In-Situ Inc.

Instrument Calibration

Glenn Carlson, Technical Support, In-Situ Inc.

Users frequently want to know how often they need to calibrate their In-Situ instrument. The most accurate answer to that question is "it depends." An instrument is considered to be properly calibrated as long as it returns values that are within pre-determined specifications when compared against known quantities. How long it will do that depends on a number of factors. Among these are the amount of regular use the instrument has seen, whether or not it was exposed to environmental extremes, and how the instrument was handled during use, transportation, and storage.

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CALIBRATION: FACTORY

In theoretical terms, a calibration performed on any instrument represents the response of the instrument only for the period of time during which the calibration was performed. As we move away from that time, the response of the instrument can change for various reasons that will be discussed in more detail. In practical usage of the instrument, we can set a pre-determined error range that is acceptable. So long as the instrument produces values that are within this acceptable error range, we can consider the last calibration to be valid. All In-Situ instruments have published error specifications for all parameters that they measure. When properly calibrated, the instrument will return values that are accurate to within these published error specifications.

CALIBRATION: FIELD EVALUATION

To determine if the instrument is operating within this error range, readings must be taken when known quantities are applied to the instrument. Preferably, these known values should be within the range expected when collecting data. For water quality sensors this is relatively easy. Solutions can be purchased or made that contain known, certified quantities of a specific analyte. For pressure sensors, it is more difficult to apply a known value to the sensor. The best way is to have a clear tube filled with water into which the instrument can be placed. By permanently mounting a certified measuring tape to the outside of the tube, the exact amount of water above the pressure sensor can be manually measured and compared against the instrument's reading. A quick check can also be performed by taking pressure readings at ambient air pressure. For gauged pressure sensors (those that compensate for barometric pressure), this ambient reading should be zero. For absolute pressure sensors (no barometric compensation), this reading should equal the ambient atmospheric pressure as measured by a certified barometer. Using measurements made at ambient pressure is not the preferred method for checking the validity of a pressure sensor's calibration, however. For gauged sensors this reading is at one extreme of the operating range. And, for both gauged and absolute sensors, this ambient reading is also not within the range that will be used for data collection. It is important to note that when checking readings, all known values applied to any analytical instrument should be certified to an acceptable level of accuracy and traceable to NIST standards.

If the values returned by an instrument are the same as the known values plus or minus the error specification, then the instrument's most recent calibration can be considered valid. If the value returned by the instrument exceeds the acceptable error range, then it is time to recalibrate the instrument. For some types of sensors, the user can do this. For others, the instrument must be returned to In-Situ for recalibration at the factory. Either way, it is important to routinely check the instrument against known values so that the user may have confidence in the data that are collected.

FACTORS THAT AFFECT CALIBRATION LIFE

What can cause an instrument's readings to drift outside of the published error specifications? One factor is simply normal usage. A pressure sensor is a mechanical device. As the sensing surface is exercised and relaxed over time, its response characteristics can change slightly. Obviously, components are chosen which show a minimal amount of this effect, but all materials will exhibit this characteristic to some extent. Also, some types of sensors require periodic maintenance after normal usage. A dissolved oxygen sensor, for example, may get sediments deposited on its membrane or experience bacterial or algal growth on that same surface. This is normal, and means that the sensor's membrane must be replaced periodically. Normal operation of a dissolved oxygen sensor also produces deposits on the sensor's anode. As a result, the anode must be periodically cleaned to restore the sensor to original specifications.

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The chemistry of the water into which an instrument is deployed may also affect how long that instrument's sensors remain within their accuracy specifications. In some cases, the water may deposit minerals onto the surface of an instrument and its sensors. In the case of a pressure sensor, such deposits may stiffen the sensing face and affect the sensor's response. If the deposits become thick enough, they may also prevent the ambient pressure from being accurately transferred to the sensing face. Deposits on selectively permeable membranes, such as those found in dissolved oxygen sensors and ion selective electrodes (ISEs) will restrict flow across those membranes and adversely affect the sensors' ability to detect specific analytes and equilibrate to changing surroundings.

Some sensors also have a finite life span. ISEs and pH sensors continuously consume chemical components of their fill solutions. Once these components are depleted beyond a certain point, the sensors must be replaced. This chemical consumption also means that readings will drift throughout the life of these sensors. These sensors must be periodically recalibrated by the user to keep this drift from taking readings outside of the accuracy specifications. In-Situ has employed the best technologies available in the design of our sensors. Such drift and finite life span, however, are necessary parts of the sensor design.

Another factor that affects an instrument's response is abuse. All instruments and sensors have a set of specification for normal operating ranges. Exposure to extremes in temperature can damage several types of sensors. Exposing pressure sensors to pressures beyond their normal operating range can cause permanent damage as well. So can bumps and jolts inflicted on an instrument during rough handling and transportation. In-Situ instruments are known for high quality and durability, but they are still analytical instruments and need to be treated with care. Always handle the instruments carefully when they are in use. When transporting instruments, make sure they are secure and protected. When not in use, instruments should be stored in a place where the temperature will be stable and where they will not experience extreme heat or cold. If mishandled or abused, an instrument could be thrown out of calibration in an instant.

TYPICAL CALIBRATION LIFE

Given all of this, what can we consider "normal" for how frequently an instrument needs to be recalibrated? Let us look at each type of sensor individually. A pressure sensor may give accurate readings indefinitely if it is used within its defined operating conditions. We do recommend that a pressure sensor's readings be checked against known values periodically, and some types of installations have regulatory requirements for doing so. Barring any misuse or abuse as described above, In-Situ pressure sensors have historically remained within original accuracy specifications indefinitely.

The dissolved oxygen sensor is probably the most variable type of sensor in its need for recalibration. Under ideal conditions, a dissolved oxygen sensor may give accurate readings for three months or even longer. In water having a large amount of nutrients and rapid algal and bacterial growth, however, the sensor may need maintenance and recalibration after only a few days.

ISEs have a life span of about six to eight months. During deployment they will typically need to be recalibrated every day or two. Both pH and oxidation-reduction potential (ORP) sensors represent special types of ISEs that are more stable than the other types. They will generally give accurate readings for a week or more before needing to be cleaned and/or recalibrated.

Conductivity sensors are very robust. In the absence of chemical deposits or sediment finding their way inside the sensor, a conductivity sensor may continue producing accurate readings indefinitely.

SUMMARY

Unfortunately, there are no firm answers to how frequently analytical instruments need to be calibrated. The most honest answer is that an instrument is considered properly calibrated for as long as it operates within its accuracy specifications. There are many factors involved in determining how long that might actually be. The user must routinely test the instrument against known values to determine whether or not those accuracy specifications are still being met. The best advice is to set up a calibration schedule appropriate for each type of sensor and operating environment as outlined above. It is best to have a routine schedule and recalibrate each sensor or instrument before its readings go outside the accuracy specifications. The exact schedule employed will depend on the type of instrument and sensors used, the amount of use the instrument gets, the specific operating environment, and the type of care the instrument receives. This means, to some degree, the calibration schedule will be unique to each user and specific application. Along with the rough guidelines above, experience and periodic checks of the instrument's readings will determine what the exact calibration schedule needs to be.

1 800 4INSITU

(toll-free, US and Canada) or 307 742 8213 **www.in-situ.com**

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