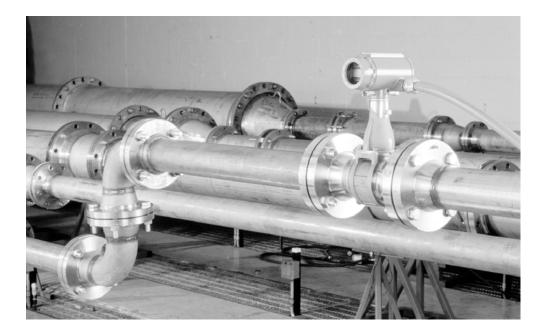
Technical Data Sheet 00816-0100-3250, Rev GD October 2015

Rosemount[™] 8800 Vortex Installation Effects





1.1 Introduction

The Rosemount 8800 Vortex Meter provides methods for maintaining accuracy in less than ideal installations.

In designing the 8800, Rosemount tested the meter for three separate types of installation effects:

- Process fluid temperature variation
- Process piping inside diameter
- Upstream and downstream disturbances

As a result of this testing, compensation factors are included in the vortex meter software; this allows the output of the vortex meter to be adjusted for the actual process temperature and process piping being used.

Data is presented in this paper to demonstrate the effectiveness of the design in limiting the errors resulting from piping disturbances. For upstream disturbances caused by pipe elbows, contractions, expansions, etc., Rosemount has conducted extensive research in a flow lab to determine the effect that these have on the meter output. These tests are the basis for the recommended 35 upstream piping diameters. While this is optimal, it is not always possible in the real world of plant design and layout. Therefore, the data presented in this paper outlines the effects of different upstream and downstream piping conditions on the vortex meter.

1.1.1 Temperature effects on K-factor

The vortex meter is fundamentally a velocity measuring device. As fluid flows past the shedder bar, vortices are shed in direct proportion to the fluid velocity. If the process temperature is different than the reference calibration temperature, the meter bore diameter will change slightly. As a result, the velocity across the shedder bar will also change slightly. For example; an elevated process temperature will cause an increase in the bore diameter, which in turn will cause a decrease in the velocity across the shedder bar.

Using the *Reference K-factor* and the value for *Process Temperature* input by the user, the Rosemount 8800 automatically calculates for the effect of temperature on the meter by creating what is called the *Compensated K-factor*. The *Compensated K-factor* is then used as the basis for all flow calculations.

1.1.2 Pipe ID effects on K-factor

All Rosemount 8800 Vortex Meters are calibrated in schedule 40 pipe. From extensive testing done in piping with different inside diameters/schedules, Rosemount has observed there is a small K-factor shift for changes in process pipe ID (inside diameter). This is due to the slight change in velocity at the inlet to the meter.

These changes have been programmed in to the 8800 electronics and will be corrected for automatically when the user supplied pipe ID is other than schedule 40.

1.1.3 Upstream and downstream piping configurations

The number of possible upstream and downstream piping configurations is infinite. Therefore, it is not possible to have software automatically calculate a correction factor for changes in upstream piping. Fortunately, in almost all cases, elbows, reducers, etc. cause less than a 0.5% shift in the meter output. In many cases, this small effect is not a large enough shift to cause the reading to be outside of the accuracy specification of the meter.

The shifts caused by upstream piping configurations are basically due to the changes in the inlet velocity profile caused by upstream disturbances. For example, as a fluid flows around an elbow, a swirl component is added to the flow. Because the factory calibration is done in a fully-developed pipe flow, the swirl component caused by the elbow will cause a shift in the vortex meter output. Given a long enough distance between an elbow and the meter, the viscous forces in the fluid will overcome the inertia of the swirl and cause the velocity profile to become fully-developed. There rarely is sufficient length in actual process piping installations for this to occur. Even though the flow profile may not be fully-developed, testing indicates that the Rosemount vortex meter can be located within 35 pipe diameters of the elbow with minimal effect on the accuracy or repeatability of the meter.

Although the upstream disturbance may cause a shift in the K-factor, the repeatability of the vortex meter is normally not affected. For example, a meter 20 pipe diameters downstream of a double elbow will be as repeatable as a meter in a straight pipe. Testing also indicates that while the K-factor is affected by upstream piping, the linearity of the meter remains within design specifications.

In many applications, this means that no adjustment for piping configuration will be necessary — even when the minimum recommended installation lengths of upstream and downstream piping cannot be used.

On the following pages are drawings illustrating various installation configurations. Extensive testing has been performed in a flow lab with these specific configurations. The results of those tests are shown as a series of graphs indicating the shift in the mean K-factor for a vortex meter placed downstream of a flow disturbance.

1.1.4 In plane versus out of plane

In the graphics, the terms *in plane* and *out-of-plane* are used. A butterfly valve and a vortex meter are considered to be *in plane* when the shaft of the valve and the shedder bar of the vortex meter are aligned (e.g. both the shaft and the shedder bar are vertical.)

- In reference to Figure 1-17A, a butterfly valve and a vortex meter are considered to be in plane when the shaft of the valve and the shedder bar of the vortex meter are aligned (e.g. both the shaft and the shedder bar are vertical).
- In reference to Figure 1-7A, the elbow is considered in plane. Referring to Figure 1-7B, the elbow is considered out of plane because the shedder bar in the vortex meter is rotated 90°.

Similarly, in Figure 1-11 on page 11, two 90° elbows (which themselves are in a common plane) are shown; their plane is considered to be *in plane* with the vortex meter. Figure 1-13 on page 12 contains data from two 90° elbows which do not have a common plane. The plane of the elbows entering and exiting the vortex meter is not aligned with the shedder bar of the vortex meter, therefore this configuration is considered *out-of-plane*.

1.2 Correcting the output of the vortex meter

Correction factors can entered into the vortex meter transmitter using AMS[™] Device Manager, ProLink[™] III v3 or a 475 or similar HART[®] Field Communicator.

For all Fieldbus devices and devices with HART software revisions 5.2.5 and earlier, the K-factor can be adjusted using the *Installation Effect* command. This command will adjust the compensated K-factor to account for any correction needed. The correction will be entered as a percentage of the K-factor shift. The possible range of the shift is +1.5% to -1.5%.

For devices with HART revision 5.3.1 or 7.2.1 and later, the correction factor will be entered using the Meter Factor command. This command works in a similar way to the Installation Effect command but has an inverse relationship to k-factor shift and an enter-able range of 0.8 to 1.2. Entering a value of 0.8 represents a +20% shift in k-factor, a value of 1.0 represents a 0% shift in k-factor, and a value of 1.2 represents a -20% shift in k-factor.

1.2.1 Fieldbus and HART software revisions 5.2.5 or earlier

Using AMS Device Manager

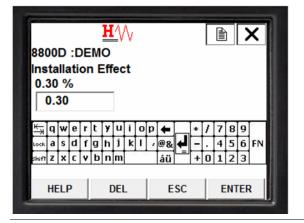
Under the Sensor tab, enter the correction in the Install Effect field. See Figure 1-1.



5 G. <u>*</u>		
Configure/Setup	Basic Setup Units Sidr/Niml Units Sensor Outputs Flow Sensor Pipe I.D. 3.068 in Process Fluid TComp Sat Steam • Reference K Fa 10.7800 Compensated K 10.7547 Install Effect 0.30 Temperature Sensor T/C Falure Mode Use Fixed Proc T € • Sensor Limits USL 41.916 kg/min	Fittering Device Display HART Process Fixed Process T 277.0 degF Fixed Process D 0.100000 lb/Cuft Meter Body Weted Material 316 SST Weter Body # 188306 Flange Type ANSI 150 Meter Body S/N 188306 Body # suffix 8
🚱 Configure/Setup	LSL 0.000 kg/min	
 Device Diagnostics Process Variables 		of Fixed Process Density unit codes can be changed by or "Process Density" from the "Sensor Configuration" item is display to access the device context menu.
	Time: Current	Send Close Help

Using a 475 HART Field Communicator

Go to **Manual Setup > Sensor > Process > Installation Effect** and then enter the correction number in the field. See Figure 1-2.



Using ProLink III v3

To enter the Installation Effect, select **Device Tools > Configuration > Device Setup > Installation Effect.** See Figure 1-3.

Ba. Mass Flow Analog Output Shedding Frequency Pulse Output 1262 1262 0.00000 kg/h 100 0.00000 Hz Volume Total 0.00000 kg/h 100 0.00000 Hz 100 Signal Strength 1.08795 0.00000 Hz 100 0.00000 Hz Merts Device Setup X None None None None Alerts Device Setup X Mithout Temperature Sensor Post Sensor Post Sensor None Fixed Process Density 450000 kg/Cum Fixed Process Density 450000 kg/Cum Plow Sensor 107 0.00000 Intallation Effect 0.00000 None None	Process Variables >			
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	Pipe I.D Units			

Figure 1-3. Using ProLink v3

1.2.2 HART software revisions 5.3.1 or 7.2.1 and later Using AMS Device Manager

Under the Sensor tab, enter the correction in the Meter Factor field. See Figure 1-4.

Figure 1-4. Using AMS Device Manager

onfigure	Sensor Variable Mapping Process Outputs	Signal Processing SMART Fluid Licenses TCom	p Liquid Display HART Device Information
Configure Guided Setup Manual Setup	Process Transmitter Mode With Temperature Sensor · · Process Ruid [Uquid · -] Fixed Process Temperature 77 000000 degF Fixed Process Denaty 62 500 b/Cuft Pipe Inside Dameter 1.049000 in	Row Sensor Reference Kfactor 302 979980 Compensated Kfactor 302 9800 Upper Sensor Limit 29 999996 ft/s Lower Sensor Limit 0 000000 ft/s Temperature Sensor Failure Mode Go To Alam	Meter Body Vetted Material 315 Stanless Steel Range Type [ASIME 150 Meter Body Senial Number Body Number Suffix [A] Meter Body Number 0
	Meter Factor 1.000000 Process Configuration Set Process Fluid Set Process Dan		Set Process Temperature Set Proc Inside Diameter
Overview Configure Service Tools			Set ripe inside Ulariteter

Using a 475 HART Field Communicator

Go to **Manual Setup > Sensor > Process > Meter Factor** and then enter the correction number in the field. See Figure 1-5.

Figure 1-5. Using a 475 HART Field Communicator

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_	z	x	C	v	b	n	m				áü		+	0	1	2	3	
Lock	a z	s x	d c	f v	-	-	j m	k	1	,	@& áü		- +	0	4 1	5 2	-	F

Using ProLink III v3

To enter the Installation Effect, select **Device Tools > Configuration > Device Setup > Meter Factor**. See Figure 1-6.

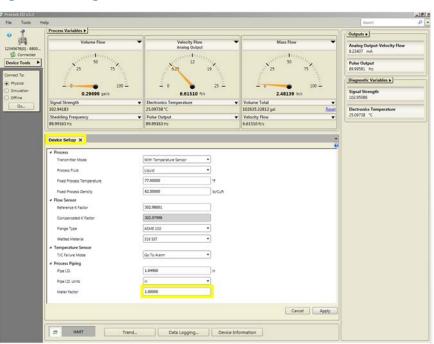


Figure 1-6. Using ProLink III v3

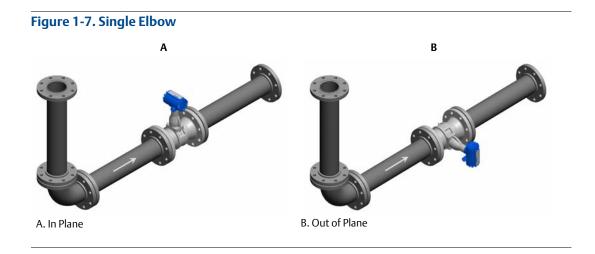
1.2.3 Correction factor examples

Example 1: The 8800 Vortex Meter is installed 15 pipe diameters downstream from a single 90° elbow, with the shedder bar in plane. Looking at Single Elbow Graph and following the *IN PLANE* line, the K-factor shift would be +0.3% at 15 pipe ID.

To adjust the K-factor to correct for this shift, enter +0.3% into the *Installation Effect* field or 0.997 for devices utilizing Meter Factor.

Example 2: The 8800 Vortex Meter is installed 10 pipe diameters downstream from a butterfly valve, with the shedder bar out of plane. Looking at Butterfly Graph and following the *OUT OF PLANE* line, the K-factor shift would be -0.1% at 10 pipe ID.

To adjust the K-factor to correct for this shift, enter -0.1% into the *Installation Effect* field or 1.001 for devices utilizing Meter Factor.



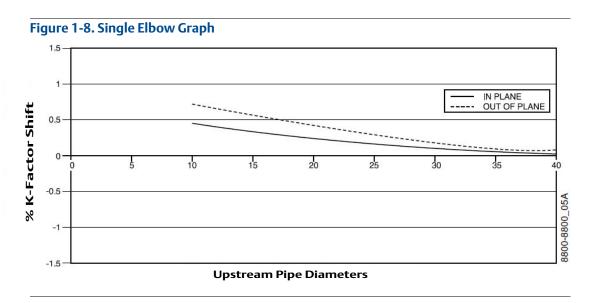


Figure 1-9. Pipe Expansion

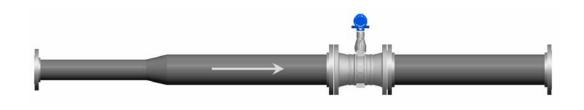
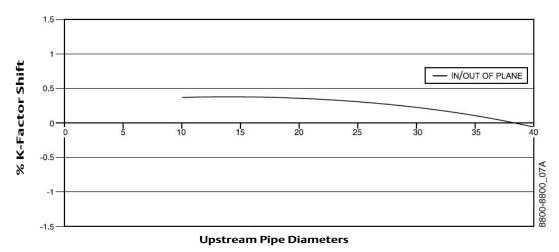
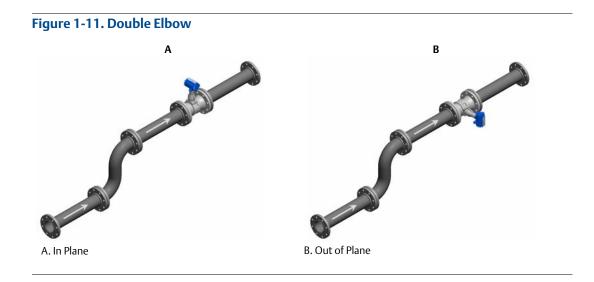


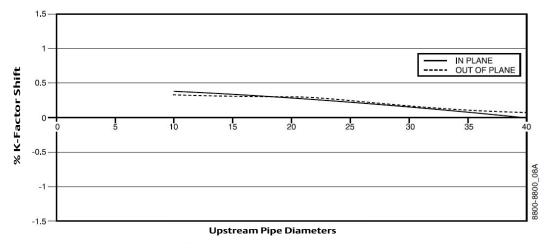
Figure 1-10. Pipe Expansion Graph



K-Factor shift based on data collected with concentric pipe expander.







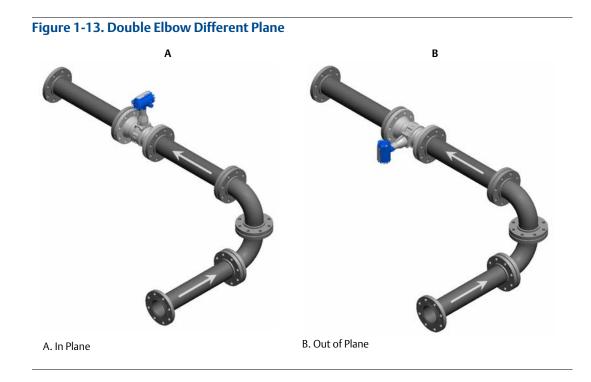


Figure 1-14. Double Elbows - Different Plane Graph

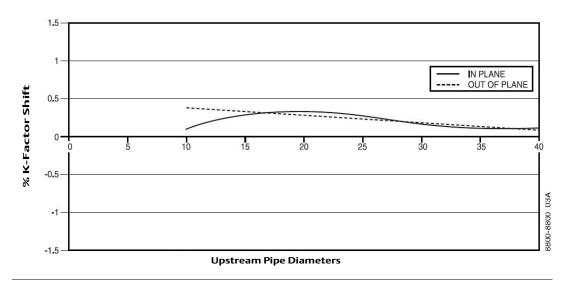
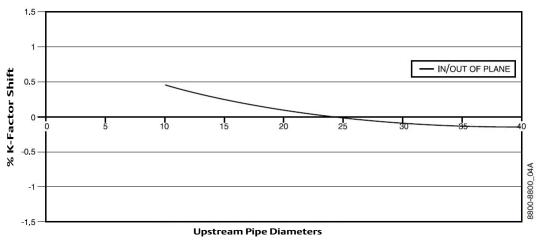


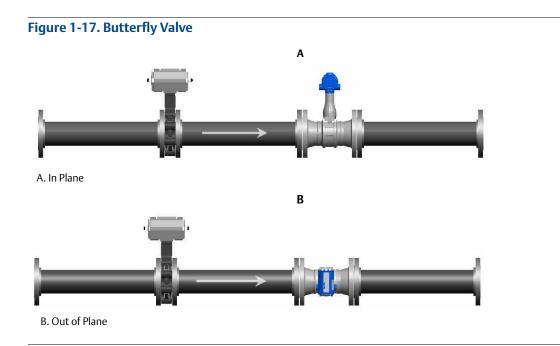
Figure 1-15. Reducer



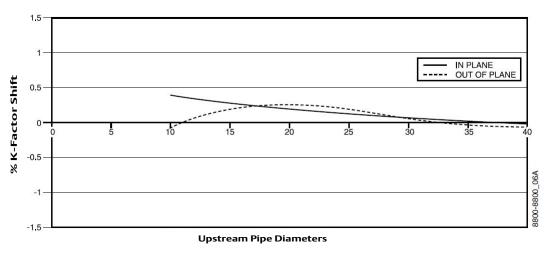
Figure 1-16. Reducer Graph



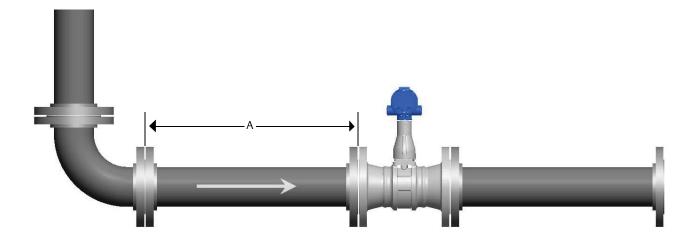
K-Factor shift based on data collected with concentric pipe reducers.







2.1 Calculating upstream and downstream pipe diameters



A. Pipe ID's calculated face to face

Note

When using a reducer Vortex, pipe ID's are calculated using the process pipe ID not the meter body ID.

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