Basics of Calibrating Pressure Transmitters

Pressure transmitters need to be calibrated on a regular basis for maximum performance. When do you do it? How do you do it? And who does it?

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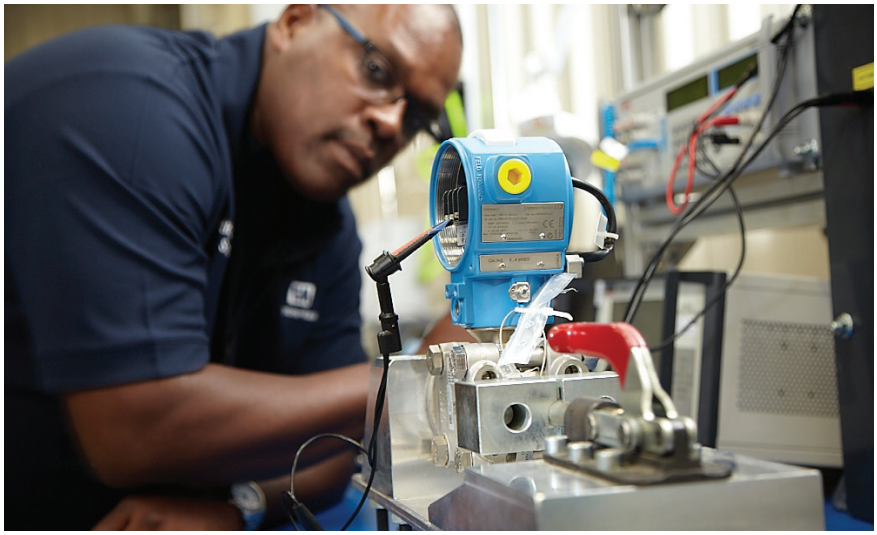

Pressure transmitters used in the process industries are very durable and reliable instruments. Even so, they still require periodic maintenance and calibration to ensure optimal performance. This is an area of confusion for many, with these and other questions typical:

- Are we calibrating our transmitters too often, resulting in excessive downtime and unnecessary maintenance expense?
- Are we calibrating our transmitters too infrequently, resulting in quality issues and possible loss of product?
- Are we calibrating our transmitters correctly?

As with most things in life, there is no "one size fits all" answer. However, there are simple best-practice guidelines, which can be modified to fit specific applications. This article helps answer the basic questions facing process plant personnel with regard to calibration.

How Often?

Each process plant has to determine correct calibration intervals based upon historical performance and process-related requirements. Factors you need to consider that may influence this decision are:

- Are there any local, national, safety or environmental regulations that must be observed?
- What is your reason for requiring calibration: quality, safety or standard maintenance?

Process conditions:

- Is there a homogeneous process fluid with a stable pressure/temperature?
- Will the process conditions fluctuate significantly?
- Is there risk of buildup, corrosion or abrasion to the pressure transmitter?
- Will heavy vibration be present?

Ambient conditions:

- Will the pressure transmitter be installed in a well-controlled environment with low humidity, normal/stable temperatures, and few contaminants such as dust or dirt?
- Is an outdoor transmitter exposed to widely varying weather conditions or high humidity?

If you have no significant history or regulatory requirements to guide you in developing your calibration procedures, a good place to start is with the following general guidelines.

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- Direct mounted pressure transmitters installed inside in a controlled environment on a process with stable conditions should be calibrated every four to six years.
- Direct mounted pressure transmitters installed outside on a process with stable conditions should be calibrated every one to four years, depending upon ambient conditions.

If a remote diaphragm seal is employed on a pressure transmitter, the calibration interval should be reduced by a factor of two; i.e., a four to six year interval is reduced to two to three years. This is because a remote diaphragm seal will employ more fill fluid than a direct mounted configuration. Consequently it will experience more mechanical stress from process or ambient temperature fluctuations. Most remote diaphragms are flush faced where the diaphragm/membrane is susceptible to physical damage (dents or abrasions) that can cause offset or linearity issues.

If the process regularly experiences significant pressure swings or over pressurization events, reducing the calibration interval by a factor of two is a good rule of thumb.

How Accurate?

How good is good enough? In other words, what is the Maximum Permissible Error (MPE) for your calibration?

Many make the mistake of adopting the manufacturer's reference accuracy as their calibration target. Unfortunately, this means they will have a MPE that is too tight, with a high rate of non-conformance in their calibration process. In the worst case with a very tight tolerance MPE, it may not be possible for their field or lab test equipment to calibrate some of their transmitters.

A manufacturer's reference accuracy is based upon tightly controlled environmental conditions seldom if ever duplicated in a plant environment. Using that reference accuracy for a calibration target also fails to take into account the long term stability of the instrument.

Over time, all instruments will experience slight accuracy degradation due to aging and simple wear and tear on mechanical components. This needs to be considered when establishing the MPE. In general, unless there are mitigating circumstances, it is better to set a reasonable MPE achievable with standard field and lab test equipment.

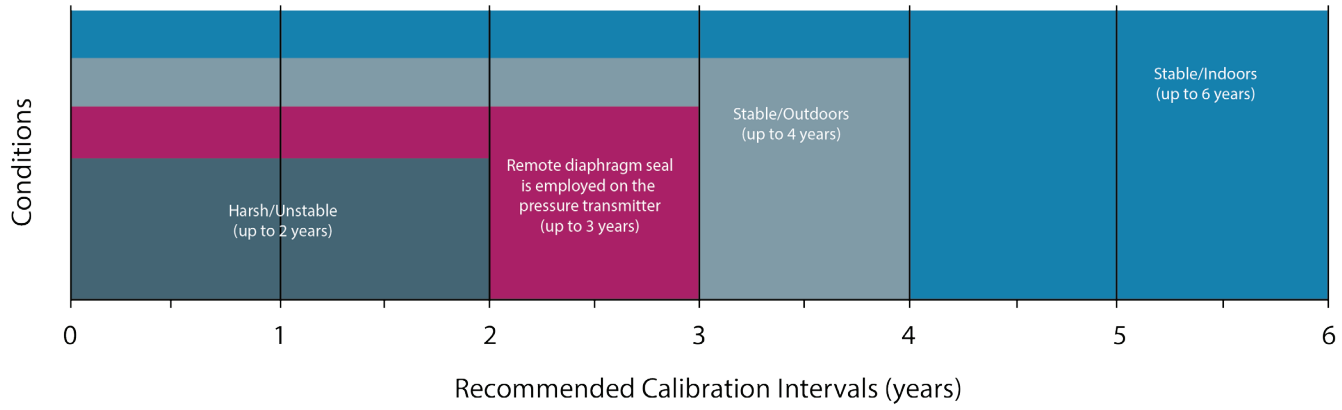
Test equipment starts with an accurate pressure source to simulate the transmitter input. The corresponding output is measured with a multimeter for a 4-20mA transmitter, or with a specialized device for smart transmitters with digital outputs such as HART, Foundation Fieldbus, Profibus or EtherNet/IP.

The test equipment you intend to use should be traceable to the National Institute of Standards and Technology. As a general recommendation, your reference equipment should be at least three times more accurate than the pressure transmitter being calibrated.

Performing the Calibration

Once your calibration interval and MPE have been established, you are ready to perform the actual calibration procedure on your pressure transmitter. The best practice recommendation from Endress+Hauser is:

1. Mount the transmitter in a stable fixture free from vibration or movement
2. Exercise the sensor/membrane before performing the calibration. This means applying pressure and raising the level to approximately 90% of the maximum range. For a 150 psi cell that would mean pressurizing it to 130-135 psig. Hold this pressure for 30 seconds then vent. Your overall results will be much better than if you calibrate "cold."
3. Perform a Position Zero Adjustment (zero the transmitter). This is important because the fixture used for calibration may be different than how the transmitter is mounted in the process. Failing to correct for this by skipping this step can result in non-conformance.



Recommended calibration intervals (years)

4. Begin the calibration procedure. Typically this means three points up (0% / 50% / 100%) and then three points down. The 4-20mA output should be 4mA, 12mA and 20mA at the three points (or the correct digital values for a smart transmitter). Each test point should be held and allowed to stabilize before proceeding to the next. Normally that should take no more than 30 seconds. More points can be used if you require a higher confidence in the performance of the instrument.
5. Compare the results of your pressure transmitter to your reference device.
6. Document the results for your records.

The calibration should be performed in as stable an environment as possible because temperature and humidity can influence the pressure transmitter being tested as well as the pressure reference.

If the results of your calibration are within the MPE, do not attempt to improve the performance of the transmitter.

One mistake many end users make is to regularly perform a sensor trim adjustment of their pressure transmitter—even on new units from the manufacturer. A sensor trim corrects the digital reading from the sensor after the A/D conversion. Performing a sensor trim on a new transmitter is essentially a single point calibration under current plant environment conditions, as opposed to sticking with the original factory calibration.

Factory calibrations of pressure transmitters are performed in a tightly controlled environment and incorporate up to as many as 100 test points. Performing a sensor trim on a new pressure transmitter under field conditions will result in a unit that operates at less than optimal capacity. A sensor trim should only be performed by a qualified technician under the manufacturer's guidance.

Who Should Perform the Calibrations?

Even with the sophisticated calibration and reference equipment currently available, there is no substitute for a properly trained technician when it comes to calibrating pressure transmitters. Not only does the technician need to be trained on the mechanics of the calibration process, he or she also needs to be equally qualified in completing and maintaining the documentation. Repeatability is the key and in the world of calibration, if it isn't properly documented, it didn't happen.

Occasionally there are some calibrations that cannot be performed in a standard maintenance shop by maintenance technicians. For these cases, an ISO17025 accredited organization is required. Not only can an ISO17025 accredited organization perform more stringent calibrations, they provide other value as well:

- Accredited labs can simplify the calibration audit process.
- The process and methodology used by an accredited lab is extremely repeatable, thus producing a high level of confidence in the results from an auditor's perspective.
- Annual audits of the accredited lab ensure they are consistently performing at a high level for their registered scope of work.

Summary

The “correct” calibration cycle for a pressure transmitter will depend on the purpose of the calibration and the application. The same pressure transmitters employed in different operating units or processes at the same plant may require different calibration intervals.

Even more important than the calibration interval of the instrument are:

- Establishing correct and realistic MPEs
- Following correct calibration procedures
- The training of the person performing the calibration
- Proper documentation of calibration results.

Following these guidelines and using judgment based on actual plant operation conditions will help establish proper calibration practices, saving money while maintaining acceptable performance.

About the Authors

Keith Riley joined Endress+Hauser in 2008 as a level product manager. He was responsible for the business development and technical direction of level products. After four years, he became the national product team leader for pressure and temperature products. In this role, Riley markets the temperature and pressure products and oversees the strategic direction for the U.S. temperature and pressure product business team.

Ehren Kiker has spent the past 20 years consulting on process instrumentation and control as well as electrical control and distribution equipment. He received his bachelor’s degree in industrial and systems engineering from the University of Florida and his MBA from the University of Houston. Kiker is the national product marketing manager for Endress+Hauser U.S. He is responsible for technology application, marketing, and business development for a wide range of pressure and temperature products.

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