"	668	220	.580	0.69
FPT-6120	2"	3/8"	459	315	.638	0.70
FPT-6125	2 1/2"	3/8"	338	410	.617	0.71
FPT-6130	3"	3/8"	237	552	.665	0.72
FPT-6135	3 1/2"	3/8"	186	657	.661	0.72
FPT-6140	4"	3/8"	150	756	.672	0.73
FPT-6160	6"	3/8"	72	1230	.706	0.77
FPT-6180	8"	3/4"	164	3109	.688	1.64
FPT-6181	10"	3/4"	107	4006	.676	1.76
FPT-6182	12"	3/4"	77	4830	.683	1.88

*Max. differential pressure shown is for up to 300° F. Above 300° F, reduce value by 4% per 100° F.

Model No. (High Press.)	Nominal Line Size	Probe Dia.	Max. Differential Press. (inches H_2O)*	Max. GPM (Liquids)	K	Wt. (lb.)
FPT-6220	2"	1/2"	1064	479	.557	2.30
FPT-6225	2 1/2"	1/2"	713	609	.598	2.32
FPT-6230	3"	1/2"	510	809	.645	2.34
FPT-6235	3 1/2"	1/2"	400	963	.630	2.36
FPT-6240	4"	1/2"	328	1119	.656	2.37
FPT-6260	6"	1/2"	163	1845	.662	2.45
FPT-6280	8"	1/2"	100	2428	.673	2.52
FPT-6281	10"	1/2"	66	3139	.682	2.59
FPT-6282	12"	1"	140	6565	.677	6.65
FPT-6283	14"	1"	117	7325	.665	6.78
FPT-6284	16"	1"	90	8285	.691	6.98
FPT-6285	18"	1"	72	9683	.678	7.19
FPT-6286	20"	1"	59	11000	.705	7.40
FPT-6287	24"	1"	41	13900	.708	7.81
FPT-6288	36"	1"	18	21400	.663	9.08

*Max. differential pressure shown is for up to 300° F. Above 300° F, reduce value by 4% per 100° F.

Model No.	Nominal Line Size	Probe Dia.	Max. Differential Press. (inches H_2O)	Max. GPM	K	Wt. (lb.)	A* (inches)
FPT-6310	1"	3/8"	1200	115	.521	2.6	10 3/8
FPT-6312	1 1/4"	3/8"	833	179	.536	2.6	10 3/4
FPT-6315	1 1/2"	3/8"	668	220	.556	2.6	11
FPT-6320	2"	3/8"	459	315	.586	2.6	11 1/2
FPT-6325	2 1/2"	3/8"	338	419	.617	2.7	12 1/2
FPT-6330	3"	3/8"	237	552	.665	2.8	13 3/4
FPT-6335	3 1/2"	3/8"	186	657	.661	2.8	14 1/2
FPT-6340	4"	3/8"	150	756	.670	2.9	15 1/2
FPT-6350	5"	3/8"	101	956	.671	3.0	17 1/2
FPT-6360	6"	3/8"	72	1230	.706	3.1	19 1/2
FPT-6380	8"	3/4"	164	3109	.688	6.29	25 3/8
FPT-6381	10"	3/4"	107	4006	.676	6.77	29 3/8
FPT-6382	12"	3/4"	77	4830	.683	7.10	33 1/8
FPT-6383	14"	3/4"	65	5443	.696	7.33	35 3/8
FPT-6384	16"	3/4"	50	6171	.688	7.72	39
FPT-6385	18"	3/4"	40	7195	.689	8.11	42 3/4
FPT-6386	20"	3/4"	32	8173	.686	8.51	46 1/2
FPT-6387	24"	3/4"	22	10210	.789	9.41	54 7/8
FPT-6388	30"	3/4"	14	12948	.729	10.63	66 1/2

*A+ nominal line size = overall length (approximate)
A+ nominal line size +5" = min. distance required for probe removal (approximate)

ADDENDUM A. FLOW CALCULATIONS

Flow Equations

1. Any Liquid

   $Q\ (GPM) = 5.668 \times K \times D_i^2 \times \sqrt{\triangle P / S_f}$

2. Steam or Any Gas

   $Q\ (lb/hr) = 359.1 \times K \times D_i^2 \times \sqrt{p \times \triangle P}$

3. Any Gas

   $Q\ (SCFM) = 128.8 \times K \times D_i^2 \times \sqrt{\dfrac{P \times \triangle P}{(T + 460) \times S_s}}$

Differential Pressure Equations

1. Any Liquid

   $\triangle P\ (in.\ H_2O) = \dfrac{Q^2\ (GPM) \times S_f}{K^2 \times D_i^4 \times 32.14}$

2. Steam or Any Gas (steam requires min$\triangle P$ of 2" H_2O)

   $\triangle P\ (in.\ H_2O) = \dfrac{Q^2\ (lb/hr)}{K^2 \times D_i^4 \times p \times 128{,}900}$

3. Any Gas

   $\triangle P\ (in.\ H_2O) = \dfrac{Q^2\ (scfm) \times S_s \times (T + 460)}{K^2 \times D_i^4 \times P \times 16{,}590}$

Technical Notations

The following notations apply:

$\triangle P$ = differential pressure expressed in inches of water column
Q = flow expressed in GPM, SCFM, or PPH as shown in equation
K = flow coefficient – See Tables A1 and A2
D_i = inside diameter of line size expressed in inches
For square and rectangular ducts use:

$$D_i = \sqrt{\frac{P \times \triangle P}{\Pi}}$$

TECHNICAL NOTATIONS (Continued)

P = static line pressure (psia)
T = temperature in degree Farenheit (plus 460 = °Rankin)
p = density of medium in pounds per cubic foot
S_f = specific gravity at flowing conditions
S_s = specific gravity at 60°F

TABLE A-1
FPT-6200 SERIES FLOW COEFFICIENT (K)
(HIGH PRESSURE)

1/2" DIAMETER PROBE

Pipe Size Inches	K
2	0.556
2-1/2	0.602
3	0.639
3-1/2	0.625
4	0.645
5	0.650
6	0.660
8	0.672
10	0.681

1" DIAMETER PROBE

Pipe Size Inches	K
6	0.620
8	0.645
10	0.625
12	0.665
14	0.655
16	0.688
18	0.674
20	0.670
24	0.697
30	0.675
36	0.675
42	0.684

TABLE A-2
FPT-6100/6300 SERIES FLOW COEFFICIENT (K)
(LOW PRESSURE)

3/8" DIAMETER PROBE

Pipe Size Inches	K
1	0.521
1-1/4	0.536
1-1/2	0.556
2	0.586
2-1/2	0.625
3	0.645
3-1/2	0.661
4	0.670
5	0.681
6	0.689
8	0.690
10	0.691

3/4" DIAMETER PROBE

Pipe Size Inches	K
6	0.652
8	0.669
10	0.677
12	0.683
14	0.686
16	0.688
18	0.689
20	0.690
24	0.692
30	0.694
36	0.695
42	0.697

WARRANTY/DISCLAIMER

OMEGA ENGINEERING, INC. warrants this unit to be free of defects in materials and workmanship for a period of **13 months** from date of purchase. OMEGA's WARRANTY adds an additional one (1) month grace period to the normal **one (1) year product warranty** to cover handling and shipping time. This ensures that OMEGA's customers receive maximum coverage on each product.

If the unit malfunctions, it must be returned to the factory for evaluation. OMEGA's Customer Service Department will issue an Authorized Return (AR) number immediately upon phone or written request. Upon examination by OMEGA, if the unit is found to be defective, it will be repaired or replaced at no charge. OMEGA's WARRANTY does not apply to defects resulting from any action of the purchaser, including but not limited to mishandling, improper interfacing, operation outside of design limits, improper repair, or unauthorized modification. This WARRANTY is VOID if the unit shows evidence of having been tampered with or shows evidence of having been damaged as a result of excessive corrosion; or current, heat, moisture or vibration; improper specification; misapplication; misuse or other operating conditions outside of OMEGA's control. Components in which wear is not warranted, include but are not limited to contact points, fuses, and triacs.

OMEGA is pleased to offer suggestions on the use of its various products. However, OMEGA neither assumes responsibility for any omissions or errors nor assumes liability for any damages that result from the use of its products in accordance with information provided by OMEGA, either verbal or written. OMEGA warrants only that the parts manufactured by the company will be as specified and free of defects. OMEGA MAKES NO OTHER WARRANTIES OR REPRESENTATIONS OF ANY KIND WHATSOEVER, EXPRESSED OR IMPLIED, EXCEPT THAT OF TITLE, AND ALL IMPLIED WARRANTIES INCLUDING ANY WARRANTY OF MERCHANTABILITY AND FITNESS FOR A PARTICULAR PURPOSE ARE HEREBY DISCLAIMED. LIMITATION OF LIABILITY: The remedies of purchaser set forth herein are exclusive, and the total liability of OMEGA with respect to this order, whether based on contract, warranty, negligence, indemnification, strict liability or otherwise, shall not exceed the purchase price of the component upon which liability is based. In no event shall OMEGA be liable for consequential, incidental or special damages.

CONDITIONS: Equipment sold by OMEGA is not intended to be used, nor shall it be used: (1) as a "Basic Component" under 10 CFR 21 (NRC), used in or with any nuclear installation or activity; or (2) in medical applications or used on humans. Should any Product(s) be used in or with any nuclear installation or activity, medical application, used on humans, or misused in any way, OMEGA assumes no responsibility as set forth in our basic WARRANTY/DISCLAIMER language, and, additionally, purchaser will indemnify OMEGA and hold OMEGA harmless from any liability or damage whatsoever arising out of the use of the Product(s) in such a manner.

RETURN REQUESTS/INQUIRIES

Direct all warranty and repair requests/inquiries to the OMEGA Customer Service Department. BEFORE RETURNING ANY PRODUCT(S) TO OMEGA, PURCHASER MUST OBTAIN AN AUTHORIZED RETURN (AR) NUMBER FROM OMEGA'S CUSTOMER SERVICE DEPARTMENT (IN ORDER TO AVOID PROCESSING DELAYS). The assigned AR number should then be marked on the outside of the return package and on any correspondence.

The purchaser is responsible for shipping charges, freight, insurance and proper packaging to prevent breakage in transit.

FOR **WARRANTY** RETURNS, please have the following information available BEFORE contacting OMEGA:

1. Purchase Order number under which the product was PURCHASED,
2. Model and serial number of the product under warranty, and
3. Repair instructions and/or specific problems relative to the product.

FOR **NON-WARRANTY** REPAIRS, consult OMEGA for current repair charges. Have the following information available BEFORE contacting OMEGA:

1. Purchase Order number to cover the COST of the repair,
2. Model and serial number of the product, and
3. Repair instructions and/or specific problems relative to the product.

OMEGA's policy is to make running changes, not model changes, whenever an improvement is possible. This affords our customers the latest in technology and engineering.

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