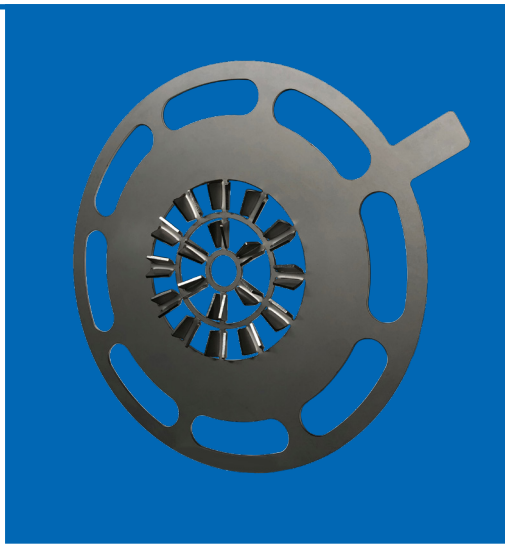
Installation Solutions for Limited Pipe Runs

Flow meter accuracy is often dependent upon a uniform flow profile near the sensing element. This is achieved with ample straight run upstream and downstream of the installation minimizing distortion and swirl in the flow. When there is limited straight pipe run available, a flow conditioner can be used to correct the disturbance.



Flow Conditioner for F-5000 Series Insertion Thermal Mass Flow Meters

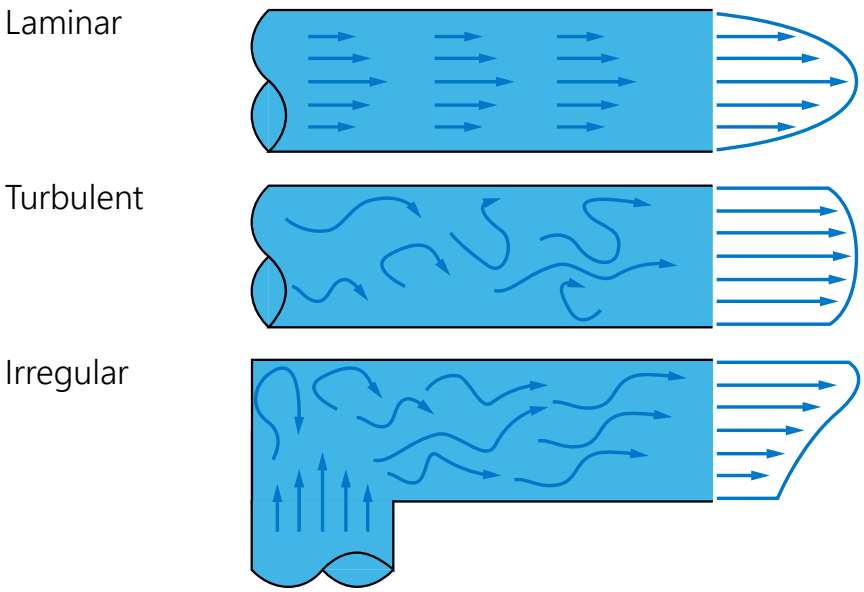


Figure 1: Typical Flow Profiles

Each flow meter is calibrated with the flow conditioner 2D upstream as shown in *Figure 3* to ensure the highest accuracy.

Performance

Flow Rate		Flow Conditioner Sizes in inches and Pipe Inner Diameters (Schedule 40 Pipes) in Inches											
		1.5″ (1.61 ID)		2″ (2.067 ID)		2.5″ (2.469 ID)		3″ (3.068 ID)		4″ (4.026 ID)		6″ (6.065 ID)	
m^3/Hr	Ft^3/Min	mBar	inH2O	mBar	inH2O	mBar	inH2O	mBar	inH2O	mBar	inH2O	mBar	inH2O
5	3	0.65	0.26										
10	6	0.68	0.27	0.65	0.26								
15	9	0.74	0.30	0.67	0.27	0.65	0.26						
20	12	0.83	0.33	0.71	0.28	0.27	0.27	0.65	0.26				
30	18	1.07	0.43	0.79	0.32	0.71	0.29	0.67	0.27	0.65	0.26		
40	24	1.40	0.56	0.92	0.37	0.77	0.31	0.69	0.28	0.65	0.26		
50	29	1.84	0.74	1.08	0.43	0.85	0.34	0.73	0.29	0.67	0.27		
60	35	2.37	0.95	1.27	0.51	0.95	0.38	0.77	0.31	0.68	0.27		
70	41	2.99	1.20	1.50	0.60	1.06	0.43	0.81	0.33	0.69	0.28	0.65	0.26
80	47	3.71	1.49	1.77	0.71	1.19	0.48	0.87	0.35	0.71	0.29	0.65	0.26
90	53	4.53	1.82	2.07	0.83	1.34	0.54	0.93	0.37	0.73	0.29	0.65	0.26
100	59	5.45	2.19	2.41	0.97	1.50	0.60	1.00	0.40	0.76	0.30	0.66	0.26
150	88	11.46	4.60	4.62	1.85	2.59	1.04	1.46	0.58	0.91	0.37	0.69	0.28
200	118	19.88	7.98	7.72	3.10	4.11	1.65	2.09	0.84	1.13	0.45	0.73	0.29
300	177	43.94	17.64	16.57	6.65	8.46	3.40	3.92	1.57	1.74	0.70	0.85	0.34
400	235	77.62	77.62	28.97	11.63	14.55	5.84	6.47	2.60	2.60	1.05	1.02	0.41
500	294			44.91	18.03	22.38	8.99	9.76	3.92	3.71	1.49	1.23	0.49
600	353			64.39	25.85	31.95	12.83	13.77	5.53	5.06	2.03	1.49	0.60
700	412			87.41	35.09	43.26	17.37	18.51	7.43	6.66	2.68	1.80	0.72
800	471					56.31	22.61	23.99	9.63	8.51	3.42	2.16	0.87
900	530					71.10	28.54	30.19	12.12	10.60	4.26	2.57	1.03
1000	589					87.63	35.18	37.12	14.90	12.94	5.19	3.02	1.21
1500	883							82.73	33.21	28.32	11.37	6.01	2.41
2000	1177									49.85	20.01	10.19	4.09
3000	1766											22.14	8.89
4000	2354											38.86	15.60
5000	2943											60.36	24.23

Table 1: Air Pressure Drop Data – Size 1.5″ – 6″ (1.61 – 6.065 ID)

Performance (Continued)

Flow Rate		Flow Conditioner Sizes in inches and Pipe Inner Diameters (Schedule 40 Pipes) in Inches					
		8" (7.981 ID)		10" (10.02 ID)		12" (11.94 ID)	
m^3/Hr	Ft^3/Min	mBar	inH2O	mBar	inH2O	mBar	inH2O
150	88	0.65	0.26				
200	118	0.67	0.27	0.65	0.26		
300	177	0.71	0.28	0.66	0.27	0.65	0.26
400	235	0.76	0.31	0.69	0.28	0.66	0.26
500	294	0.83	0.33	0.71	0.29	0.67	0.27
600	353	0.92	0.37	0.75	0.30	0.69	0.28
700	412	1.02	0.41	0.79	0.32	0.71	0.29
800	471	1.14	0.46	0.84	0.34	0.73	0.29
900	530	1.28	0.51	0.89	0.36	0.76	0.31
1000	589	1.43	0.57	0.95	0.38	0.79	0.32
1500	883	2.43	0.97	1.36	0.54	0.99	0.40
2000	1177	3.82	1.53	1.92	0.77	1.26	0.50
3000	1766	7.81	3.13	3.52	1.41	2.04	0.82
4000	2354	13.38	5.37	5.77	2.31	3.13	1.26
5000	2943	20.55	8.25	8.65	3.47	4.53	1.82
6000	3531	29.32	11.77	12.18	4.89	6.25	2.51
7000	4120	39.68	15.93	16.35	6.56	8.27	3.32
8000	4709	51.63	20.73	21.16	8.49	10.61	4.26
9000	5297	65.17	26.16	26.61	10.68	13.26	5.32
10000	5886	80.31	32.24	32.70	13.13	16.22	6.51
15000	8829			72.79	29.22	35.71	14.34
20000	11772					62.99	25.29
30000	17657						
40000	23543						

Table 2: Air Pressure Drop Data – Size 8" – 12" (7.981 – 11.94 ID)

Equation

dP = 0.01786 * KE + 0.6343
Error for 95% Confidence Interval: +/-25%

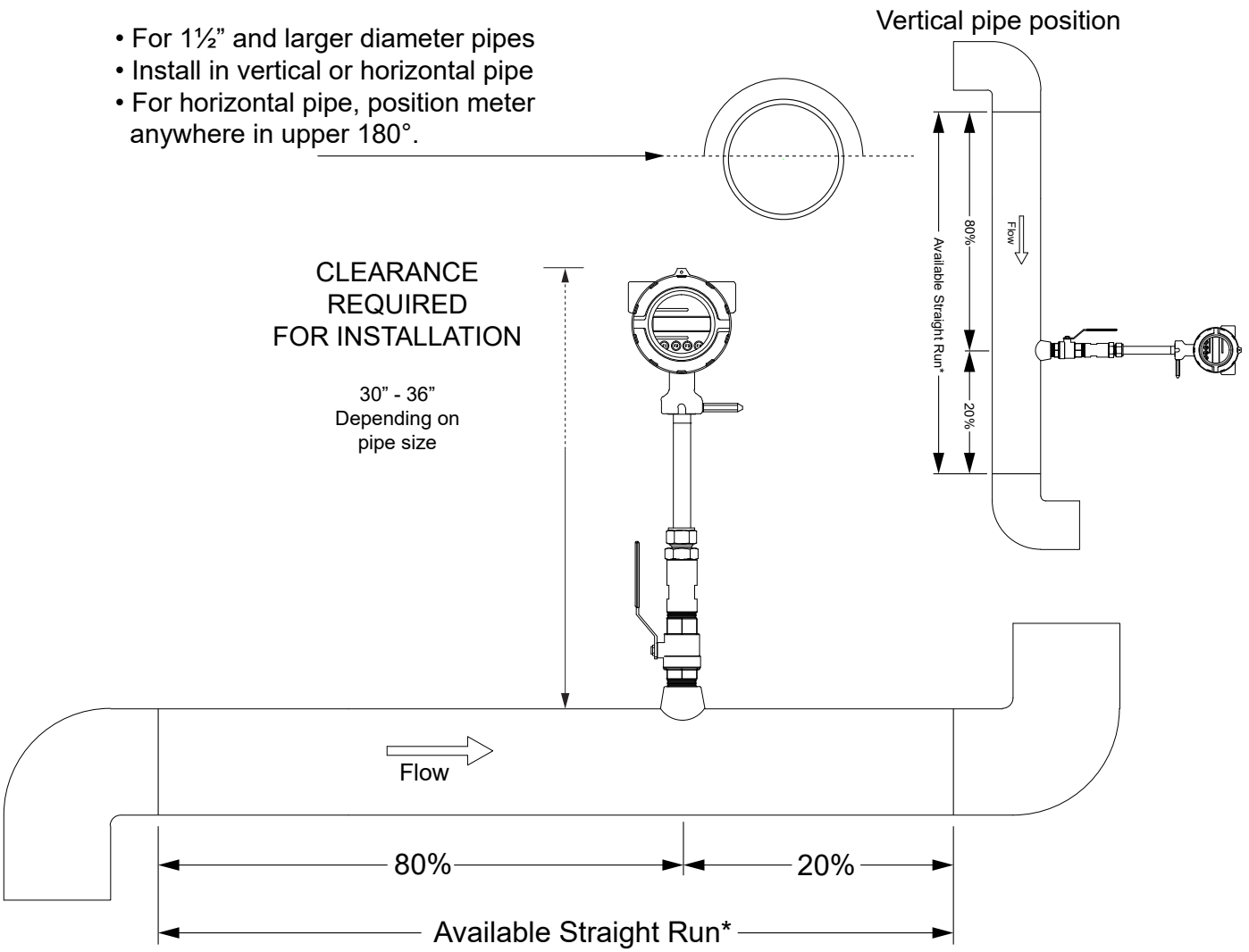
The pressure drop can be minimized when the flow profile requires less correction.

Term Definitions

dP = Pressure Differential [mBar]
D = Actual Density [kg/m^3]
V = Actual Average Velocity [m/s]
KE = Kinetic Energy = 0.5*D*V^2

Flow Meter Site Selection General Guidelines

- For 1½" and larger diameter pipes
- Install in vertical or horizontal pipe
- For horizontal pipe, position meter anywhere in upper 180°.



* See following page for straight run requirements

Evaluating Upstream Piping Conditions

Better

Straight Pipe

Single Bend

Pipe Reduction or Enlargement

Outflowing Tees

Multiple Bends in Same Plane

Worse

Multiple Bends Out of Plane

Inflowing Tees

Pressure Reducing Valve

How to determine the available straight pipe diameters:

For each application, locate the longest straight, unobstructed section of pipe (no bends, tees, valves, other insertion probes, size transitions, etc.). The longest straight pipe run in inches divided by nominal pipe size in inches equals diameters of straight pipe. For closed loop applications, consider both the supply and return lines as possible locations.

Unobstructed Flow Requirements

Select an installation site that will minimize possible distortion in the flow profile. Valves, elbows, control valves and other piping components may cause flow disturbances. Check your specific piping condition against the examples shown in *Table 3*. In order to achieve accurate and repeatable performance, install the flow meter using at least the recommended number of straight run pipe diameters upstream and downstream of the sensor.

General Practices

1. For best results, install the flow meter in a straight run of pipe free of bends, tees, valves, transitions and obstructions.
2. Straight run requirements vary based on the nature of the upstream obstruction (see *Table 3* for guidelines based on obstruction type). Depending upon specific location details, more or less straight run may be required to produce a satisfactory flow profile.
3. If there is insufficient straight run, allow 80% of the run upstream and 20% of the run downstream. If the total length of straight run is less than 70% of the recommended distance, performance may seriously degrade, and consideration should be given to installing an ONICON flow conditioner.

Recommended Straight Run Requirements for Installation

To determine where to install the flow conditioner, the pipe size is important. Flow conditioners require 5 diameters (5D) of upstream straight pipe. Also, the flow meter's sensor should be 5D before any downstream disturbances.

The distance between the flow conditioner and the flow meter's sensor is 2D. The relationship between pipe size and pipe diameters is illustrated in *Figure 3* with lengths listed in *Table 3*. If more total straight pipe run than the minimum is available, most of it should be used upstream. The pressure drop can be minimized when the flow profile requires less correction.

Important Note:
Flow conditioners installed upstream of flow meters reduce the need for long, straight pipe runs.

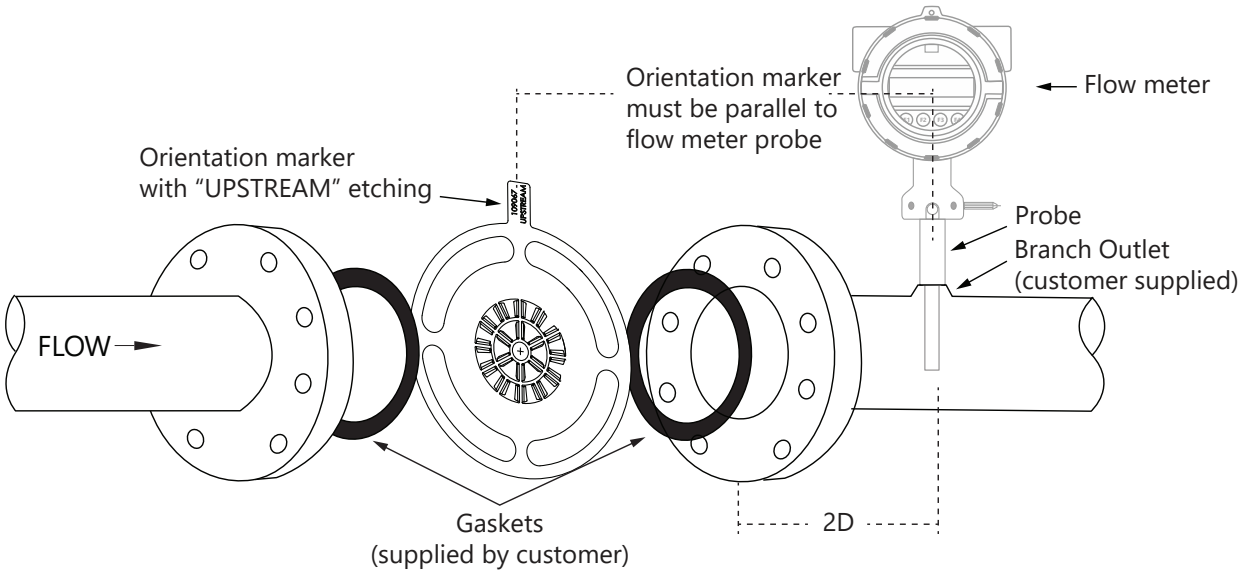


Figure 2: Orientation of Flow Conditioner

Recommended Straight Run Requirements for Installation (Continued)

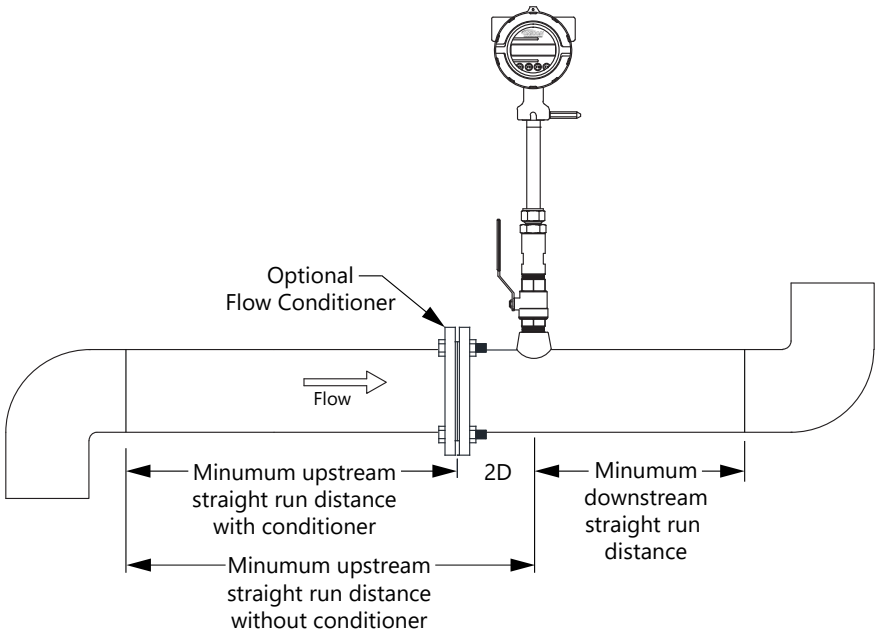


Figure 3: Straight Pipe Run Requirement

Upstream obstruction	Straight run requirements		
	Minimum required upstream diameters (without flow conditioner)	Minimum required upstream diameters (with flow conditioner)	Minimum required downstream diameters
Single bend preceded by ≥ 9 diameters of straight pipe	15 Diameters	5 Diameters	5 Diameters
Pipe size reduction in straight pipe run	15 Diameters	5 Diameters	5 Diameters
Multiple bends in plane with < 9 diameters of straight pipe between them	20 Diameters	9 Diameters	5 Diameters
Pipe size expansion in straight pipe run	30 Diameters	10 Diameters	5 Diameters
Tees	30 Diameters	10 Diameters	5 Diameters
Multiple bends out of plane	40 Diameters	10 Diameters	5 Diameters
Modulating or regulating valve	40 Diameters	10 Diameters	5 Diameters

Table 3: Straight Pipe Run Requirements

Important Note
Always use the maximum available straight run. When more than the minimum required straight run is available, place the meter such that the excess straight run is upstream of the meter's location.