

Select the Proper Transmitter Range for DP Level Applications

SELECT THE PROPER TRANSMITTER RANGE FOR DP LEVEL APPLICATIONS

Remote seal assemblies (which include a transmitter, remote seals, and capillary connection) offer high quality performance for DP level applications. However, limitations may occur when using transmitters with too small of a range. Although transmitter best practices recommend using the lowest sensor range that will operate at the maximum pressure, a transmitter with too low of a range will not function properly in certain applications.

It may seem practical to use a small range transmitter in applications with a small distance between the high and low taps, as distance relates to transmitter span. However, the limits of a small range transmitter are low enough to cause ranging limitations for many applications. It is recommended to use a larger range transmitter for all DP level applications with remote seals on small span applications. For example, the limits of a Range 2 transmitter are ten times larger than a Range 1 sensor (-250 to 250 inH₂O or -0.6 to 0.6 bar compared to -25 to 25 inH₂O or -62.2 to 62.2 mbar). Additionally, a Range 2 transmitter offers identical performance to a Range 1 transmitter when remote seals are used due to the expansion and contraction of additional fill fluid in the capillary as the temperature increases and decreases. Table 3 on page 2 lists the five different transmitter ranges that Rosemount offers.

When choosing a transmitter, it is important to account for the pressure from the process fluid (the liquid level) and the fill fluid in the capillary. If either pressure is greater than the upper range limit of a sensor, it will cause the output sensor to saturate. That being the case, a larger range sensor offers just as good of performance with a larger measurement range.

The following sections will further explain why selecting a larger range transmitter is a more reliable choice than a small range transmitter for small spans on DP level applications.

FIELD RANGING

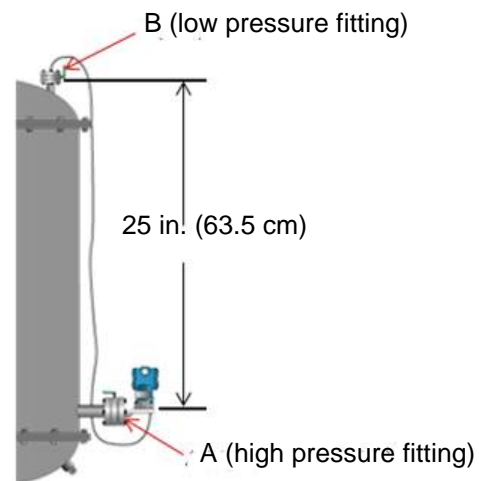
It is very common to assume that the span of the application is within the range of the transmitter.

The following example shows a Range 1 transmitter, with a range of -25 to 25 in. H₂O (-62.2 to 62.2 mbar), in an application where one might think that the span of the application is within the range of the transmitter.

However, even when the vertical distance between the fittings is 25 in. (63.5 cm), which is within the Range 1 transmitter range, it is possible to exceed the limits of the transmitter.

Figure 1 shows a small empty tank with a distance of 25 in. (63.5 cm) between the high (A) and low (B) pressure fittings.

Figure 1. Empty tank, 25 in. (63.5 cm) distance between fittings.



In order to determine the maximum vertical distance between pressure fittings that the transmitter will allow, also known as the transmitter's span, it's necessary to determine:

1. The range of the transmitter (In this case, ± 25 in. H₂O or ± 62 mbar).
2. The specific gravity of the fill fluid used (see Table 1 for specific gravities of fill fluids offered by Rosemount).

As mentioned in the previous equation, the fill fluid chosen for the application has a major part when determining the maximum vertical distance. Fill fluids have unique specific gravities that will change the maximum vertical distance between pressure fittings necessary for the transmitter to correctly read the pressure measurement. Each unique fill fluid has a different temperature limit and some are used in hygienic or cryogenic applications, allowing multiple options for customers to choose from.

Table 1 below shows Rosemount’s published fill fluids along with the specific gravity of each and the maximum vertical distance allowed with a Range 1 transmitter.

Table 1. Fill fluids, specific gravities, and the maximum allowed distance while using a Range 1 transmitter.

Fill Fluid	Specific Gravity	Range 1 Maximum Vertical Distance
Syltherm XLT	0.85	29.41 in. (74.7cm)
Silicone 200	0.934	26.77 in. (70cm)
Silicone 704	1.07	23.36 in. (59.34cm)
INERT	1.85	13.51 in. (34.32cm)
Glycerin	1.13	22.12 in. (56.18cm)
Neobee M-20	0.92	27.17 in. (69cm)
Propylene Glycol	1.02	24.51 in. (62.26cm)

By dividing the range of the transmitter by the specific gravity of the fill fluid, it will give maximum vertical distance between pressure fittings that the transmitter can handle.

$$\frac{\text{Range of transmitter}}{\text{Specific gravity of fill fluid}} = \text{Maximum distance between pressure fittings}$$

Equation 1: Maximum vertical distance between pressure fittings (transmitter span).

As the specific gravity of a fill fluid increases, the transmitter's span decreases.

Therefore, if Silicone 200 fill fluid is used (specific gravity of 0.934) with the Range 1 transmitter (± 25 in. H₂O or ± 62 mbar) the maximum vertical distance between pressure fittings is 26.77 in. (68 cm) See Equation 2.

$$\frac{25 \text{ inH}_2\text{O}}{0.934} = 26.77 \text{ in. (68 cm)}$$

Equation 2: Transmitter span for this example

Although this example works for a Range 1 transmitter, it is important to understand that best practices avoid using Range 1 transmitters whenever possible in DP level applications.

There are some fill fluids that will not work for this example application of 25 in. (63.5 cm) vertical distance with a smaller range transmitter. Table 2 below identifies which transmitter range is required in this application with each fill fluid.

Table 2. Transmitter range required for this example application

Fill Fluid	Specific Gravity	Maximum Vertical Distance	Transmitter Range Required
Syltherm XLT	0.85	29.41 in. (74.7cm)	Range 1
Silicone 200	0.934	26.77 in. (70cm)	Range 1
Silicone 704	1.07	23.36 in. (59.34cm)	Range 2
INERT	1.85	13.51 in. (34.32cm)	Range 2
Glycerin	1.13	22.12 in. (56.18cm)	Range 2
Neobee M-20	0.92	27.17 in. (69cm)	Range 1
Propylene Glycol	1.02	24.51 in. (62.26 cm)	Range 2

Table 3 shows the differential pressure range for all five transmitter ranges. Again, moving from a Range 1 transmitter to a Range 2 transmitter gives 10 times as much vertical distance in applications.

Table 3. Ranges 1-5 transmitters with DP ranges

	Differential Pressure Range
1A	-25 to 25 inH ₂ O (-62.2 to 62.2 mbar)
2A	-250 to 250 inH ₂ O (0.6 to 0.6 bar)
3A	-1000 to 1000 inH ₂ O (-2.5 to 2.5 bar)
4A	-300 to 300 psi (-20.7 to 20.7 bar)
5A	-2000 to 2000 psi (-137.9 to 137.9 bar)

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PERFORMANCE

As mentioned previously, small range transmitters offer no difference in performance when remote seals are used due to temperature effects on the fill fluid in the capillary.

The following equations further explain how there is identical performance.

TOTAL SYSTEM ERROR EQUATIONS

With remote seal applications there is a Total Remote Seal Effect (TRSE) which is the sum of the seal temperature effects (STE) and head temperature effects (HTE). The performance of the transmitter is very accurate. However, the additional fill fluid in a remote seal system will create a much larger error than the transmitter alone.

Seal temperature effect (STE) is the change in pressure seen at the transmitter caused by the change in fill fluid volume in the seal and capillary as the temperature changes. Head temperature effect (HTE) is the change in weight of the fill fluid in the capillary pushing down on the transmitter.

$$TRSE = STE + HTE$$

Equation 4: Total Remote Seal Effect

TRSE is factored into the Total Probable Error (TPE) which is the error from the transmitter. In remote seal applications, the TRSE usually is larger than the TPE.

The numbers are then root sum squared to determine the Total System Error (TSE). The TSE is the error of the entire remote seal assembly (includes: transmitter, capillary, and seal).

$$TSE = \sqrt{TRSE^2 + TPE^2}$$

Equation 5: Total System Error

Example: Range 1 and Range 2 transmitters with an FFW remote seal and 5 feet of capillary on the low pressure side (Tuned-System™ Assembly).

Results

	Total System Error with Remote Seal
3051S1CD1 (Range 1)	±0.231 inH ₂ O
3051S1CD2 (Range 2)	±0.231 inH ₂ O

There is no difference in performance between Range 1 and Range 2 transmitters for DP level applications when remote seals are used.

SUMMARY

Using small range transmitters for short vertical distances creates ranging limitations. It is important to understand these limitations and apply these principles to help select the proper range transmitter for each specific application.

If there are any further questions on selecting the proper range transmitter for DP Level applications, please contact our technical specialists at Emerson.

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