Beamex

Calibration White Paper

www.beamex.com
info@beamex.com

The business benefits of calibration

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WORLD-CLASS CALIBRATION SOLUTIONS™

Why Calibrate? What is the risk of not calibrating?

Calibration can be briefly described as an activity where the instrument being tested is compared to a known reference value. At the simplest level, calibration is a comparison between measurements – one of known magnitude or correctness made or set with one device, and another measurement made in as similar a way as possible with a second device. The device with the known or assigned correctness is called the standard. The second device is the unit under test or test instrument.

Calibration is often required with a new instrument or when a specified time period or a specified number of operating hours has elapsed. In addition, calibration is usually carried out when an instrument has been subjected to an unexpected shock or vibration that may have put it out of its specified limits.

Calibration in industrial applications

When a sensor or instrument experiences temperature variations or physical stress over time, its performance will invariably begin to decline, which is known as 'drift'. This means that measurement data from the sensor becomes unreliable and could even affect the quality of a company's production.

However, neglecting calibration can lead to unscheduled production or machine downtime, product and process quality issues or even product recalls and rework.

Although drift cannot be completely eliminated, it can be discovered and rectified via calibration. The purpose of calibration is to determine how accurate an instrument or sensor is. Although most instruments provide high accuracy these days, regulatory bodies often need to know just how inaccurate a particular instrument is and whether it drifts in and out of specified tolerance over time.

The costs and risks of not calibrating

Unfortunately, calibration has costs associated with it and in uncertain economic times, this activity can often become neglected or the interval between calibration checks on instruments can be extended in order to cut costs or simply through a lack of resources or manpower. However, neglecting calibration can lead to unscheduled production or machine downtime, product and process quality issues or even product recalls and rework.

Furthermore, if the instrument is critical to a process or is located in a hazardous area, allowing that sensor to drift over time could potentially result in a risk to employee safety. Similarly, an end product manufactured by a plant with poorly calibrated instruments could present a risk to both consumers and customers. In certain situations, this may even lead to a company losing its license to operate due to company not meeting its regulatory requirements. This is particularly true for the food and beverage sector and for pharmaceutical manufacturers.

Weighing instruments also need to be calibrated regularly. Determining th ecorrect mass of a product or material is particularly important for companies that supply steel, paper and pulp, power, aviation companies, harbours and retail outlets, who invoice customers based on the mass of what they supply (fiscal metering). These companies need to prove not only that the mass is accurate but also that the equipment producing the readings was correctly calibrated. Invoicing in these industries is often based on process measurements. There is therefore a growing need to have the metrological quality of these weighing instruments confirmed by calibration.

Product manufacturing also depends on accurate masses and so laboratories and production departments in the food and beverage, oil and gas, energy, chemicals and pharmaceuticals industries, also need to calibrate their weighing instruments.

Why is calibration important?

Calibration ensures that instrument drift is minimised. Even the highest quality instruments will drift over time and lose their ability to provide accurate measurements. It is therefore

critical that all instruments are calibrated at appropriate intervals.

The stability of an instrument very much depends on its application and the environment it operates in. Fluctuating temperatures, harsh manufacturing conditions (dust and dirt) and elapsed time are all contributing factors here. Even instruments manufactured by the same supplier can vary in their performance over time.

Calibration also ensures that product or batch quality remains high and consistent over time. Quality systems such as ISO 9001, ISO 9002 and ISO 14001 require systematic, well-documented calibrations with respect to accuracy, repeatability, uncertainty and confidence levels. This affects all process manufacturers.

Armando Rivero Rubalcaba is head of Instrumentation at beer producer Heineken (Spain). He comments: "For Heineken, the quality of the beer is a number one priority. All the plants in Spain have received ISO 9001 and ISO 14001 certifications, in addition to the BRC certificate of food safety. They must therefore ensure that all processes correspond to the planned characteristics, and the role of calibration is very important to ensure the quality and safety of the processes."

Pharmaceutical manufacturers must follow current Good Manufacturing Practices. cGMP requires that calibration records are maintained and calibrations have to be carried out in accordance with written, approved procedures. Typically, each instrument has a master history record and a unique ID. All product, process and safety instruments should also be physically tagged.

Furthermore, a calibration interval and error limits should be defined for each instrument and standards should be traceable to national and international standards. Standards must also be more accurate than the required accuracy of the equipment being calibrated.

On the people side, there must be documented evidence that employees involved in the calibration process have been properly trained and competent. The company must also have a documented change management system in place, with all electronic systems complying with FDA regulations 21 CFR Part 11.

In the power generation, energy and utilities industries, instrument calibration can help to optimise a company's production process or to increase the plant's production capacity. For example, at the Almaraz Nuclear Power Plant in Spain, by improving the measurement of reactor power parameters from 2% to 0.4%, enabled the reactor power in each unit to be increased by 1.6%, which has a significant effect on annual production capacity.

Safety is another important reason to calibrate instruments. Production environments are potentially high risk areas for employees and can involve high temperatures and high pressures. Incorrect measurements in a hazardous area could lead to serious consequences, particularly in the oil and gas, petrochemicals and chemicals sectors. Similarly, manufacturers of food and beverage or pharmaceutical products could put their customers' lives at risk by neglecting to calibrate their process instruments.

Heikki Karhe is a measurement technician at tyre manufacturer Nokian Tyres. As he puts it: "Calibration is of great importance, especially from the viewpoint of production safety and quality of the final product. Preparation of the right rubber mixture is precision work and a sample is taken from each rubber mixture to ensure quality. Measuring instruments that yield wrong values could easily ruin the final product. The factory is also full of pressure instruments and so it is also important for the safety of the workers that those instruments show the right values."

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Neglecting to calibrate process instruments can also affect a company's bottom line profits. This is particularly true if sales invoicing is based on accurate process measurements, for example, weighing scales or gas conversion devices.

Indeed, according to recent research by Nielsen Research/ ATS Studies in 2006 and 2008, poor quality calibration is on average costing manufacturers more than 1.7 million US dollars every year. When only large companies with revenues of more than 1 billion US dollars are considered, this figure rises dramatically to more than 4 million US dollars per year.

Proper invoicing is therefore critical to energy and utilities companies. As Jacek Midera, measurement specialist at Mazovian Gas Company states: "Most importantly, accurate measurements ensure proper billing. The impact of even a

small measurement error can be tremendous in terms of lost revenue. Customers want to pay for the exact amount of gas they've received. Therefore, gas conversion devices must be extremely accurate in measuring delivered gas. This means that requirements for the calibrators are especially high."

Today, controlling emissions is another critical factor for many process manufacturers. Calibrating instruments can help to make combustion more efficient in industrial ovens and furnaces. The latest Government regulations relating to carbon emissions may also require that companies calibrate specific instruments on a regular basis, including sensors used for measuring CO_2 and NO_X emissions.

As Ed de Jong, Instrument Maintenance Engineer at Shell (Netherlands) explains: "Until recently, calibration was mainly driven by economic motives: even the smallest of errors in delivery quantities are unacceptable in Shell's operation due to the vast sums of money involved for both customers and governments [fiscal metering]. Nowadays, calibration has an important role especially for the license to operate. Government regulations demand that specific instruments must be calibrated, for example, instruments related to CO_2 and NO_X emissions."

Common misconceptions

There are some common misconceptions when it comes to instrument calibration. For example, some manufacturers claim that they do not need to calibrate their fieldbus instruments because they are digital and so are always accurate and correct. This is simply not true. The main difference between fieldbus and conventional transmitters is that the output signal is a fully digital fieldbus signal. Changing the output signal does not change the need for periodic calibration. Although fieldbus transmitters have been improved in terms of their measurement accuracy when compared to analogue transmitters, this does not eliminate the need for calibration.

Another common misunderstanding is that new instruments do not require calibration. Again, this is not true. Just because a sensor is newly installed does not mean that it will perform within the required specifications. By calibrating an instrument before installation, a company is able to enter all the necessary instrument data to its calibration database or calibration management software, as well as begin to monitor the stability or drift of the instrument over time.

When to calibrate

Due to drift, all instruments require calibrating at set intervals. How often they are calibrated depends on a number of factors. First, the manufacturer of the instrument will provide a recommended calibration interval. This interval may be decreased if the instrument is being used in a critical process or application. Quality standards may also dictate how often a pressure or temperature sensor needs calibrating.

The most effective method of determining when an instrument requires calibrating is to use some sort of history trend analysis. The optimal calibration interval for different instruments can only be determined with software-based history trend analysis. In this way, highly stable sensors are not calibrated as often as those sensors that are more susceptible to drift.