Section 2 Installation

Safety Messages . . . . . page 2-1
Installation Flowchart and Checklist . . . . . page 2-2
Mounting . . . . . page 2-4
Installation . . . . . page 2-18
Wire the Transmitter . . . . . page 2-53

SAFETY MESSAGES

Instructions and procedures in this section may require special precautions to ensure the safety of the personnel performing the operations. Please refer to the following safety messages before performing any operation in this section.

⚠CAUTION

If pipe/duct wall is less than .125" (3.2mm) use extreme caution when installing sensor. Thin walls can deform during welding, installation, or from the weight of a cantilevered flowmeter. These installations may require a fabricated outlet, saddle, or external flowmeter support. Please consult factory for assistance.

⚠WARNING

Explosions could result in death or serious injury:

- Do not remove the transmitter cover in explosive atmospheres when the circuit is live.
- Before connecting a Field Communicator in an explosive atmosphere, make sure the instruments in the loop are installed in accordance with intrinsically safe or non-incendive field wiring practices.
- Verify that the operating atmosphere of the transmitter is consistent with the appropriate hazardous locations certifications.
- Both transmitter covers must be fully engaged to meet explosion-proof requirements.

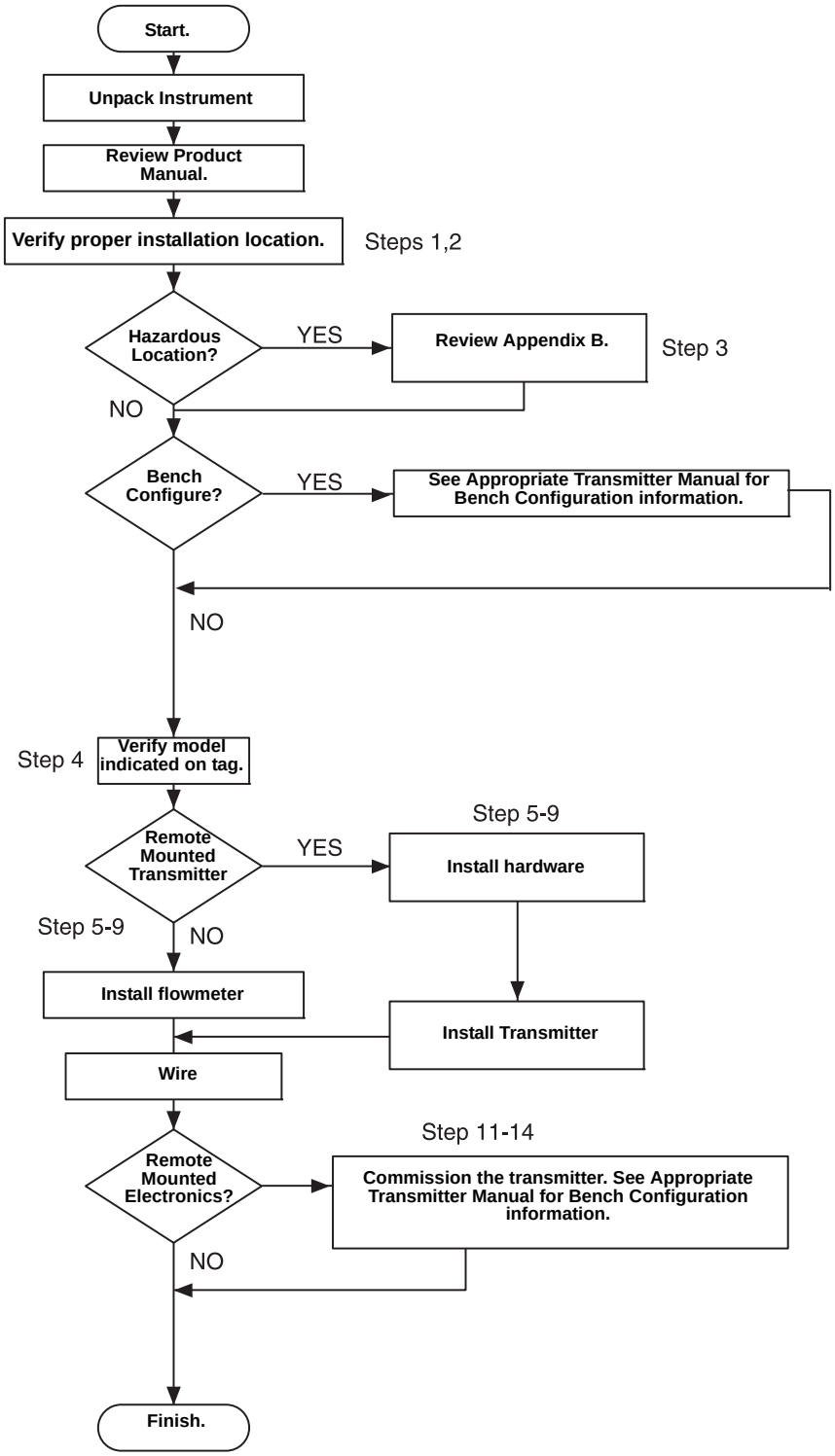
Failure to follow these installation guidelines could result in death or serious injury:

- Make sure only qualified personnel perform the installation.

INSTALLATION FLOWCHART AND CHECKLIST

Figure 2-1 is an installation flowchart that provides guidance through the installation process. Following the figure, an installation checklist has been provided to verify that all critical steps have been taken in the installation process. The checklist numbers are indicated in the flowchart.

Figure 2-1. Installation Chart



The following list is a summary of the steps required to complete a flowmeter installation. If this is a new installation, begin with step 1. If the mounting is already in place, verify that the hole size and the fittings match the recommended specifications (see Table 2-3 on page 2-19) and begin with step 5.

1. Determine where the flowmeter is to be placed within the piping system.
2. Establish the proper orientation as determined by the intended application.
3. Review Appendix B: Approvals and determine if the flowmeter is located in a hazardous location.
4. Confirm the configuration.
5. Drill the correct sized hole into the pipe and deburr. Do not torch-cut holes.
6. For instruments equipped with opposite-side support, drill a second hole 180° from the first hole.
7. Weld the mounting per plant welding procedures.
8. Measure the pipe's internal diameter (ID), preferably at 1 x ID from the hole (upstream or downstream).

NOTE
To maintain published flowmeter accuracy, provide the pipe ID when purchasing the flowmeter.

9. Check the fit-up of the instrument assembly to the pipe.
10. Install the flowmeter.
11. Wire the instrument.
12. Supply power to the flowmeter.
13. Perform a trim for mounting effects.
14. Check for leaks.
15. Commission the instrument.

MOUNTING

Tools and Supplies

Tools required include the following:

- Open end or combination wrenches (spanners) to fit the pipe fittings and bolts: 9/16-in., 5/8-in., 7/8-in.
- Adjustable wrench: 15-in. (1½-in. jaw).
- Nut driver: 3/8-in. for vent/drain valves (or 3/8-in. wrench).
- Phillip's screwdriver: #1.
- Standard screwdrivers: ¼-in., and 1/8-in. wide.
- Pipe wrench: 14-in.
- Wire cutters/strippers
- 7/16-in. box wrench (required for the ferry head bolt design)

Supplies required include the following:

- ½-in. tubing or ½-in. pipe (recommended) to hook up the electronics to the sensor probe. The length required depends upon the distance between the electronics and the sensor.
- Fittings including (but not limited to)
  - Two tube or pipe tees (for steam or high temperature liquid) and
  - Six tube/pipe fittings (for tube)
- Pipe compound or PTFE tape (where local piping codes allow).

Mounting Brackets

Mounting brackets are provided with any flowmeter order with a remote mounted transmitter to facilitate mounting to a panel, wall, or 2-in. (50.8 mm) pipe. The bracket option for use with the Coplanar flange is 316 SST with 316 SST bolts.

When installing the transmitter to one of the mounting brackets, torque the bolts to 125 in-lb (169 n-m).

Bolt Installation Guidelines

The following guidelines have been established to ensure a tight flange, adapter, or manifold seal. Only use bolts supplied with the instrument or sold by the factory.

The instrument is shipped with the coplanar flange installed with four 1.75-in. (44.5 mm) flange bolts. The following bolts also are supplied to facilitate other mounting configurations:

- Four 2.25-in. (57.2 mm) manifold/flange bolts for mounting the coplanar flange on a three-valve manifold. In this configuration, the 1.75-in. (44.5 mm) bolts may be used to mount the flange adapters to the process connection side of the manifold.
- (Optional) If flange adapters are ordered, four 2.88-in. (73.2 mm) flange/adapter bolts for mounting the flange adapters to the coplanar flange.

Stainless steel bolts supplied by Rosemount Inc. are coated with a lubricant to ease installation. Carbon steel bolts do not require lubrication. Do not apply additional lubricant when installing either type of bolt. Bolts supplied by Rosemount Inc. are identified by the following head markings:

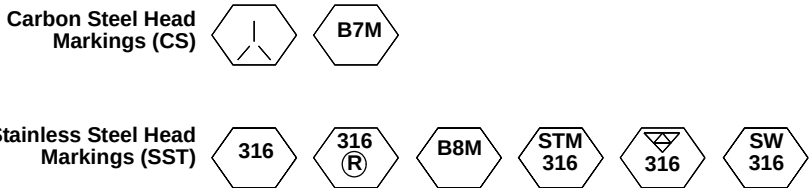
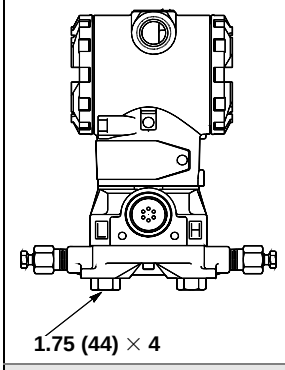
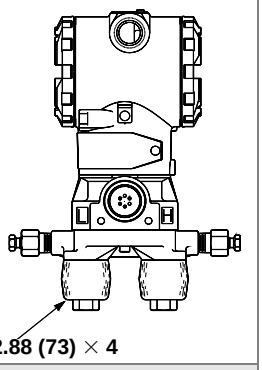
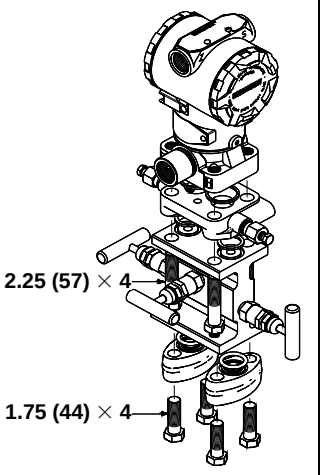


Figure 2-2. Coplanar Mounting Bolts and Bolting Configurations for Coplanar Flange.

Transmitter with Flange Bolts	Transmitter with Optional Flange Adapters and Flange/Adapter Bolts	Transmitter with 3-Valve Manifold, Manifold/Flange Bolts, Flange Adapters, and Flange/Adapter bolts
		

Description	Size in. (mm)
Flange bolts (4)	1.75 -in. (44 mm)
Flange/adapter bolts (4)	2.88 -in. (73 mm)
Manifold/flange bolts (4)	2.25 -in. (57 mm)

Instrument Manifolds

Figure 2-3 on page 2-6 identifies the valves on a 5-valve and a 3-valve manifold. Table 2-1 on page 2-6 explains the purpose of these valves.

An instrument manifold is recommended for all installations. A manifold allows an operator to equalize the pressures prior to the zero calibration of the transmitter as well as to isolate the electronics from the rest of the system without disconnecting the impulse piping. Although a 3-valve manifold can be used, a 5-valve manifold is recommended.

5-valve manifolds provide a positive method of indicating a partially closed or faulty equalizer valve. A closed faulty equalizer valve will block the DP signal and create errors that may not be detectable otherwise. The labels for each valve will be used to identify the proper valve in the procedures to follow.

NOTE
Some recently-designed instrument manifolds have a single valve actuator, but cannot perform all of the functions available on standard 5-valve units. Check with the manufacturer to verify the functions that a particular manifold can perform. In place of a manifold, individual valves may be arranged to provide the necessary isolation and equalization functions.

Figure 2-3. Valve Identification for 5-valve and 3-Valve Manifolds

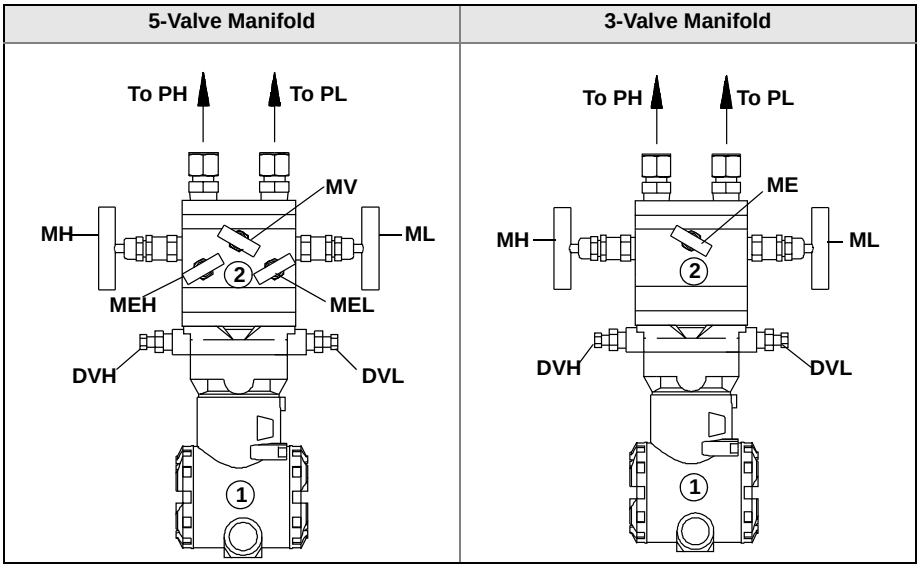


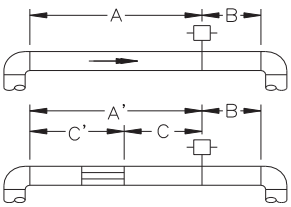
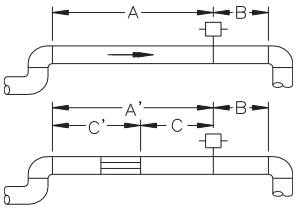
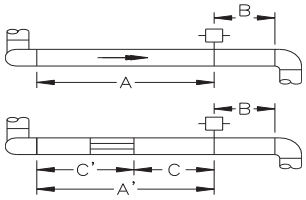
Table 2-1. Description of Impulse Valves and Components

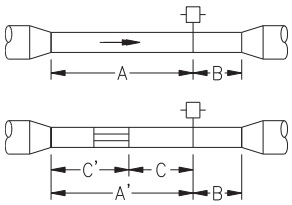
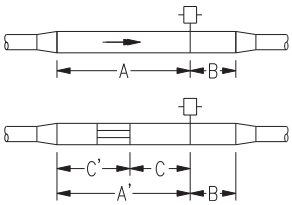
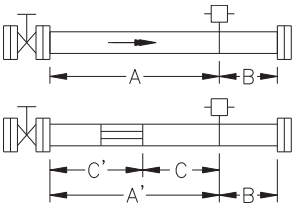
Name	Description	Purpose
Manifold and Impulse Pipe Valves		
PH	Primary Sensor – High Pressure	Isolates the flowmeter sensor from the impulse piping system
PL	Primary Sensor – Low Pressure	
DVH	Drain/Vent Valve – High Pressure	Drains (for gas service) or vents (for liquid or steam service) the DP electronics chambers
DVL	Drain/Vent Valve – Low Pressure	
MH	Manifold – High Pressure	Isolates high side or low side pressure from the process.
ML	Manifold – Low Pressure	
MEH	Manifold Equalizer – High Pressure	Allows high and low pressure side access to the vent valve, or for isolating the process fluid
MEL	Manifold Equalizer – Low Pressure	
ME	Manifold Equalizer	Allows high and low side pressure to equalize
MV	Manifold Vent Valve	Vents process fluid
Components		
1	Transmitter	Reads Differential Pressure
2	Manifold	Isolates and equalizes transmitter
3	Vent Chambers	Collects gases in liquid applications.
4	Condensate Chamber	Collects condensate in gas applications.

Straight Run Requirements

Use the following to aid in determining the straight run requirements

Table 2-2. Straight Run Requirements

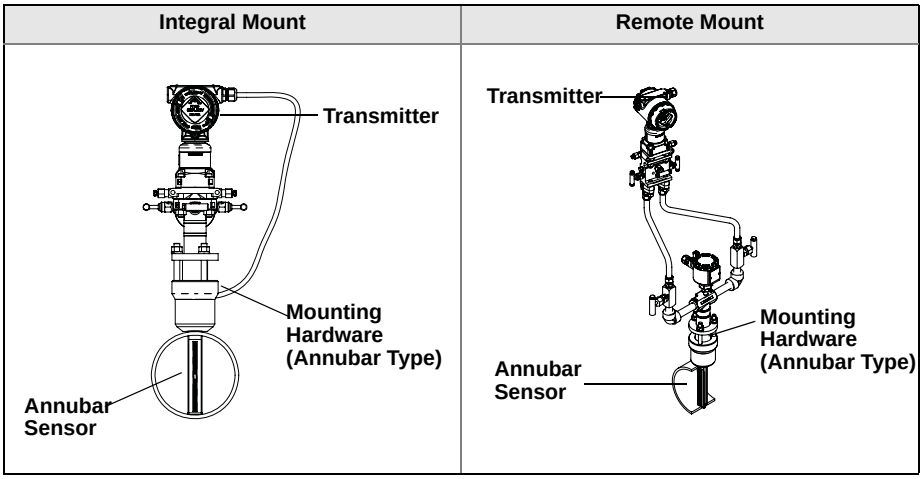
	In Plane / Out of Plane	Upstream Dimensions					Downstream Dimensions
		Without Straightening Vanes		With Straightening Vanes			
		In Plane A	Out of Plane A	A'	C	C'	B
1	**Single Elbow**  **Single Elbow with Straightening Vanes**	8 —	10 —	— 8	— 4	— 4	4 4
2	**Double Elbows in plane**  **Double Elbow in plane with Straigthening Vanes**	11 —	16 —	— 8	— 4	— 4	4 4
3	**Double Elbows out of plane**  **Double Elbows out of plane with Straightening Vanes**	23 —	28 —	— 8	— 4	— 4	4 4

	In Plane / Out of Plane	Upstream Dimensions					Downstream Dimensions
		Without Straightening Vanes		With Straightening Vanes			
		In Plane A	Out of Plane A	A'	C	C'	B
4	**Reducer**  **Reducer with Straightening Vanes**	12 —	12 —	— 8	— 4	— 4	4 4
5	**Expander**  **Expander with Straightening Vanes**	18 —	18 —	— 8	— 4	— 4	4 4
6	**Valve**  **Valve with Straightening Vanes**	30 —	30 —	— 8	— 4	— 4	4 4

NOTE

- If proper lengths of straight run are not available, position the mounting such that 80% of the run is upstream and 20% is downstream.
- “In Plane A” means the sensor is in the same plane as the elbow. “Out of Plane A” means the sensor is perpendicular to the plane of the elbow.
- The information contained in this manual is applicable to circular pipes only. Consult the factory for instructions regarding use in square or rectangular ducts.
- Straightening vanes may be used to reduce the required straight run length.
- Row 6 in Table 2-2 applies to gate, globe, plug, and other throttling valves that are partially opened, as well as control valves.

Figure 2-4. Mounting Configuration



NOTE
The direct-mounted flowmeter is usually shipped with the transmitter assembled to the sensor, unless it is ordered with a Remote-mount Transmitter Connection Platform.

Flowmeter Orientation

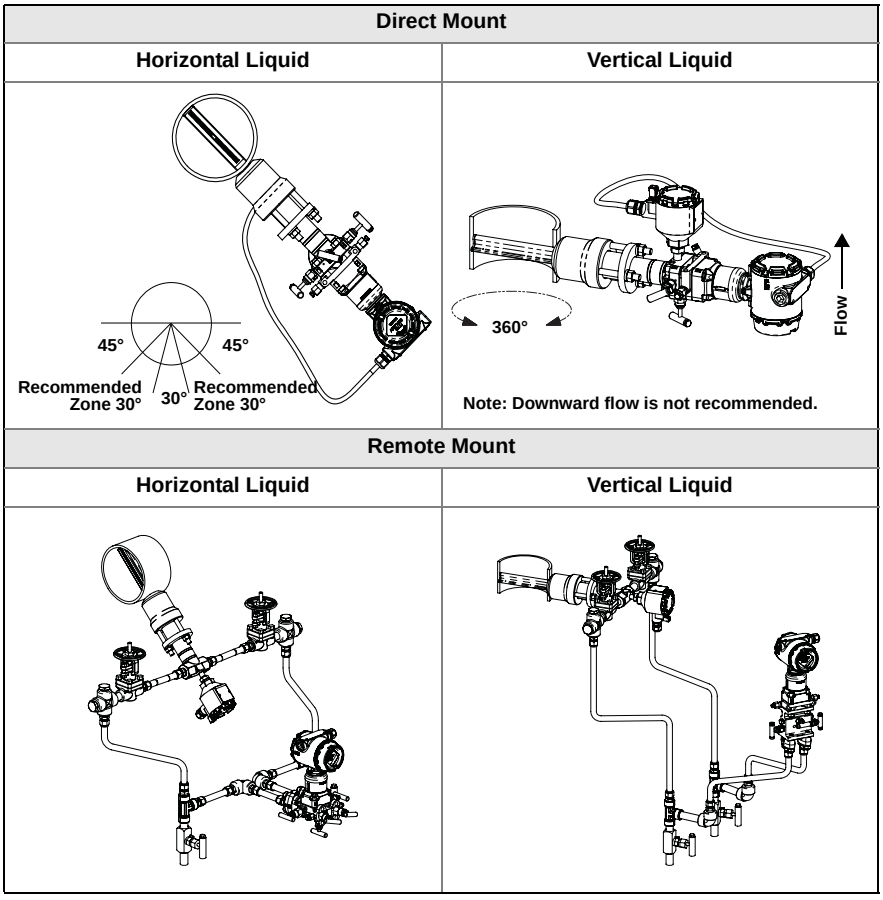
Liquid

Due to the possibility of air getting trapped in the Annubar sensor, it should be located according to Figure 2-5 for liquid applications. It should be mounted between 15° to 45° from vertical down to ensure that air is vented from the Annubar, and that sediment or solid particles are not collect within the Annubar.

For *liquid* applications, mount the side drain/vent valve upward to allow the gases to vent. In vertical lines, the Annubar sensor can be installed in any position around the circumference of the pipe, provided the vents are positioned properly for bleeding or venting. Vertical pipe installations require more frequent bleeding or venting, depending on the location.

For a remote mounted transmitter, mount the transmitter below the process piping, adjust 10° to 15° above direct vertical down. Route the impulse piping down to the transmitter and fill the system with cool water through the two cross fittings.

Figure 2-5. Liquid Applications



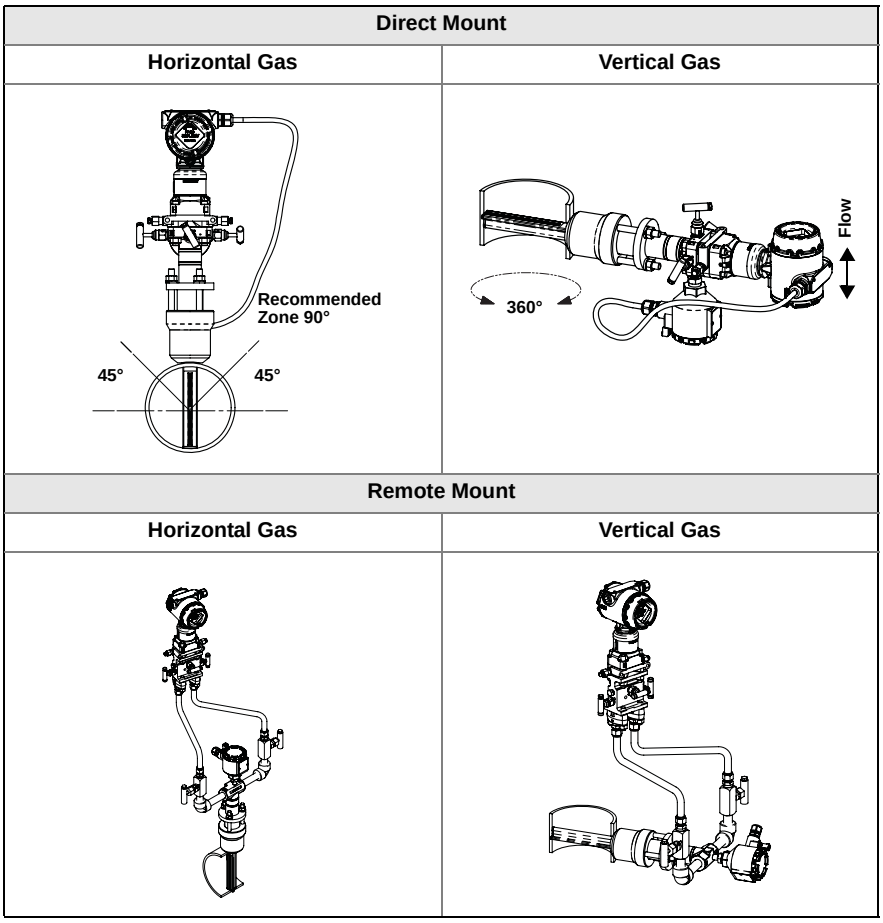
Gas

Figure 2-6 illustrates the recommended location of the flowmeter in gas applications. The sensor should be located on the upper half of the pipe, at least 45° above the horizontal line.

For *gas* applications, mount the drain/vent valve downward to allow liquid to drain. In vertical lines, the Annubar sensor can be installed in any position around the circumference of the pipe, provided the vents are positioned properly for bleeding or venting. Vertical pipe installations require more frequent bleeding or venting, depending on the location.

For a remote mounted transmitter, secure the transmitter above the Annubar sensor to prevent condensable liquids from collecting in the impulse piping and the DP cell.

Figure 2-6. Gas Applications



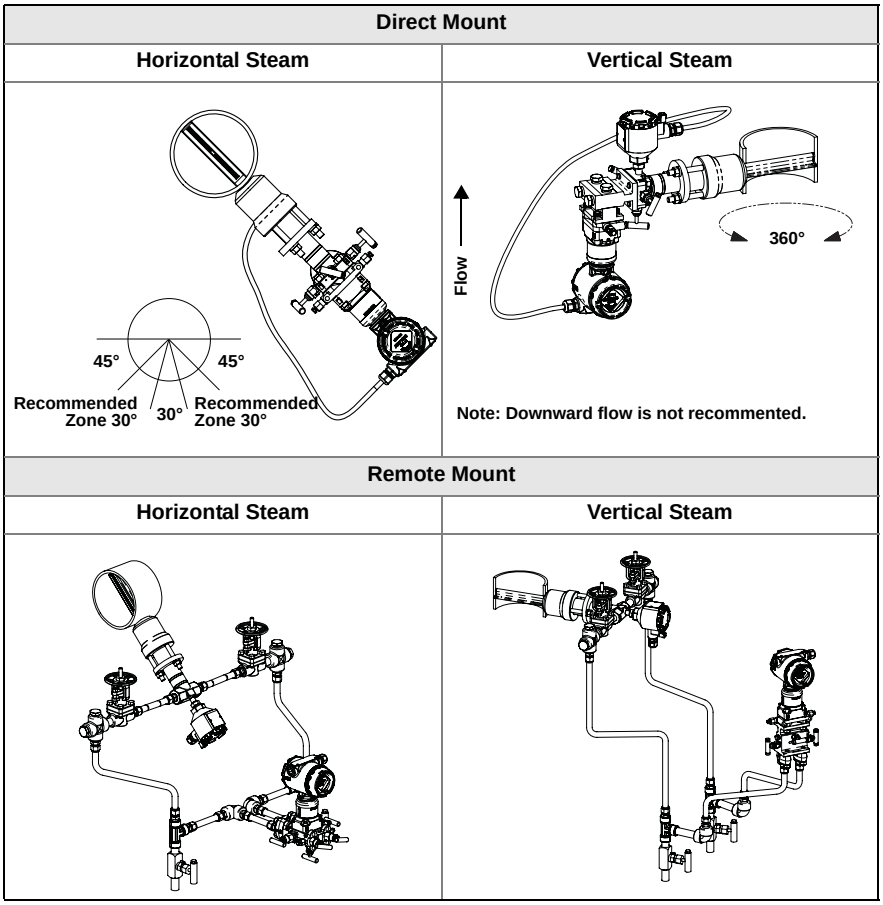
Steam

In *steam* applications, fill the lines with water to prevent the steam from contacting the transmitter. Condensate chambers are not required because the volumetric displacement of the transmitter is negligible.

For a remote mounted transmitter, mount the transmitter below the process piping, adjust to 10° to 15° above direct vertical down. Route the impulse piping down to the transmitter and fill the system with cool water through the two cross fittings.

Figure 2-7 illustrates the recommended location of the flowmeter in steam applications.

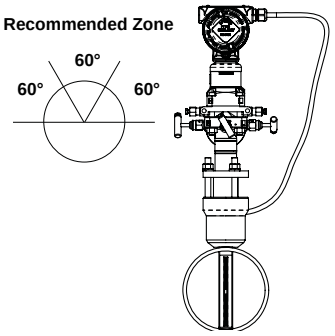
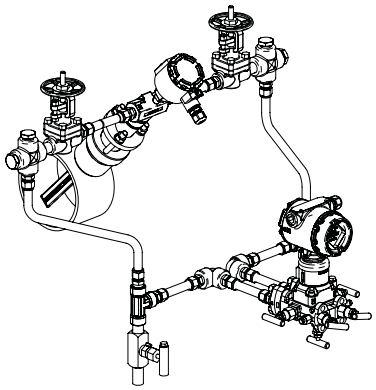
Figure 2-7. Steam Applications



Top Mounting for Steam

This orientation can be used for any steam temperature. However, it is recommended for installations above 600 °F (315 °C). For remote mount installations, the impulse piping should slope up slightly from the instrument connections on the Annubar to the cross fittings, allowing condensate to drain back into the pipe. From the cross fittings, the impulse piping should be routed downward to the transmitter and the drain legs. The transmitter should be located below the instrument connections of the Annubar. Depending on the environmental conditions, it may be necessary to insulate the mounting hardware. The temperature limit for top mounting a Direct Mount flowmeter is 400 °F (205 °C).

Figure 2-8. Top Mounting for Steam

Direct Mount	Remote Mount
Horizontal Top Mounting for Steam	
 **NOTE** For wet steam, do not mount the flowmeter at the direct vertical position. Mounting at an angle will avoid measurement inaccuracy due to water running along the bottom of the pipe.	

Remote Mounted Transmitter

Instrument head connections differ between horizontal and vertical pipes. For horizontal lines, the instrument connections are parallel to the pipe and for vertical lines, the instrument connection are perpendicular.

Valves and Fittings

Throughout the remote mounting process:

- Use only valves, fittings, and pipe thread sealant compounds that are rated for the service pipeline design pressure and temperature as specified in Appendix A: Specifications and Reference Data.
- Verify that all connections are tight and that all instrument valves are fully closed.
- Verify that the Annubar sensor is properly oriented for the intended type of service: liquid, gas, or steam (see “Flowmeter Orientation” on page 2-10).

Impulse Piping

Impulse piping connects a remote mounted transmitter to the Annubar sensor. Temperatures in excess of 250 °F (121 °C) at the transmitter will damage electronic components; impulse piping allows service flow temperatures to decrease to a point where the transmitter is no longer vulnerable.

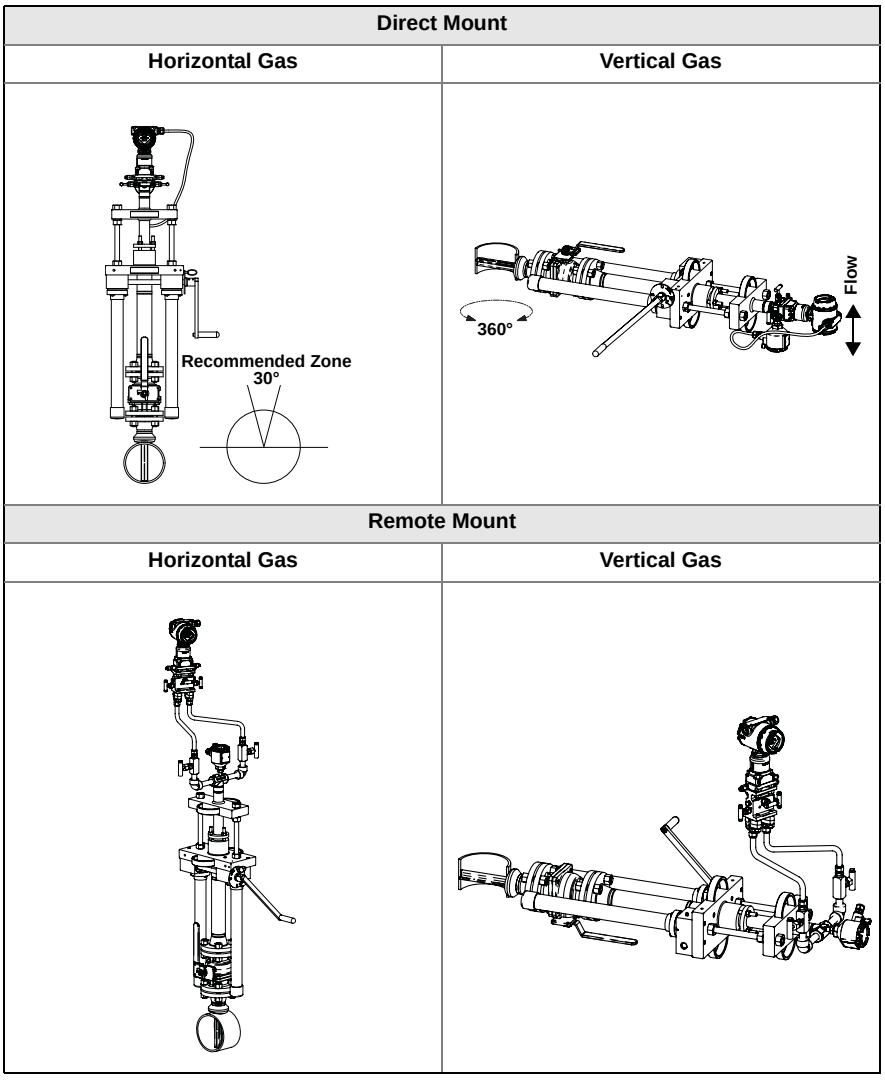
The following restrictions and recommendations apply to impulse piping location.

- Piping used to connect the Annubar sensor and transmitter must be rated for continuous operation at the pipeline-designed pressure and temperature.
- Impulse piping that runs horizontally must slope at least 1–in. per foot (83 mm/m).
- With the Annubar mounted below the pipe, impulse piping must slope downwards (toward the transmitter) for liquid and steam applications.
- With the Annubar mounted above the pipe, impulse piping must slope up (toward from the transmitter) for gas and top mount steam applications.
- For applications where the pipeline temperature is below 250 °F (121 °C), the impulse piping should be as short as possible to minimize flow temperature changes. Insulation may be required.
- For applications where pipeline temperature is above 250 °F (121 °C), the impulse piping should have a minimum length of 1-ft. (0.30 m) for every 100 °F (38 °C) over 250 °F (121 °C), which is the maximum operating transmitter temperature. Impulse piping must be uninsulated to reduce fluid temperature. All threaded connections should be checked after the system comes up to temperature, because connections may be loosened by the expansion and contraction caused by temperature changes.
- A minimum of ½-in. (12mm) outer diameter (OD) stainless steel tubing with a wall thickness of at least 0.035-in. is recommended.
- Outdoor installations for liquid, saturated gas, or steam service may require insulation and heat tracing to prevent freezing.
- For installations where the transmitter is more than 6-ft. (1.8m) from the Annubar sensor, the high and low impulse piping must be run together to maintain equal temperature. They must be supported to prevent sagging and vibration.
- Threaded pipe fittings are not recommended because they create voids where air can become entrapped and have more possibilities for leakage.
- Run impulse piping in protected areas or against walls or ceilings. If the impulse piping is run across the floor, ensure that it is protected with coverings or kick plates. Do not locate the impulse piping near high temperature piping or equipment.
- Use an appropriate pipe sealing compound rated for the service temperature on all threaded connections. When making threaded connections between stainless steel fittings, Loctite® PST® Sealant is recommended.

Flo-Tap Models

Figure 2-9. Gas Service

Gas



Liquid

Figure 2-10. Liquid Service

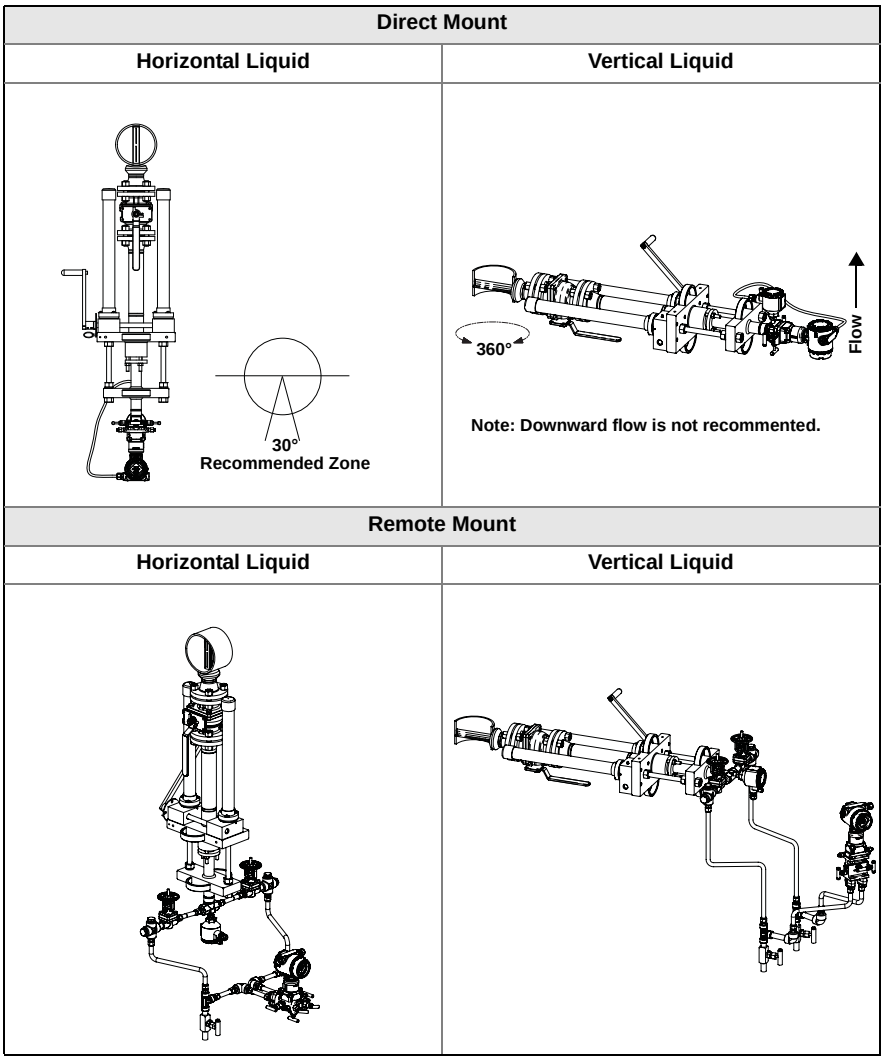


Figure 2-11. Steam

Steam

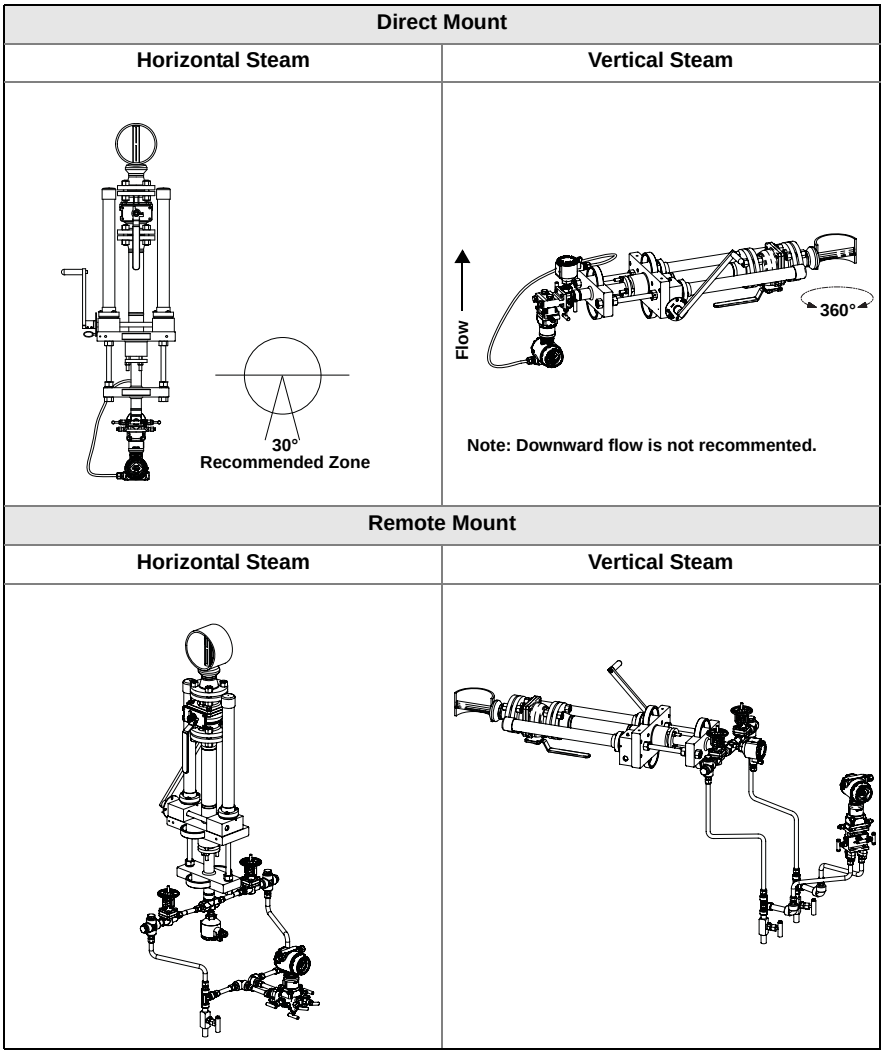
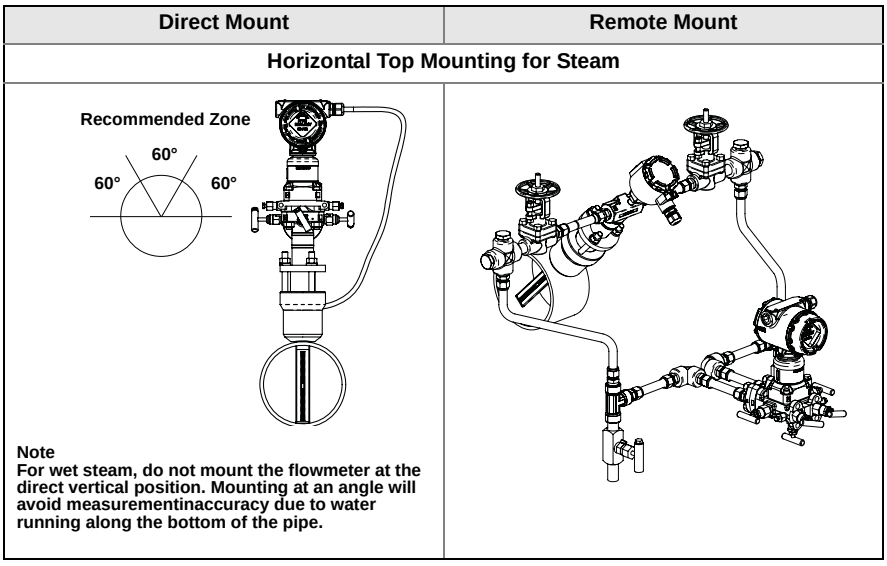


Figure 2-12. Top Mounting for Steam



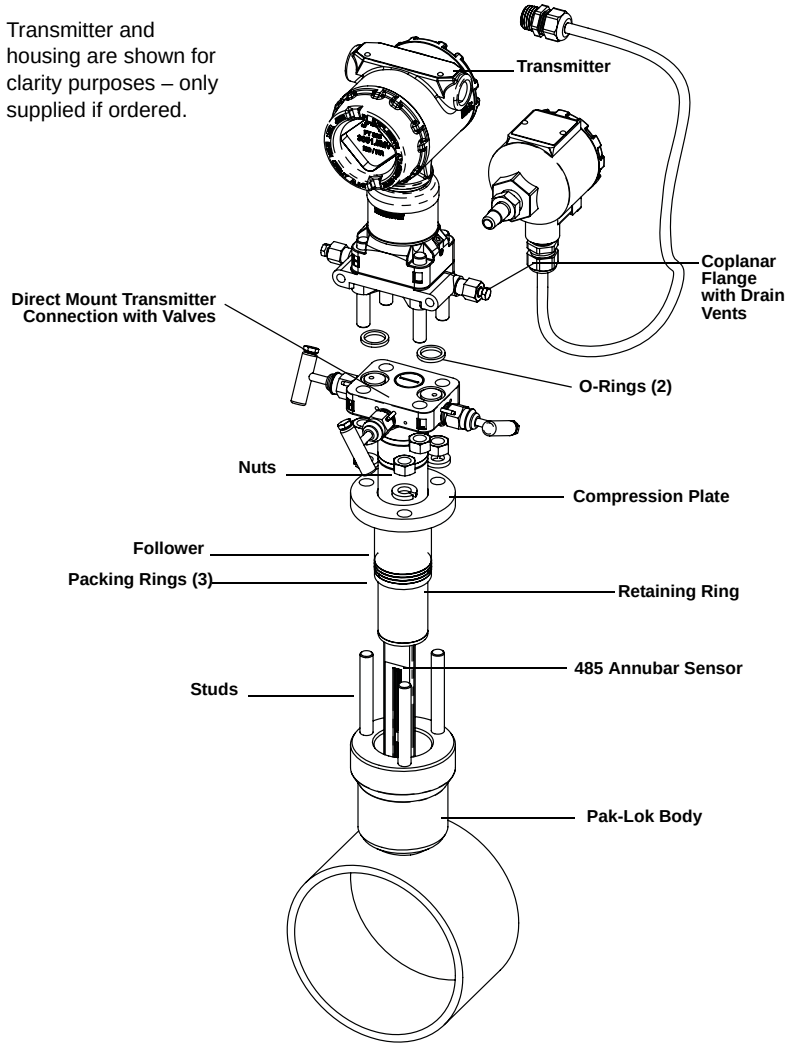
INSTALLATION

This manual contains the horizontal and vertical installation procedures for the Pak-Lok, Flanged, Flange-Lok, Threaded Flo-Tap, Flanged Flo-tap, and Main Steam Annubar models.

Pak-Lok Annubar Type (for 485 Annubar Flowmeters)

Figure 2-13 identifies the components of the Pak-Lok assembly.

Figure 2-13. Components



Step 1: Determine the Proper Orientation

Please refer to “Mounting” on page 2-4 for straight run requirements and orientation information.

Step 2: Drill a Hole into the Pipe

1. Determine the drill hole size based on the Sensor Size of Sensor Width.
2. Determine the sensor size based on the width of the Annubar. See Table 2-3.
3. From the previous steps, select the location to drill the hole.
4. Determine the diameter of the hole to be drilled according to the specifications in Table 2-3 and drill the hole with a hole saw or drill. **Do not torch cut the hole.**

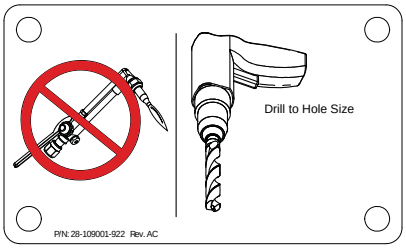
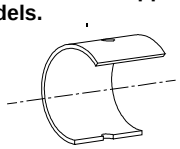


Table 2-3. 485 Sensor Size / Hole Diameter Chart

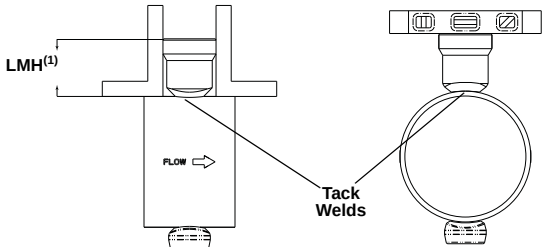
Sensor Size	Sensor Width	Hole Diameter		Note: Drill the hole 180° from the first hole for opposite- side support models.  Drill the appropriate diameter hole through the pipe wall.
1	0.590-in. (14.99 mm)	3/4-in. (19 mm)	+ 1/32-in (0.8 mm)	
			– 0.00	
2	1.060-in. (26.92 mm)	1 5/16-in. (34 mm)	+ 1/16-in. (1.6 mm)	
			– 0.00	
3	1.935-in. (49.15 mm)	2 1/2-in. (64 mm)	+ 1/16-in. (1.6 mm)	
			– 0.00	

5. If opposite-side support coupling is supplied, a second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. (To determine an opposite-side support model, measure the distance from the tip of the first slot or hole. If the distance is greater than 1-in. (25.4 mm), it is the opposite-side model.) To drill the second hole, follow these steps:
   a. Measure the pipe circumference with a pipe tape, soft wire, or string (for the most accurate measurement the pipe tape needs to be perpendicular to the axis of flow).
   b. Divide the measured circumference by two to determine the location of the second hole.
   c. Rewrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.
   d. Using the diameter determined from Table 2-3, drill the hole into the pipe with a hole saw or drill. **Do not torch cut the hole.**
6. Deburr the drilled hole(s) on the inside of the pipe.

Step 3: Weld the Mounting Hardware

1. Center the Pak-Lok body over the mounting hole, gap 1/16-in. (1.5 mm) and place four 1/4-in. (6-mm) tack welds at 90° increments.
2. Check alignment of the Pak-Lok body both parallel and perpendicular to the axis of flow. If alignment of mounting is within tolerances (see Figure 2-14), finish weld per local codes. If alignment is outside of specified tolerance, make adjustments prior to finish weld.

Figure 2-14. Alignment

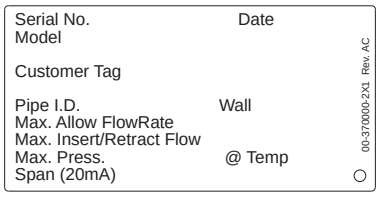


3. If opposite side support is being used, center the fitting for the opposite side support over the opposite side hole, gap 1/16-in. (1.5 mm) and place four 1/4-in. (6 mm) tack welds at 90° increments. Insert the sensor into the mounting hardware. Verify that the tip of the bar is centered in the opposite side fitting and verify that the plug will fit around bar. If the bar is centered in the fitting and plug fits around the bar, finish weld per local codes. If the alignment of the bar does not allow enough clearance to insert the opposite side plug, make the necessary adjustments prior to making the finish weld.
4. To avoid serious burns, allow the mounting hardware to cool before continuing.

Step 4: Insert Annubar

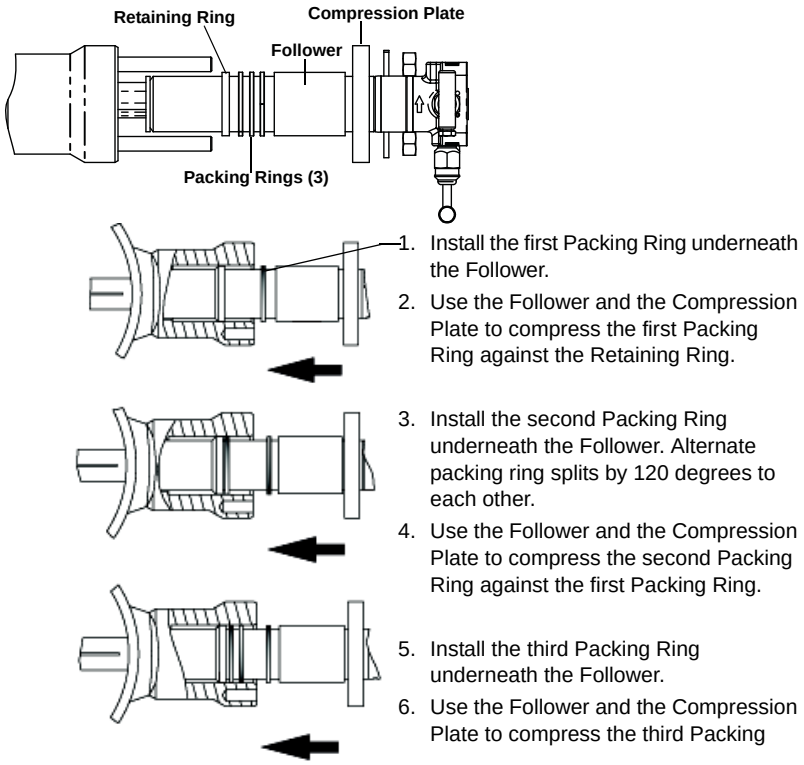
After the mounting hardware has cooled, use the following steps for installation.

1. Thread studs into the Pak-Lok body.
2. To ensure that the flowmeter contacts the opposite side wall, mark the tip of the sensor with a marker. (Do not mark if the sensor was ordered with special-cleaned option code P2 or PA.)
3. Insert the flowmeter into the Pak-lok body until the sensor tip contacts the pipe wall (or support plug). Rotate the flowmeter back and forth.
4. Remove the flowmeter.



5. Verify that the sensor tip made contact with the pipe wall by removing the pipe and ensuring that some of the marker has been rubbed off. For special-cleaned Annubar sensors, look for wear marks on the tip. If the tip did not touch the wall, verify pipe dimensions and the height of mounting body from the outer diameter of the pipe and re-insert.
6. Align the flow arrow with the direction of flow. Re-insert the flowmeter into the Pak-Lok body and install the first packing ring on the sensor between the lock ring and the packing follower. Take care not to damage the split packing rings.
7. Push the packing ring into the Pak-Lok body and against the weld lock ring. Repeat this process for the two remaining rings, alternating the location of the packing ring split by 180°.

Figure 2-15. Packing Ring Detail



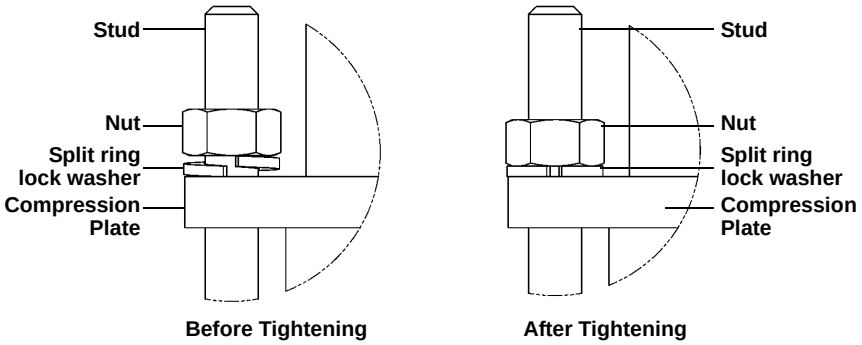
8. Tighten the nuts onto the studs:
   - Place the included split-ring lock washer between each of the nuts and the compression plate. Give each nut one half (1/2) turn in succession until the split-ring lock washer is flat between the nut and the compression plate.

Sensor Size	Torque
1	40-in. / lb (4.52 Nm)
2	100-in. / lb (11.30 Nm)
3	250-in. / lb (28.25 Nm)

   - Inspect the unit for leakage; if any exists, tighten the nuts in one-quarter (1/4) turn increments until there is no leakage.

NOTE
On sensor size (1), failure to use the split-ring lock washers, improper washer orientation, or over-tightening the nuts may result in damage to the flowmeter.

Figure 2-16. Split-Ring Lock Washer Orientation



NOTE
Pak-Lok sealing mechanisms generate significant force at the point where the sensor contacts the opposite pipe wall. Caution needs to be exercised on thin-walled piping (ANSI Schedule 10 and below) to avoid damage to the pipe.

Figure 2-17. Complete installation of Pak-lok

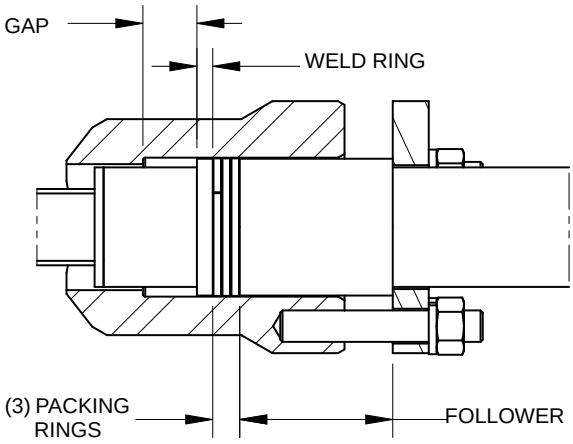


Figure 2-17 shows a view of the Pak-lok Annubar when installation is completed. Please note that there should be a gap between the Pak-lok Body and the Weld Ring.

Step 5: Mount the Transmitter

Direct Mount Head

With Valves

- Place PTFE O-rings into grooves on the face of head.
- Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.
- Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

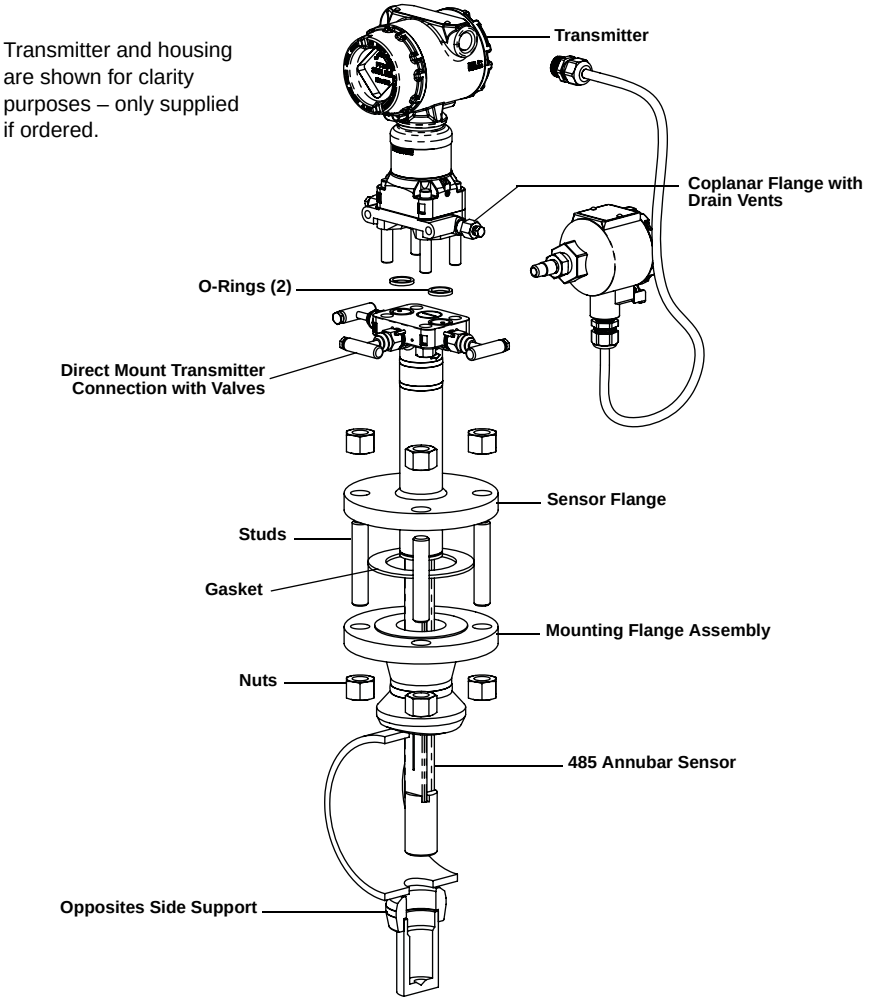
Without Valves

- Place PTFE O-rings into grooves on the face of head.
- To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb (45 N-m).
- Place PTFE O-rings into grooves on the face of the manifold.
- Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.
- Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

Flanged with Opposite Side Support Annubar Type (for 485 and 585 Annubar Flowmeters)

Figure 2-18 identifies the components of the Flanged assembly.

Figure 2-18. Components



Step 1: Determine the Proper Orientation

Please refer to “Mounting” on page 2-4 for straight run requirements and orientation information.

Step 2: Drill a Hole into the Pipe

1. Determine the drill hole size based on the Sensor Size of Sensor Width.
2. Depressurize and drain the pipe.
3. From the previous steps, select the location to drill the hole.
4. Determine the diameter of the hole to be drilled according to the specifications in Table 2-1 and drill the hole with a hole saw or a drill. **Do not torch cut the hole.**

Table 2-1. 485 Sensor Size/ Hole Diameter Chart

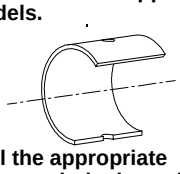
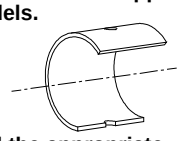
SensorSize	Sensor Width	Hole Diameter		
1	0.590-in. (14.99 mm)	3/4-in. (19 mm)	+ 1/32-in (0.8 mm)	**Note: Drill the hole 180° from the first hole for opposite- side support models.**  **Drill the appropriate diameter hole through the pipe wall.**
			– 0.00	
2	1.060-in. (26.92 mm)	1 5/16-in. (34 mm)	+ 1/16-in. (1.6 mm)	
			– 0.00	
3	1.935-in. (49.15 mm)	2 1/2-in. (64 mm)	+ 1/16-in. (1.6 mm)	
			– 0.00	

Table 2-2. 585 Sensor Size/ Hole Diameter Chart

Sensor Size	Sensor Width	Hole Diameter		
11	0.80-in. (20.32 mm)	7/8-in. (23 mm)	+ 1/32-in (0,8 mm)	**Note: Drill the hole 180° from the first hole for opposite- side support models.**  **Drill the appropriate diameter hole through the pipe wall.**
			– 0.00	
22	1.20-in. (30.48 mm)	1 5/16-in. (34 mm)	+ 1/16-in. (1,6 mm)	
			– 0.00	
44	2.30-in.	2 1/2-in.	+ 1/16-in. (1,6 mm)	
	(58.42 mm)	(64 mm)	– 0.00	

5. If opposite-side support coupling is supplied, a second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. To drill the second hole, follow these steps:
   a. Measure the pipe circumference with a pipe tape, soft wire, or string (for the most accurate measurement the pipe tape needs to be perpendicular to the axis of flow).
   b. Divide the measured circumference by two to determine the location of the second hole.
   c. Rewrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.
   d. Using the diameter determined from Table 2-1, drill the hole into the pipe with a hole saw or drill. **Do not torch cut the hole.**
6. Deburr the drilled holes on the inside of the pipe.

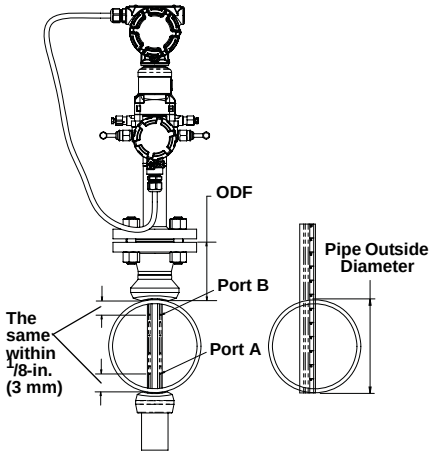
Step 3: Assemble and check Fit-Up

For accurate measurement, use the following steps to ensure that Ports A and B are equal distances from the inside walls of the pipe.

1. Assemble the Annubar sensor to the mounting hardware with the gaskets and bolts.
2. Hand tighten the bolts just enough to hold the position of the sensor centered in the mounting hardware.
3. Measure the distance from the high point of the weldolet to the first sensing hole, port B, then subtract 1/16-in. (1.6 mm).
4. Measure the distance from the end of the transferred length in step 3 to the last sensing hole, port A.
5. Compare the numbers obtained in steps 3 and 4.

Small discrepancies can be compensated for with the fit-up of the mounting hardware. Large discrepancies may cause installation problems or error.

Figure 2-19. Fit-up Check for Annubar with Opposite Side Support



Step 4: Weld the Mounting Hardware

1. Center the Flanged body over the mounting hole, gap 1/16-in. (1.5 mm) and measure the distance from the outside diameter of the pipe to the face of the flange. Compare this to the table below and adjust the gap as necessary.

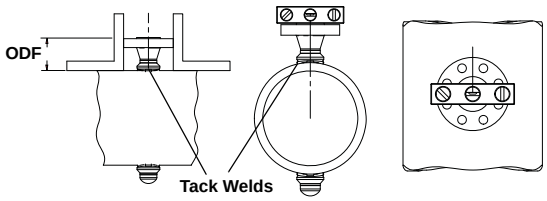
Table 2-3. 485 and 585 Flange Sizes and ODF Per Sensor Size

485 Sensor Size	585 Sensor Size	Flange Type	Pressure Class	Flange Size / Rating / Type	ODF in. (mm)(1)
1	11	A	1	1 1/2-in. 150# RF	3.88 (98.6)
			3	1 1/2-in. 300# RF	4.13 (104.9)
			6	1 1/2-in. 600# RF	4.44 (112.8)
			N / 9	1 1/2-in. 900# RF	4.94 (125.5)
			F	1 1/2-in. 1500# RF	4.94 (125.5)
			T	1 1/2-in. 2500# RF	6.76 (171.7)
		R	1	1 1/2-in. 150# RTJ	4.06 (103.1)
			3	1 1/2-in. 300# RTJ	4.31 (109.5)
			6	1 1/2-in. 600# RTJ	4.44 (112.8)
			N / 9	1 1/2-in. 900# RTJ	4.94 (125.5)
			F	1 1/2-in. 1500# RTJ	4.94 (125.5)
			T	1 1/2-in. 2500# RTJ	6.81 (173.0)
		D	1	DN40 PN16 RF	3.21 (81.5)
			3	DN40 PN40 RF	3.21 (81.5)
			6	DN40 PN100 RF	3.88 (98.6)
2	22	A	1	2.0-in. 150# RF	4.13 (104.9)
			3	2.0-in. 300# RF	4.38 (111.3)
			6	2.0-in. 600# RF	4.75 (120.7)
			N / 9	2.0-in. 900# RF	5.88 (149.4)
			F	2.0-in. 1500# RF	5.88 (149.4)
			T	3.0-in. 2500# RF	9.88 (251.0)
		R	1	2.0-in. 150# RTJ	4.31 (119.5)
			3	2.0-in. 300# RTJ	4.63 (117.6)
			6	2.0-in. 600# RTJ	4.81 (122.2)
			N	2.0-in. 900# RTJ	5.94 (150.9)
			F	2.0-in. 1500# RTJ	5.94 (150.9)
			T	3.0-in. 2500# RTJ	10.00 (254.0)
		D	1	DN50 PN16 RF	3.40 (86.4)
			3	DN50 PN40 RF	3.52 (89.4)
			6	DN50 PN100 RF	4.30 (109.5)
3	44	A	1	3.0-in. 150# RF	4.63 (117.6)
			3	3.0-in. 300# RF	5.00 (127.0)
			6	3.0-in. 600# RF	5.38 (136.7)
			N / 9	4.0-in. 900# RF	8.19 (208.0)
			F	4.0-in. 1500# RF	8.56 (217.4)
			T	4.0-in. 2500# RF	11.19 (284.2)
		R	1	3.0-in. 150# RTJ	4.81 (122.2)
			3	3.0-in. 300# RTJ	5.25 (133.4)
			6	3.0-in. 600# RTJ	5.44 (138.2)
			N / 9	4.0-in. 900# RTJ	8.25 (209.6)
			F	4.0-in. 1500# RTJ	8.63 (219.2)
			T	4.0-in. 2500# RTJ	11.38 (289.1)
		D	1	DN80 PN16 RF	3.85 (97.8)
			3	DN80 PN40 RF	4.16 (105.7)
			6	DN80 PN100 RF	4.95 (125.7)

(1) Tolerances for the ODF dimension above a 10-in. (254 mm) line size is ±0.060-in. (1,6 mm). Below 10-in. (254 mm) line size is ±0.030-in. (0,8 mm).

2. Place four 1/4-in. (6-mm) tack welds at 90° increments. Check alignment of the mounting both parallel and perpendicular to the axis of flow (see Figure 2-20). If alignment of the mounting is within tolerances, finish weld per local codes. If alignment is outside of specified tolerance, make adjustments prior to making the finish weld.

Figure 2-20. Alignment



3. Center the fitting for the opposite side support over the opposite side hole, gap 1/16-in. (1.5 mm) and place four 1/4-in. (0.5 mm) tack welds at 90° increments. Insert the sensor into the mounting hardware. Verify that the tip of the bar is centered in the opposite side fitting and that the plug will fit around bar. If the sensor is centered in the fitting and plug fits around the sensor, finish weld per local codes. If alignment of the sensor does not allow enough clearance to insert the opposite side plug, make the necessary adjustments prior to making the finish weld.
4. To avoid serious burns, allow the mounting hardware to cool before continuing.

Step 5: Insert the Annubar Sensor

1. If opposite side support is threaded, apply an appropriate thread sealing compound to the support plug threads and tighten until no leakage occurs.
2. Align the flow arrow on the head with the direction of flow. Assemble the Annubar to the mounting flange using a gasket, bolts, and nuts.
3. If opposite side support is a socket weld fitting, insert the plug into the sockolet fitting until the parts contact. Retract the plug 1/16-in. (1.5 mm), remove the Annubar sensor and apply fillet weld per local codes.
4. Tighten the nuts in a cross pattern to allow even compression of the gasket.

Step 6: Mount the Transmitter

Direct Mount Head

With Valves

1. Place PTFE O-rings into grooves on the face of head.
2. Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

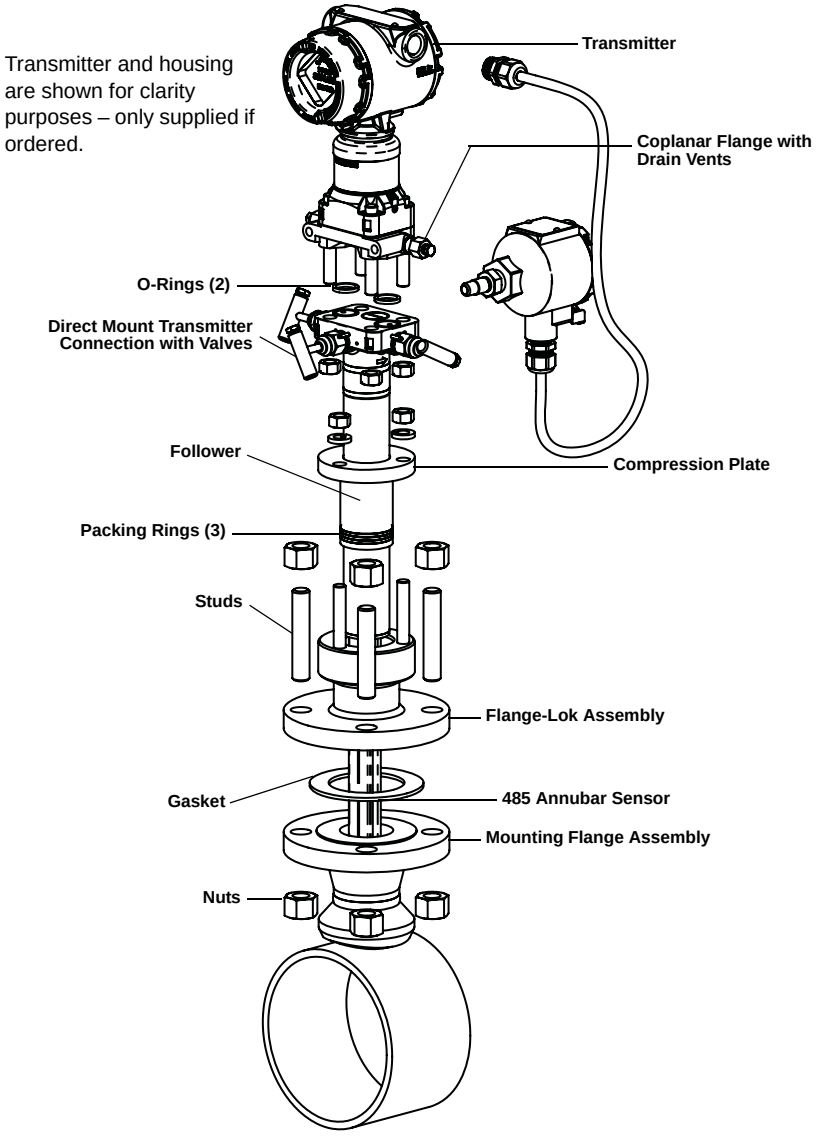
Without Valves

1. Place PTFE O-rings into grooves on the face of head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb (45 N-m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.
5. Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

Flange-Lok Model (for 485 Annubar Flowmeters)

Figure 2-21 identifies the components of the Flange-Lok assembly.

Figure 2-21. Components



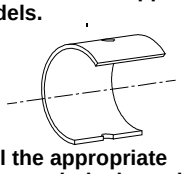
Step 1: Determine the Proper Orientation

Please refer to “Mounting” on page 2-4 for straight run requirements and orientation information.

Step 2: Drill a Hole into the Pipe

1. Determine the drill hole size based on the Sensor Size of Sensor Width.
2. Depressurize and drain the pipe.
3. Select the location to drill the hole.
4. Determine the diameter of the hole to be drilled according to the specifications in Table 2-4 and drill the hole with a hole saw or a drill. **Do not torch cut the hole.**

Table 2-4. Drill Hole into Pipe

SensorSize	Sensor Width	Hole Diameter		
1	0.590-in. (14.99 mm)	3/4-in. (19 mm)	+ 1/32-in (0.8 mm)	**Note: Drill the hole 180° from the first hole for opposite- side support models.**  **Drill the appropriate diameter hole through the pipe wall.**
			– 0.00	
2	1.060-in. (26.92 mm)	1 5/16-in. (34 mm)	+ 1/16-in. (1.6 mm)	
			– 0.00	
3	1.935-in. (49.15 mm)	2 1/2-in. (64 mm)	+ 1/16-in. (1.6 mm)	
			– 0.00	

5. If opposite-side support coupling is supplied, a second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. (To determine an opposite-side support model, measure the distance from the tip of the first slot or hole. If the distance is greater than 1-in. (25.4 mm), it is the opposite-side model.) To drill the second hole, follow these steps:
   a. Measure the pipe circumference with a pipe tape, soft wire, or string (for the most accurate measurement the pipe tape needs to be perpendicular to the axis of flow).
   b. Divide the measured circumference by two to determine the location of the second hole.
   c. Rewrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.
   d. Using the diameter determined from Table 2-4, drill the hole into the pipe with a hole saw or drill. **Do not torch cut the hole.**
6. Deburr the drilled hole or holes on the inside of the pipe.

Step 3: Weld the Mounting Hardware

1. Center the Flange-Lok body over the mounting hole, gap 1/16-in. (2 mm) and measure the distance from the OD of the pipe to the face of the flange. Compare this to the table below and adjust the gap as necessary.

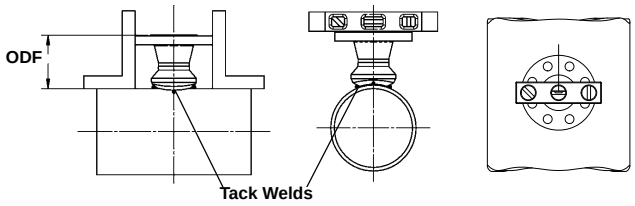
Table 2-5. 485 and 585 Flange Sizes and ODF Per Sensor Size

485 Sensor Size	Flange Type	Pressure Class	Flange Size / Rating / Type	ODF in. (mm)(1)
1	A	1	1 1/2-in. 150# RF	3.88 (98.6)
		3	1 1/2-in. 300# RF	4.13 (104.9)
		6	1 1/2-in. 600# RF	4.44 (112.8)
		N	1 1/2-in. 900# RF	4.94 (125.5)
		F	1 1/2-in. 1500# RF	4.94 (125.5)
		T	1 1/2-in. 2500# RF	6.76 (171.7)
	R	1	1 1/2-in. 150# RTJ	4.06 (103.1)
		3	1 1/2-in. 300# RTJ	4.31 (109.5)
		6	1 1/2-in. 600# RTJ	4.44 (112.8)
		N	1 1/2-in. 900# RTJ	4.94 (125.5)
		F	1 1/2-in. 1500# RTJ	4.94 (125.5)
		T	1 1/2-in. 2500# RTJ	6.81 (173.0)
	D	1	DN40 PN16 RF	3.21 (81.5)
		3	DN40 PN40 RF	3.21 (81.5)
		6	DN40 PN100 RF	3.88 (98.6)
2	A	1	2.0-in. 150# RF	4.13 (104.9)
		3	2.0-in. 300# RF	4.38 (111.3)
		6	2.0-in. 600# RF	4.75 (120.7)
		N	2.0-in. 900# RF	5.88 (149.4)
		F	2.0-in. 1500# RF	5.88 (149.4)
		T	3.0-in. 2500# RF	9.88 (251.0)
	R	1	2.0-in. 150# RTJ	4.31 (119.5)
		3	2.0-in. 300# RTJ	4.63 (117.6)
		6	2.0-in. 600# RTJ	4.81 (122.2)
		N	2.0-in. 900# RTJ	5.94 (150.9)
		F	2.0-in. 1500# RTJ	5.94 (150.9)
		T	3.0-in. 2500# RTJ	10.00 (254.0)
	D	1	DN50 PN16 RF	4.63 (117.6)
		3	DN50 PN40 RF	5.00 (127.0)
		6	DN50 PN100 RF	5.38 (136.7)
3	A	1	3.0-in. 150# RF	4.63 (117.5)
		3	3.0-in. 300# RF	5.00 (126.9)
		6	3.0-in. 600# RF	5.38 (136.6)
	R	1	3.0-in. 150# RTJ	4.81 (122.2)
		3	3.0-in. 300# RTJ	5.25 (133.4)
		6	3.0-in. 600# RTJ	5.44 (138.2)
	D	1	DN80 PN16 RF	3.85 (97.8)
		3	DN80 PN40 RF	4.16 (105.7)
		6	DN80 PN100 RF	4.95 (125.7)

(1) Tolerances for the ODF dimension above a 10-in. (254 mm) line size is ±0.060-in. (1,6 mm). Below 10-in. (254 mm) line size is ±0.030-in. (0,8 mm).

2. Place four 1/4-in. (6-mm) tack welds at 90° increments. Check alignment of the mounting both parallel and perpendicular to the axis of flow (see Figure 2-22). If alignment of the mounting is within tolerances, finish weld per local codes. If outside of specified tolerance, make adjustments prior to making the finish weld.

Figure 2-22. Alignment



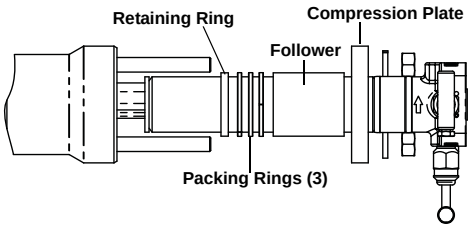
3. If opposite side support is being used, center the fitting for the opposite side support over the opposite side hole, gap 1/16-in. (1.5 mm) and place four 1/4-in. (6-mm) tack welds at 90° increments. Insert the sensor into the mounting hardware. Verify that the tip of the bar is centered in the opposite side fitting and that the plug will fit around the bar. If the sensor is centered in the fitting and plug fits around the sensor, finish weld per local codes. If alignment of the sensor does not allow enough clearance to insert the opposite side plug, make the necessary adjustments prior to making the finish weld. The Annubar sensor must be removed before welding or installing the opposite side support plug.
4. To avoid serious burns, allow the mounting hardware to cool before continuing.

Step 4: Insert into Pipe

1. After the mounting hardware has cooled, use the following steps for installation.
2. Assemble the sensor flange to the mounting flange using gasket, studs, and nuts.
3. Tighten the nuts in a cross pattern to allow even compression of the gasket.
4. Thread studs into Flange-Lok body.
5. To ensure that the flowmeter contacts the opposite side wall, mark the tip of the sensor with a marker. (Do not mark if the sensor was ordered with special-cleaned option code P2 or PA.)
6. Insert the flowmeter into the Flange-lok body until the sensor tip contacts the pipe wall (or support plug), rotating back and forth.
7. Remove the flowmeter.

8. Verify that the sensor tip made contact with the pipe wall by ensuring that some of the marker has been rubbed off. For special-cleaned bars, look for wear marks on the tip. If the tip did not touch the wall, verify pipe dimensions and the height of the mounting body from the OD of the pipe and re-insert.
9. Re-insert the flowmeter into the Flange-Lok body and install the first packing ring on the sensor between the lock ring and the packing follower. Take care not to damage the split packing rings.
10. Push the packing ring into the Flange-Lok body and against the weld retaining ring. Repeat this process for the two remaining rings, alternating the location of the packing ring split by 180°.

Figure 2-23. Packing Ring Detail



11. Tighten the nuts onto the studs:

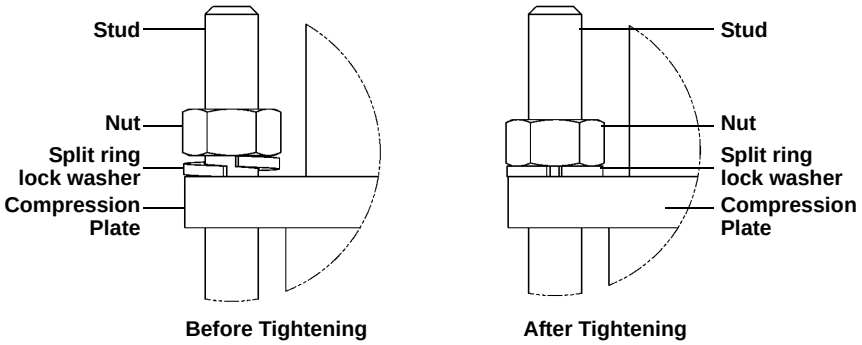
    a. Place the included split-ring lock washer between each of the nuts and the compression plate. Give each nut one half (1/2) turn in succession until the split-ring lock washer is flat between the nut and the compression plate. Torque is as follows:

Sensor Size	Torque
1	40-in. / lb (4.52 Nm)
2	100-in. / lb (11.30 Nm)
3	250-in. / lb (28.25 Nm)

    b. Inspect the unit for leakage; if any exists, tighten the nuts in one-quarter (1/4) turn increments until there is no leakage.

NOTE
On sensor size (1), failure to use the split-ring Lock washers, improper washer orientation, or over-tightening the nuts may result in damage to the flowmeter.

Figure 2-24. Split-Ring Lock Washer Orientation



NOTE
Flange-Lok sealing mechanisms generate significant force at the point where the sensor contacts the opposite pipe wall. Caution needs to be exercised on thin-walled piping (ANSI Schedule 10 and below) to avoid damage to the pipe.

Figure 2-25. Complete installation of Flange-lok

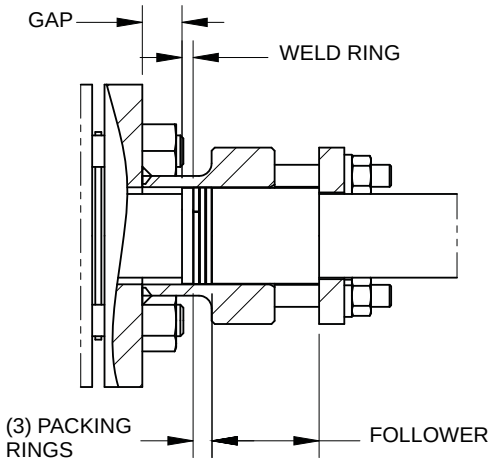


Figure 2-25 shows a view of the Flange-lok Annubar when installation is completed. Please note that there should be a gap between the Flange-lok Body and the Weld Ring.

Step 5: Mount the Transmitter

Direct Mount Head

With Valves

1. Place PTFE O-rings into grooves on the face of head.
2. Align the high side of the transmitter to the high side of the Annubar (“Hi” is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

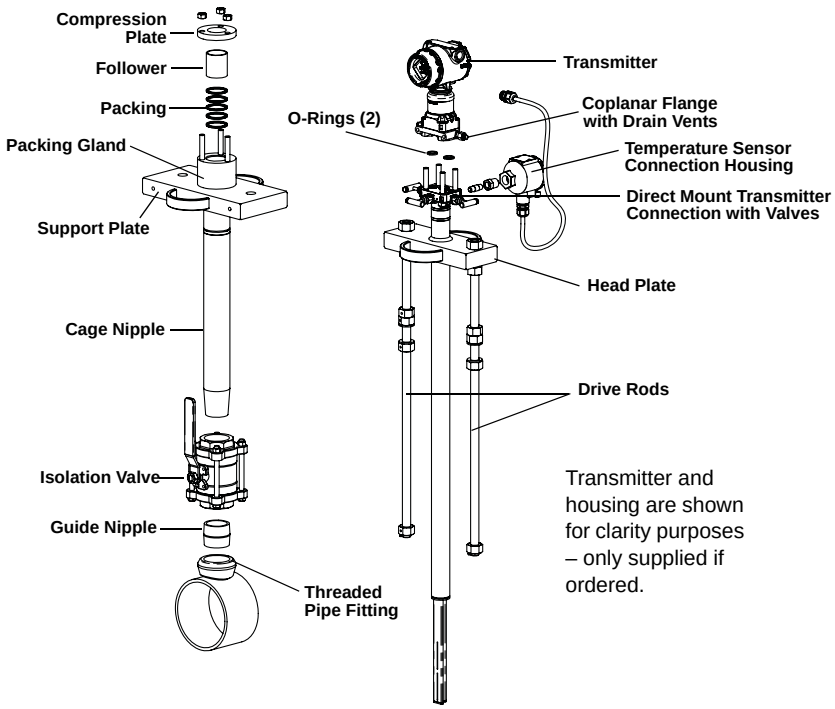
Without Valves

1. Place PTFE O-rings into grooves on the face of head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb (45 N-m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the Annubar (“Hi” is stamped on the side of the head) and install.
5. Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

Threaded Flo-Tap (for 485 Annubar Flowmeter)

Figure 2-26 identifies the components of the Threaded Flo-Tap assembly.

Figure 2-26. Components



Step 1: Determine the Proper Orientation

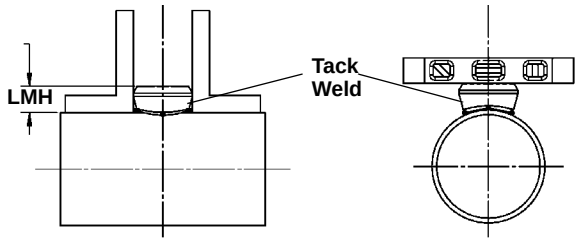
Please refer to “Mounting” on page 2-4 for straight run requirements and orientation information.

Step 2: Weld the Mounting Hardware

NOTE
Rosemount-supplied mounting includes critical alignment hardware that assists in the correct drilling of the mounting hole. This significantly reduces problems encountered during insertion.

1. At the pre-determined position, place the threadolet on the pipe, gap 1/16 in. (16 mm) and place four 1/4-in. (6-mm) tack welds at 90° increments.
2. Check alignment of the mounting both parallel and perpendicular to the axis of flow. If the mounting alignment is within tolerances, finish weld per local codes. If outside of tolerances, make adjustments prior to making the finish weld.
3. To avoid serious burns, allow mounting hardware to cool before continuing.

Figure 2-27. Alignment

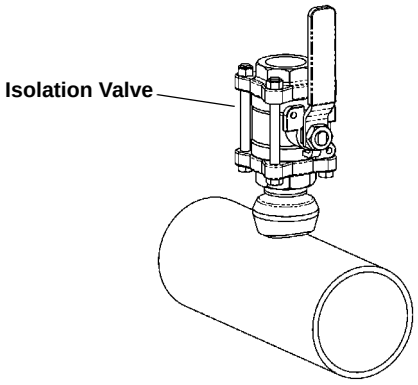


Step 3: Install the Isolation Valve

1. Thread the guide nipple into the mounting.
2. Thread the isolation valve into the guide nipple, ensuring that the valve stem is positioned so that when the Flo-Tap is installed, the insertion rods will straddle the pipe and the valve handle will be centered between the rods (see Figure 2-28).

NOTE:
Interference will occur if the valve is located inline with the insertion rods.

Figure 2-28. Install the Isolation Valve



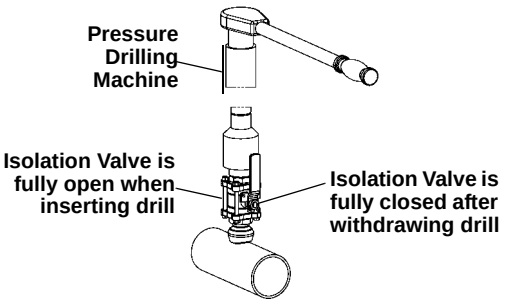
Step 4: Mount the Drilling Machine and Drill Hole

Drilling Machine is not provided with the assembly.

1. Determine the drill hole size based on the sensor size or sensor width.
2. Mount the drilling machine to the isolation valve.
3. Open the valve fully.
4. Drill the hole into the pipe wall in accordance with the instructions provided by the drilling machine manufacturer.
5. Fully retract the drill beyond the valve.

Table 2-6. Sensor Size / Hole Diameter Chart

Sensor Size	Sensor Width	Hole Diameter	
1	0.590-in. (14.99 mm)	3/4-in. (19 mm)	+ 1/32-in (0.8 mm)
			– 0.00
2	1.060-in. (26.92 mm)	1 5/16-in. (34 mm)	+ 1/16-in. (1.6 mm)
			– 0.00
3	1.935-in. (49.15 mm)	2 1/2-in. (64 mm)	+ 1/16-in. (1.6 mm)
			– 0.00



Step 5: Remove the Drilling Machine

Follow these steps to remove the drilling machine:

1. Verify that the drill has been fully retracted past the valve.
2. Close the isolation valve to isolate the process.
3. Bleed drilling machine pressure and remove.
4. Check isolation valve and mounting for leakage.

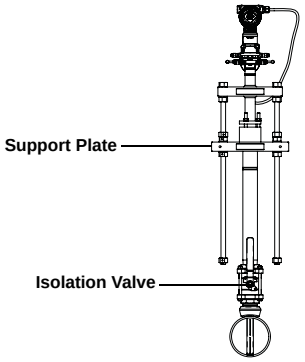
Step 6: Mount the Annubar

1. Install the complete Flo-Tap assembly (fully retracted) onto the isolation valve by threading the close nipple into the valve using the proper thread sealant compound.
2. Rotate the Flo-Tap assembly until the flow arrow on the head aligns with the direction of flow in the pipe.
3. Ensure that the vent valves are closed before proceeding to the next step.
4. Quickly open and close the isolation valve to pressurize the Annubar. Use extreme caution if the flowing medium is steam or caustic.
5. Check the entire installation for leakage. Tighten as required to stop any connection from leaking. Repeat steps 4 and 5 until there is no leakage.

   a. If the Flo-tap comes equipped with the gear drive option, place the PVC protector rod assembly over the drive rods and attach to the gear drive with the supplied hardware.

NOTE
Flo-Tap Annubars have the potential to carry a large amount of weight at a great distance from the piping, necessitating external support. The support plate has threaded holes to assist in supporting the Annubar. Threaded holes (3/8"-16 UNC) are provided on the support plate for external support.

Figure 2-29. Flo-Tap Installation



Step 7: Insert the Annubar

Insert the sensor with one of the two drive options available – manual drive (M) or gear drive (G).

Manual (Not recommended for line sizes above 12 inches (300 mm))

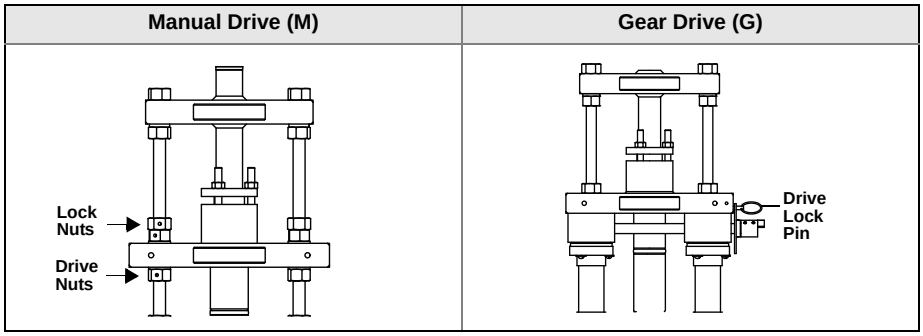
1. Open the isolation valve fully.
2. Rotate drive nuts clockwise (as viewed from the top) as shown in Figure 2-29. The nuts must be tightened alternately, about two turns at a time to prevent binding caused by unequal loading.
3. Continue this procedure until the tip of the probe firmly contacts the opposite side of the pipe.
   a. The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.
   b. As the orange stripe approaches the support plate, place a finger above the packing gland while cranking.
   c. Turn the drive nuts an additional 1/4 to 1/2 turn to secure the sensor.

Gear Drive (G)

1. Fully open the isolation valve.
2. Rotate the crank clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.
   a. Continue rotating the crank until the sensor firmly contacts the opposite side of the pipe. The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.
   b. As the orange stripes approach the support plate, remove the power drill and continue cranking manually. Place a finger above the packing gland while cranking. When the movement stops, the sensor is in contact with the opposite side wall.
   c. Turn the handle an additional 1/4 to 1/2 turn to secure the sensor.
3. Secure the drive by inserting the drive lock pin as shown in Figure 2-30.

NOTE:
Do not place a finger above the packing gland for high temperature applications.

Figure 2-30. Insert Annubar



Step 8: Mount the Transmitter

Direct Mount Head

With Valves

1. Place PTFE O-rings into grooves on the Annubar head.
2. Align the high side of the transmitter to the high side of the sensor (“Hi” is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in•lb (45 N•m).

Without Valves

1. Place PTFE O-rings into grooves on the Annubar head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in•lb (45 N•m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.

Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

Step 9: Retract the Annubar

Manual Drive (M)

1. Retract by rotating the drive nuts counter-clockwise. The nuts must be turned alternately, about two turns at a time, to prevent binding caused by unequal loading.
2. Continue this procedure until the rod end nuts are against the packing body mechanism.

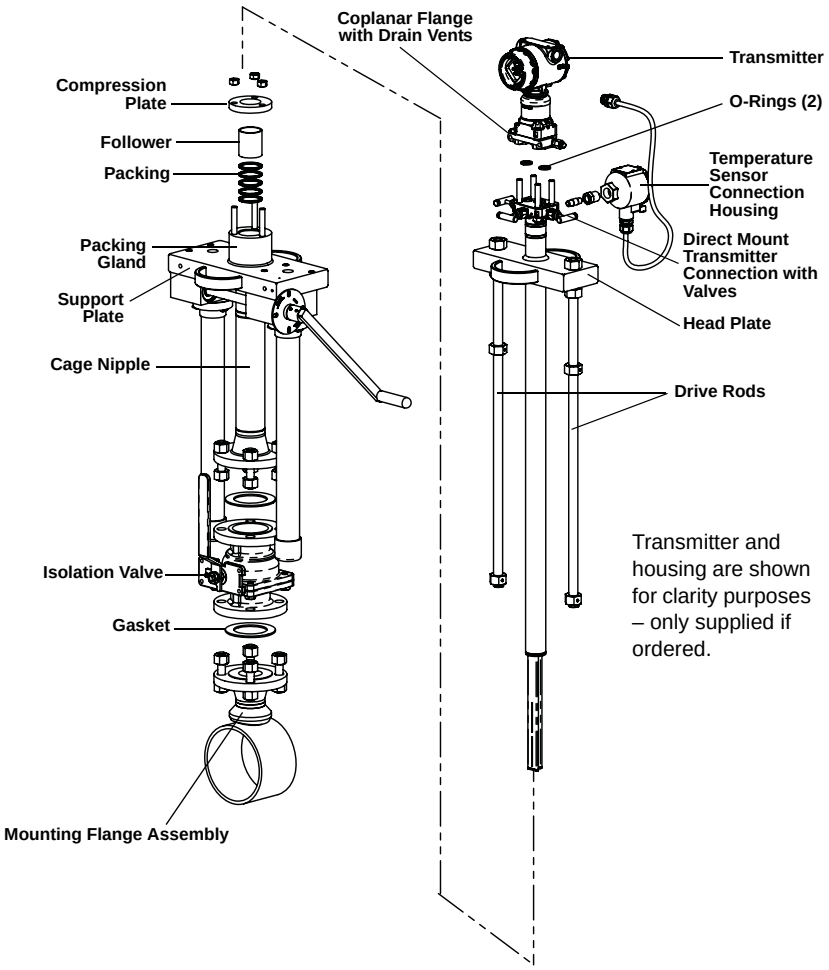
Gear Drive (G)

1. Remove the drive lock pin.
2. Retract the sensor by rotating the crank counter-clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.
3. Retract until the rod end nuts are against the packing body mechanism.

Flanged Flo-Tap (for 485 and 585 Annubar Flowmeters)

Figure 2-31 identifies the components of the Flanged Flo-Tap assembly.

Figure 2-31. Components



Step 1: Determine the Proper Orientation

Please refer to “Mounting” on page 2-4 for straight run requirements and orientation information.

Step 2: Weld the Mounting Hardware

NOTE
Rosemount-supplied mounting includes critical alignment hardware that assists in the correct drilling of the mounting hole. This significantly reduces problems encountered during insertion.

1. At the pre-determined position, place the flanged assembly on the pipe, gap $^{1}/_{16}$ in. (1,6 mm) and measure the distance from the outside diameter of the pipe to the face of the flange. Compare this to the chart below and adjust the gap as necessary.

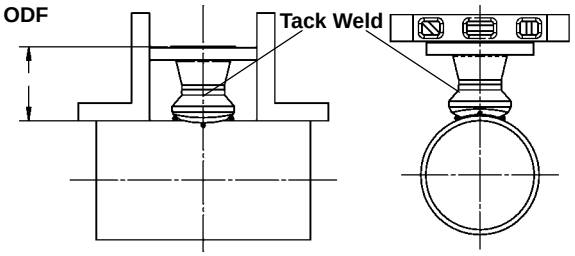
Table 2-7. 485 and 585 Flange Sizes and ODF Per Sensor Size

485 Sensor Size	585 Sensor Size	Flange Type	Pressure Class	Flange Size / Rating / Type	ODF in. (mm)(1)
1	11	A	1	1 1/2-in. 150# RF	3.88 (98.6)
			3	1 1/2-in. 300# RF	4.13 (104.9)
			6	1 1/2-in. 600# RF	4.44 (112.8)
			N	1 1/2-in. 900# RF	4.94 (125.5)
			F	1 1/2-in. 1500# RF	4.94 (125.5)
			T	1 1/2-in. 2500# RF	6.76 (171.7)
		R	1	1 1/2-in. 150# RTJ	4.06 (103.1)
			3	1 1/2-in. 300# RTJ	4.31 (109.5)
			6	1 1/2-in. 600# RTJ	4.44 (112.8)
			N	1 1/2-in. 900# RTJ	4.94 (125.5)
			F	1 1/2-in. 1500# RTJ	4.94 (125.5)
			T	1 1/2-in. 2500# RTJ	6.81 (173.0)
		D	1	DN40 PN16 RF	3.21 (81.5)
			3	DN40 PN40 RF	3.21 (81.5)
			6	DN40 PN100 RF	3.88 (98.6)
2	22	A	1	2.0-in. 150# RF	4.13 (104.9)
			3	2.0-in. 300# RF	4.38 (111.3)
			6	2.0-in. 600# RF	4.75 (120.7)
			N	2.0-in. 900# RF	5.88 (149.4)
			F	2.0-in. 1500# RF	5.88 (149.4)
			T	3.0-in. 2500# RF	9.88 (251.0)
		R	1	2.0-in. 150# RTJ	4.31 (119.5)
			3	2.0-in. 300# RTJ	4.63 (117.6)
			6	2.0-in. 600# RTJ	4.81 (122.2)
			N	2.0-in. 900# RTJ	5.94 (150.9)
			F	2.0-in. 1500# RTJ	5.94 (150.9)
			T	3.0-in. 2500# RTJ	10.00 (254.0)
		D	1	DN50 PN16 RF	3.40 (86.4)
			3	DN50 PN40 RF	3.52 (89.4)
			6	DN50 PN100 RF	4.30 (109.5)
3	44	A	1	3.0-in. 150# RF	4.63 (117.6)
			3	3.0-in. 300# RF	5.00 (127.0)
			6	3.0-in. 600# RF	5.38 (136.7)
			N	4.0-in. 900# RF	8.19 (208.0)
			F	4.0-in. 1500# RF	8.56 (217.4)
			T	4.0-in. 2500# RF	11.19 (284.2)
		R	1	3.0-in. 150# RTJ	4.81 (122.2)
			3	3.0-in. 300# RTJ	5.25 (133.4)
			6	3.0-in. 600# RTJ	5.44 (138.2)
			N	4.0-in. 900# RTJ	8.25 (209.6)
			F	4.0-in. 1500# RTJ	8.63 (219.2)
			T	4.0-in. 2500# RTJ	11.38 (289.1)
		D	1	DN80 PN16 RF	3.85 (97.8)
			3	DN80 PN40 RF	4.16 (105.7)
			6	DN80 PN100 RF	4.95 (125.7)

(1) Tolerances for the ODF dimension above a 10-in. (254 mm) line size is ±0.060-in. (1,6 mm). Below 10-in. (254 mm) line size is ±0.030-in. (0,8 mm).

2. Place four 1/4-in. (6-mm) tack welds at 90° increments. Check alignment of the mounting both parallel and perpendicular to the axis of flow.
3. If the mounting alignment is within tolerances, finish weld per local codes. If outside of tolerances, make adjustments prior to making the finish weld.
4. To avoid serious burns, allow the mounting hardware to cool before continuing.

Figure 2-32. Alignment



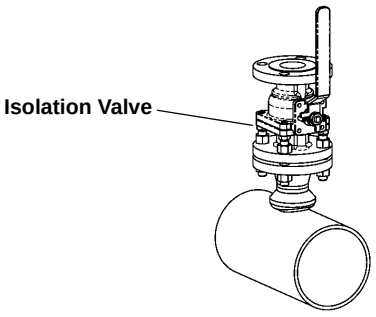
Step 3: Install the Isolation Valve

1. Position the isolation valve onto the mounting flange. Ensure that the valve stem is positioned so that when the Flo-Tap is installed, the insertion rods will straddle the pipe and the valve handle will be centered between the rods (see Figure 2-33).

NOTE:
Interference will occur if the valve is located inline with the insertion rods.

2. Fasten the isolation valve to the mounting using gasket, bolts, and nuts.

Figure 2-33. Install Isolation Valve



Step 4: Mount the Drilling Machine and Drill Hole

Drilling Machine is not provided with the assembly

1. Determine the drill hole size based on the sensor size or sensor width.
2. Mount the drilling machine to the isolation valve.
3. Open the valve fully.
4. Drill the hole into the pipe wall in accordance with the instructions provided by the drilling machine manufacturer.
5. Retract the drill fully beyond the valve.

Table 2-8. 485 Drill Hole Sizes

Sensor Size	Sensor Width	Hole Diameter	
1	0.590-in. (14.99 mm)	3/4-in. (19 mm)	+ 1/32-in (0.8 mm)
			– 0.00
2	1.060-in. (26.92 mm)	1 5/16-in. (34 mm)	+ 1/16-in. (1.6 mm)
			– 0.00
3	1.935-in. (49.15 mm)	2 1/2-in. (64 mm)	+ 1/16-in. (1.6 mm)
			– 0.00

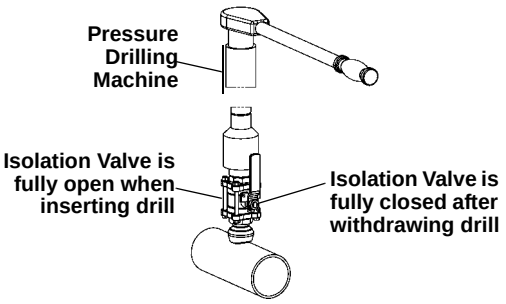


Table 2-9. 585 Drill Hole Sizes

Sensor Size	Sensor Width	Hole Diameter	
11	0.8-in. (20.32 mm)	7/8-in. (23 mm)	+ 1/32-in (0,8 mm)
			– 0.00
22	1.20-in. (30.48 mm)	1 5/16-in. (34 mm)	+ 1/16-in. (1,6 mm)
			– 0.00
44	2.30-in. (58.42 mm)	2 1/2-in. (64 mm)	+ 1/16-in. (1,6 mm)
			– 0.00

Step 5: Remove the Drilling Machine

1. Verify that the drill has been fully retracted past the valve.
2. Close the isolation valve to isolate the process.
3. Bleed drilling machine pressure and remove.
4. Check isolation valve and mounting for leakage.

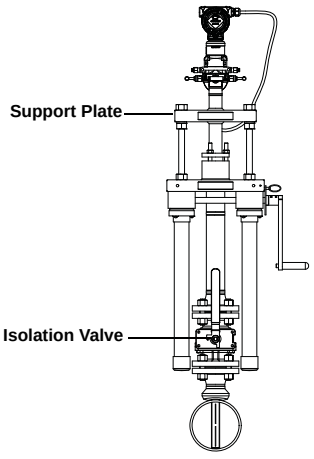
Step 6: Mount the Annubar

1. Align the flow arrow on the head with the direction of flow.
2. Use the supplied gaskets and flange bolts to fasten the Flo-Tap assembly to the isolation valve.
3. Tighten the nuts in a cross pattern to compress the gasket evenly.
4. Ensure that the vent valves are closed before proceeding.
5. Quickly open and close the isolation valve to pressurize the Annubar. Use extreme caution if the flowing medium is steam or caustic.
6. Check the entire installation for leakage. Tighten as required to stop any connection from leaking. Repeat steps 4 and 5 until there is no leakage.

   a. If the Flo-tap comes equipped with the gear drive option, place the PVC protector rod assembly over the drive rods and attach to the gear drive with the supplied hardware.

NOTE
Flo-Tap Annubars have the potential to carry a large amount of weight at a great distance from the piping, necessitating external support. The support plate has threaded holes to assist in supporting the Annubar. Threaded holes ($^3/_8$"-16 UNC) are provided on the support plate for external support.

Figure 2-34. Flo-Tap Installation



Step 7: Insert the Annubar

Insert the sensor with one of the two drive options available – manual (M) or gear drive (G).

Manual (M) (Not recommended for line size above 12 in. (300 mm))

1. Open the isolation valve fully.
2. Rotate drive nuts clockwise (as viewed from the top) as shown in Figure 2-34. The nuts must be tightened alternately, about two turns at a time to prevent binding caused by unequal loading.
3. Continue this procedure until the tip of the probe firmly contacts the opposite side of the pipe.

   a. The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.

   b. As the orange stripe approaches the support plate, place a finger above the packing gland while cranking.

   c. Turn the drive nuts an additional 1/4 to 1/2 turn to secure the sensor.

Gear Drive (G)

1. Open the isolation valve fully.
2. Rotate the crank clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.

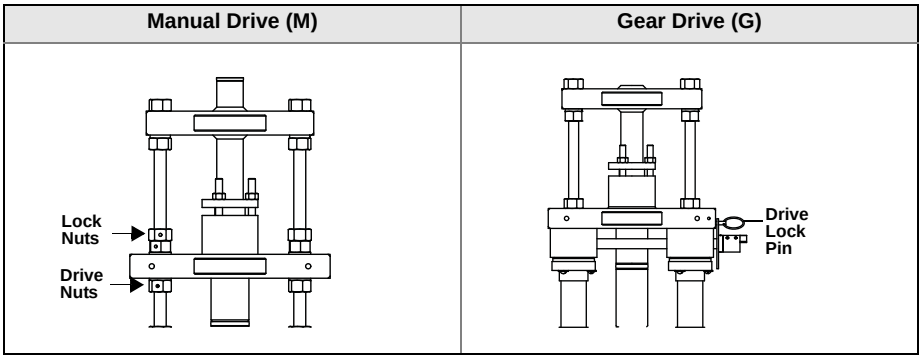
   a. Continue rotating the crank until the sensor firmly contacts the opposite side of the pipe. The orange stripes are a visual indication of when the sensor is approaching the opposite side wall.

   b. As the orange stripes approach the support plate, remove the power drill and continue cranking manually. Place a finger above the packing gland while cranking. When movement stops, the sensor is in contact with the opposite side wall.

   c. Turn the handle an additional 1/4 to 1/2 turn to secure the sensor.

3. Secure the drive by inserting the drive lock pin as shown in Figure 2-35.

Figure 2-35. Insert Annubar



Step 8: Retract the Annubar

Manual Drive (M)

1. Retract by rotating the drive nuts counter-clockwise. The nuts must be turned alternately, about two turns at a time, to prevent binding caused by unequal loading.
2. Continue this procedure until the rod end nuts are against the packing body mechanism.

Gear Drive (G)

1. Remove the drive lock pin.
2. Retract the sensor by rotating the crank counter-clockwise. If a power drill with an adapter is used, do not exceed 200 rpm.
3. Retract until the rod end nuts are against the packing body mechanism.

Step 9: Mount the Transmitter

Direct Mount Head

With Valves

1. Place PTFE O-rings into grooves on the face of head.
2. Align the high side of the transmitter to the high side of the sensor (“Hi” is stamped on the side of the head) and install.
3. Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

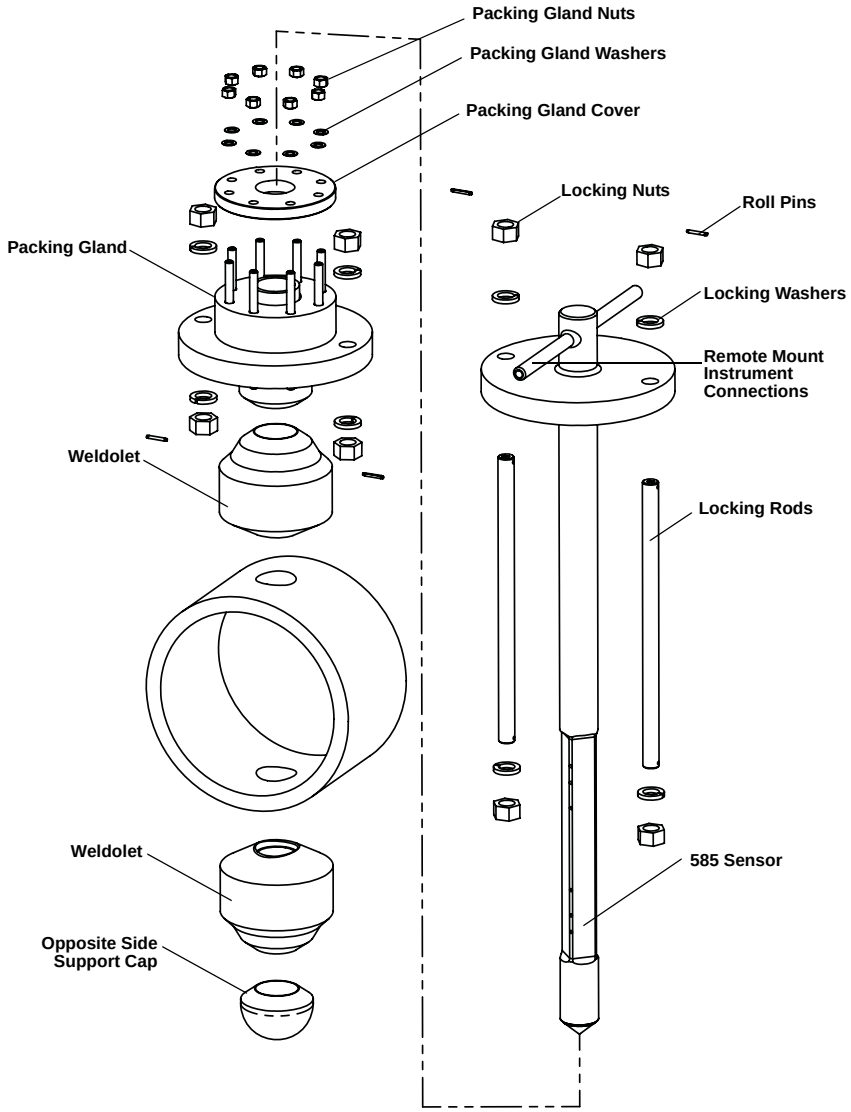
Without Valves

1. Place PTFE O-rings into grooves on the face of head.
2. To install a manifold, orient the equalizer valve or valves so they are easily accessible. Install manifold with the smooth face mating to the face of the head. Tighten in cross pattern to a torque of 400 in-lb (45 N-m).
3. Place PTFE O-rings into grooves on the face of the manifold.
4. Align the high side of the transmitter to the high side of the probe (“Hi” is stamped on the side of the head) and install.
5. Tighten the nuts in a cross pattern to 400 in-lb (45 N-m).

Main Steam Line (for 585 Annubar Flowmeters)

Figure 2-36 identifies the components of the Main Steam Annubar assembly.

Figure 2-36. Components



Step 1: Determine the Proper Orientation

Please refer to “Mounting” on page 2-4 for straight run requirements and orientation information.

Step 2: Drill Mounting Hole into Pipe

1. Depressurize and drain the pipe.
2. At the predetermined position, drill the hole into the pipe wall in accordance with the instructions provided by the drilling machine manufacturer. Drill 2.5 in. (64 mm) hole. Drill hole has a tolerance of +1/16 in./ -0 in. (1,6 mm/ -0 mm).
3. After the hole is drilled, deburr the hole on the inside of the pipe.
4. A second identically sized hole must be drilled opposite the first hole so that the sensor can pass completely through the pipe. To drill the second hole, follow these steps:

   a. Measure the pipe circumference with a pipe tape, soft wire, or string. (For the most accurate measurement the pipe tape needs to be perpendicular to the axis of flow.)

   b. Divide the measured circumference by two to determine the location of the second hole.

   c. Re-wrap the pipe tape, soft wire, or string from the center of the first hole. Then, using the number calculated in the preceding step, mark the center of what will become the second hole.

   d. Using the diameter determined in step 3, drill the hole into the pipe with a hole saw or drill. **Do not torch cut the hole.**
5. Deburr the drilled holes on the inside of the pipe.

Step 3: Weld the Mounting Hardware

1. An alignment bar is needed during the welding of the heavy wall weldolets to the steam pipeline. The alignment bar can be ordered from Emerson Process Management.
2. Weld the heavy wall weldolet to the packing gland assembly with a full penetration-groove weld.

   a. Place the alignment bar through the packing gland and the weldolet. The weldolet will also have a bearing sleeve in it and it should be near the radius end of the weldolet which will be the end welded to the pipe. Ensure the support plate is attached to the packing gland before making the weld.

   b. Tack weld the weldolet to the packing gland. Remove the alignment bar.

   c. Weld the first pass. Recheck alignment with the alignment bar. Adjust alignment as necessary. Do not allow the alignment bar to get too hot, as it will be difficult to remove. Use it only briefly to check alignment between weld passes.

   d. Complete remaining weld passes, using alignment bar to verify alignment several times during the process. Emerson Process Management recommends that the weld thickness is equal to the base metal thickness.

3. Weld the weldolet and packing gland assembly to the pipe.

   a. Place alignment bar back into the pipe, slide the weldolet and packing gland assembly down the alignment bar, and let it rest on the pipe.

   b. Ensure the $1^{1}/_{8}$-in. (29 mm) holes in the support plate are perpendicular to the pipe centerline within ± 3° for horizontal lines and parallel to the pipe centerline within ± 3° for vertical lines. This will ensure that the impact and static holes will be in line with the flow stream. See Figure 2-3 on page 2-6.

   c. Tack weld the weldolet to the pipe. Check alignment. Remove the alignment bar and weld the first pass. Emerson Process Management recommends using TIG welding for the first two passes as a minimum. Experience has shown that welding about $^{1}/_{2}$ to $^{2}/_{3}$ of the weld using GTAW (TIG) and then using other weld processes (GMAW, SMAW, FCAW) leads to lower chances of movement of the weldment during welding.

NOTE:
It is very helpful to have two welders welding the assemblies to pipe, with one welder starting 180° from the other. This helps prevent movement of the fittings during the temperature changes associated with welding.

   d. Check the alignment after the first pass. Remove the alignment bar and weld the next pass. Recheck alignment.

   e. Continue applying weld passes and rechecking alignment until welding is complete. The fillet welds will be approximately $1^{1}/_{8}$-in. (29 mm).

4. Weld the opposite side weldolet to the pipe.

   a. Slide the alignment bar through mounting and hole in top side of pipe and place the opposite-side support weldolet over the end of the alignment bar.

   b. Visually center the opposite-side weldolet over the hole. Tack weld the weldolet, using tack bars or an equivalent method.

   c. Weld the first pass and check alignment using the alignment bar and continue welding. Check alignment frequently during welding. Adjust weldolet as you are making tacks to keep aligned. Do not leave alignment bar in too long as it will heat up and make it very difficult to remove.

   d. When welding is complete, the alignment bar should slide freely through the packing into the opposite-side weldolet.

   e. Weld opposite end cap to weldolet using a full penetration groove weld.

5. Perform required heat treatment.
6. Reinstall 585 Main Steam Annubar after heat treating and ensure flow arrow is pointing in the direction of flow.

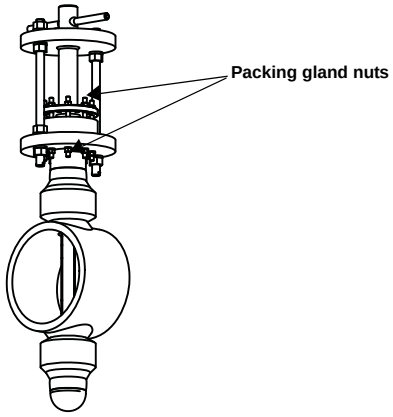
Step 4: Insert the Annubar

1. Place the packing into the packing gland with the two split rings (Garlock style 1303FEP) on the outside and the three Garlock Carbon/Graphite solid die-formed rings on the inside. Make sure the splits in the outer packing are 180° apart.

NOTE:
The packing gland and support plate will be shipped fully assembled.

2. Slide the 585 Annubar through the packing and install the locking rods, nuts, and lock washers. The dimension between the plates should be 11.0 in (279 mm). See Figure 2-37 on page 2-51. If there is visual access to the inside of the pipe, ensure that the sensing holes are equally spaced from the inner diameter of the pipe.
3. Make the small adjustment (if necessary), then lock the 585 in place with the locking rods, nuts, and lock washers. When installed, the 585 will have a dimension of 29.6 in (752 mm) from pipe OD to top of head.
4. The last thing to be done is to tighten the packing gland nuts to 25 to 30 ft.-lbs. (34 to 41 Nm). See Figure 2-35.

Figure 2-37. Tighten the Packing Gland Nuts



Step 5: Mount the Transmitter

1. Impulse piping that runs horizontally must slope downward at least one inch per foot (83 mm/m).
2. Impulse piping should have a minimum length of one foot (0.3048 m) for every 100 °F (38 °C) temperature increase over 250 °F (121 °C). Impulse piping must be non-insulated to reduce fluid temperature. Any threaded connections should be checked after the system reaches the intended temperature because connections may come loose with contraction and expansion caused by temperature change.
3. Outdoor installations may require insulation and heat tracing to prevent freezing.
4. When impulse piping is longer than six feet (1.8 m) the high and low impulse lines must be positioned together to maintain equal temperature. They must be supported to prevent sagging and vibration.
5. Impulse lines should be positioned in protected areas or against walls or ceilings. Use appropriate pipe sealing compound rated for the service temperature on all threaded connections. Do not place the impulse piping near high temperature piping or equipment.

   a. An instrument manifold is recommended for all installations. Manifolds allow an operator to equalize the pressures prior to zeroing and isolates the process fluid from the transmitter.

   b. Use only valves and fittings rated for the design pressure and temperature (in some cases the primary instrument valve may be supplied by Emerson Process Management with the Annubar).

   c. Use a pipe thread sealant compound that is rated for use at the service temperature and pressure for all valves and fittings.

   d. Verify that all connections are tight and that all instrument valves are fully closed.

   e. Verify that the sensor probe is properly oriented as per the submitted outline drawings.

   f. The piping used to connect the sensor probe and transmitter must be rated for continuous operation at the pipeline-designed pressure and temperature. A minimum of one-half inch (1/2-in., 12 mm) O.D. stainless steel tubing with a wall thickness of at least 1/16-in. (1,6 mm) is recommended.

WIRE THE TRANSMITTER

See Appropriate Transmitter Manual for Bench Configuration information.

Transmitter	HART document Number	FOUNDATION fieldbus document number	Profibus document number
Rosemount 3051S MultiVariable Mass and Energy Flow Transmitter	00809-0100-4803	N/A	N/A
Rosemount 3051S Pressure Transmitter	00809-0100-4801	00809-0200-4801	N/A
Rosemount 3095 MultiVariable Mass Flow Transmitter	00809-0100-4716	00809-0100-4716	N/A
Rosemount 3051 Pressure Transmitter	00809-0100-4001	00809-0100-4774	00809-0100-4797
Rosemount 2051 Pressure Transmitter	00809-0100-4101	00809-0200-4101	N/A

Do not connect the powered signal wiring to the test terminals. Power may damage the test diode in the test connection.

Plug and seal unused conduit connections on the electronics housing to avoid moisture accumulation in the terminal side of the housing. Excess moisture accumulation may damage the electronics. If the connections are not sealed, the electronics should be remote mounted with the electrical housing positioned downward for drainage. Wiring should be installed with a drip loop and the bottom of the drip loop should be lower then the conduit connections and the housing.

⚠ Inductive-based transient protectors, including the Rosemount 470 transient protector, can adversely affect the output of the Annubar. If transient protection is desired, install the Transient Protection Terminal Block. Consult the factory for instructions.

Wiring Diagrams

⚠

1. Remove the housing cover on the side marked FIELD TERMINALS. Do not remove the instrument covers in explosive atmospheres when the circuit is live.
2. Connect the lead that originates at the positive side of the power supply to the terminal marked “+” and the lead that originates at the negative side of the power supply to the terminal marked “–.” Avoid contact with the leads and terminals.