Calibration WORLD

BEAMEX CORPORATE MAGAZINE • 2018

Calibration in HAZARDOUS AREAS

WEIGHING SCALE CALIBRATION

How to calibrate weighing instruments

HOW TO CALIBRATE PRESSURE GAUGES

20 things you should consider

CUSTOMER SUCCESS STORIES

EDF Bouchain, France
DC Water, USA

beamex

CEO'S LETTER

Jan-Henrik Svensson
CEO, Beamex Group

Three years ago, we initiated an accelerated investment scheme targeting faster time to market for new products, services and business concepts. As a result of this scheme, we have during the last months released new products, features and services more actively than ever before in the history of Beamex.

Reading through this issue of Calibration World I'm proud of what we have accomplished so far. But more than that, I get reminded of how important it is that we stay well-informed about what you, as our customers, desire from us. We have collected and recorded feedback from customers since the mid-80's and as a result we have a lot of statistics and customer user stories available, but to decide what stories are the most relevant in today's changing environment is not an easy task. In this magazine you will have the opportunity to get acquainted with several "user stories" that were prioritized for development into brand-new calibration solutions, that have been released during the last couple of months.

Specifically, I'd like to pick three very different initiatives as examples of our ambition to meet your emerging requirements. The MC6-Ex was developed to meet the needs of calibration within hazardous areas and is the first intrinsically safe calibrator on the market without any compromises in terms of functionality or usability. Beamex LOGiCAL was recently launched responding to the increasing adoption of cloud computing within the process industries and is a first step for us in providing a cloud based calibration solution. The third example is Mobile Security Plus which is a cross product solution that ensures data integrity and revolutionizes calibration for our customers within the pharmaceutical industry responding to significant changes in regulation. In this issue you will also get to read about how we work together with our customers in the pharmaceutical industry to develop new solutions that meet their needs.

Understanding how we can assist you in implementing "better ways to calibrate" is the purpose of Beamex and I hope that by reading our magazine you get assured that we listen to your feedback and that you'll get inspired to implement better ways within your own environment.

Enjoy your reading and remember that we very much appreciate (and need) your feedback!

CALIBRATION WORLD

Published by Beamex Oy Ab,
Ristisuonraitti 10, FI-68600
Pietarsaari, Finland
Phone +358 10 550 5000
Fax +358 10 550 5404
info@beamex.com
www.beamex.com

Address details and subscriptions
calibrationworld@beamex.com
Layout Studio PAP

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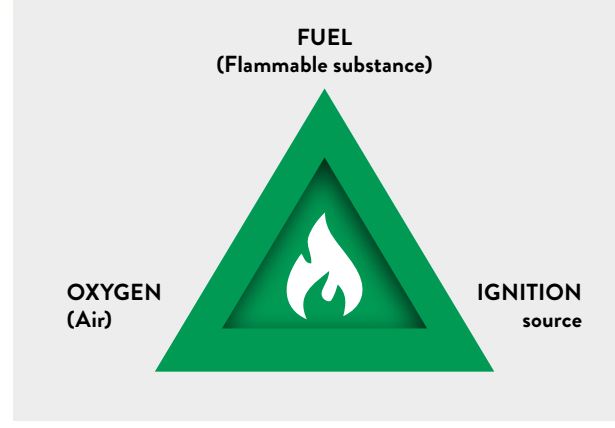
Calibration in HAZARDOUS AREAS

This article discusses calibration in hazardous areas and what everyone needs to be aware of before entering into a hazardous area with calibration equipment.


BEAMEX
WHITE
PAPER

Calibration in HAZARDOUS AREAS

Other topics covered are **flammable and combustible liquids**, definition of a **hazardous area**, the types of industries **where hazardous areas are found**, the different levels of **hazardous zones**, **regulations**, **equipment classification** and various other practical and related issues.



PIC 1. Explosion Triangle

There are many different levels of hazardous areas. There are also many different types of Ex-rated calibration equipment.

FAST FORWARD BULLETS:
- What is a hazardous area?
- Brief explanation of related legislation
- Which Ex calibration equipment can be taken into an Ex area?

WHAT IS A HAZARDOUS AREA?

A hazardous area is an area (indoors or outdoors) that contains, or may contain, f lammable substances. The flammable substance may be a liquid, gas, vapor or dust. The area may contain a flammable substance all of the time, most of the time, or only in specific situations, such as during shutdowns or accidents.

In such a hazardous area, an explosion or fire is possible if all three conditions of the "Explosion Triangle" (***SEE PIC. 1***) are met. These three conditions are fuel (a flammable substance), source of ignition (or heat) and oxygen (air). The situation is often presented as a triangle; hence the name Explosion Triangle.

HOW TO PREVENT AN EXPLOSION

Keeping in mind the Explosion Triangle, we can conclude that one or more of the three elements must be eliminated. Many times, eliminating the flammable substance is not possible, and therefore the oxygen (air) or source of ignition has to be eliminated. However, it is also often impossible to eliminate the air. Therefore, the most practical solution is to eliminate the source of ignition, spark or heat.

In the case of electrical calibration equipment, it can be specially designed to use in hazardous areas. There are many ways to design electrical equipment suitable for hazardous areas and this topic will be discussed later on. Calibration equipment is often designed in such a way that it cannot provide enough energy to cause the source of ignition, spark or heat.

BRIEF HISTORY

Some of the first hazardous areas were discovered in the early coal mines. Being flammable substances, both the coal dust and the methane absorbed created a hazardous area. The lighting in early mines was produced by candles and torches, generating a source of ignition. This led to many accidents.

Later, when miners began to use electrical equipment (lighting, tools), many accidents occurred due to sparking or heating. Eventually, design standards were developed to guide the design process to prevent the sparking and heating of electrical equipment. This was the first "intrinsically safe" electrical equipment and it led the way to the standards compiled for equipment used in hazardous areas today.

TYPICAL INDUSTRIES WITH HAZARDOUS AREAS

There are many industries that have hazardous areas. Some plants have large hazardous areas, while others have only small sections classified as hazardous areas. Typical industries with hazardous areas include chemical and petrochemical industries, offshore and on-shore oil and gas, oil refining, the pharmaceutical industry, food and beverage, energy production, paint shops and mining.

Since a flammable substance may be a liquid, gas, vapor or dust, there are surprisingly many different industries that may have some areas where these substances may be present during the normal operation or during shut-down. Even some seemingly safe industries may have hazardous areas.

In plants, all areas classified as hazardous should be clearly marked with the Ex logo. (***SEE PIC. 2***)

FLAMMABLE AND COMBUSTIBLE LIQUIDS

There is often discussion about flammable and combustible liquids. But what are they precisely? Generally speaking, they are liquids that can burn. They may be gasoline, diesel fuel, many solvents, cleaners, paints, chemicals, etc. Some of these liquids are present in many workplaces.

Flashpoint and autoignition temperatures are also often discussed. Flashpoint is the lowest temperature of a liquid at which it produces sufficient vapor to form an ignitable mixture with air. With a spark or enough heat, it will ignite. Autoignition temperature is the lowest temperature at which a liquid will ignite even without an external source of ignition. Most commonly, flammable and combustible liquids have autoignition temperatures in the range of 572 °F to 1022 °F (300 °C to 550 °C). However, there are liquids that have an auto-ignition temperature as low as 392 °F (200 °C) or less.

PIC 2. In plants, all areas classified as hazardous should be clearly marked with the Ex logo.

Based on their flashpoint, liquids are classified as flammable or combustible. Flammable liquids may ignite at normal working temperatures, while combustible liquids burn at higher temperatures. Often 100 °F (37.8 °C) is considered as the temperature limit. Flammable liquids have a flashpoint below 100 °F and combustible liquids above.

To be more precise, flammable and combustible liquids themselves do not burn, it is the vapors that burn. More precisely, it is the mixture of the vapors and air that burns. There are also limits of the concentration within which the mixture can burn. If the concentration of the mixture is too low (too thin) it will not burn; the same is true if the concentration is too high (too rich). The limits are known as lower and upper explosive limits (LEL and UEL).

It is good to remember that some liquids may have a rather low flashpoint. For example, gasoline has a flashpoint as low as c. -40 °F (-40 °C). It produces enough vapors in normal environmental conditions to make a burnable mixture with air. Combustible liquids have a flashpoint way above normal environmental conditions, and therefore they have to be heated before they will ignite.

Some examples of flashpoint and autoignition temperatures:

SUBSTANCE	FLASHPOINT	AUTOIGNITION TEMPERATURE
Ethylene	–276.8 °F (–136 °C)	914 °F (490 °C)
Propane	–155.2 °F (–104 °C)	878 °F (470 °C)
Butane	–76 °F (–60 °C)	550.4 °F (288 °C)
Diethyl ether	–113 °F (–45 °C)	320 °F (160 °C)
Ethanol	61.9 °F (16.6 °C)	685.4 °F (363 °C)
Gasoline	–45.4 °F (–43 °C)	536 °F (280 °C)
Diesel	143.6 °F (62 °C)	410 °F (210 °C)
Jet fuel	140 °F (60 °C)	410 °F (210 °C)
Kerosene	100 to 162 °F (38 to 72 °C)	428 °F (220 °C)

TECHNIQUE	MARKING ON EQUIPMENT	DESCRIPTION
Exe	e	Increased safety
Exi	i	Intrinsically safe
Exn	n	Non incendive
Exd	d	Flameproof
Exp	p	Pressurized
Exq	q	(Sand/quartz) filled
Exo	o	Oil filled
Exm	m	Encapsulated

PIC 3. Technique table

VARIOUS PROTECTIVE TECHNIQUES

As mentioned earlier, in order to prevent an explosion, one of the three elements of the Explosion Triangle should be eliminated. In practice, eliminating the source of ignition would be the most sensible.

There are various techniques in electrical equipment that make them safer for hazardous areas. These different techniques fall into two main categories: eliminate the source of ignition (Exe, Exi) or isolate the source of ignition (Exd, Exp, Exq, Exo, Exm).

The table above briefly describes some of these different techniques: (***SEE PIC. 3***)

The table also describes the letter that is written on the equipment classification. For example, a device with the Intrinsically Safe technique will have the "Exi" label.

INTRINSICALLY SAFE TECHNIQUE

The Exi "Intrinsically Safe" technique is the most commonly used and most suitable protective technique for electrical calibration equipment. Intrinsically Safe equipment is designed for any situation; it will not provide enough energy to generate sparks and excessively high surface temperatures, even in the case of a faulty device. The equipment is designed to be intrinsically safe.

Inside an Exi device, the Exm ("Encapsulated") technique may also be used for certain parts of the equipment (as in a battery pack).

"HOT WORK PERMIT"

Using non-Ex calibration equipment in a hazardous area may be possible, but it requires special approval from the safety personnel in the factory. Oftentimes, this also involves the use of safety devices, such as personal portable gas detectors, to be carried in the field while working. Using equipment rated Ex correctly is easier, as it does not require any special approvals. Naturally, the Ex-rated calibration equipment must be suitable for the hazardous area to which it is taken.

INTERNATIONAL / NORTH AMERICAN LEGISLATION AND DIFFERENCES

There are two different standardizations specifying hazardous areas and classification of the equipment used in hazardous areas. One is the International IEC standard and the ATEX directive used in International and European legislation. The second is the North American legislation.

As there are some differences between these two, this article looks, first, at the two separately and then makes a comparison of them.

INTERNATIONAL IEC STANDARDS, IECEX SCHEME AND ATEX DIRECTIVE

The international standard family of IEC 60079 defines the different standards for related regulations.

The IECEx scheme involves international co-operation based on the IEC standards. The objective of the IECEx system is to facilitate international trade in equipment and services for use in explosive atmospheres, while maintaining the required level of safety. Today, there are approximately 30 member countries in the IECEx, including the USA.

The ATEX directive was introduced to unify hazardous equipment and work environments within the European Union. It was established about 10 years ago and is based on the directives introduced in the 90s.

HAZARDOUS ZONES CLASSIFICATION

The zone classification specifies how likely it is for a certain flammable substance to occur in the atmosphere in a certain area.

The classification has been developed to specify the different hazardous areas (Zones): (***SEE PIC. 4***).

PIC 4. Different hazardous areas (Zones)

ZONE (GAS, VAPOR)	**ZONE** (DUST)	DESCRIPTION
Zone 0	Zone 20	Area in which an explosive substance in the atmosphere is present continuously or for long periods or frequently.
Zone 1	Zone 21	Area in which an explosive substance in the atmosphere is likely to occur in normal operation occasionally.
Zone 2	Zone 22	Area in which an explosive substance in the atmosphere is not likely to occur in normal operation but, if it does occur, will persist for a short period only.

PRODUCT CATEGORY AND EQUIPMENT PROTECTION LEVELS (EPL)

In ATEX-directive Group II, equipment is divided into product categories specifying the use of the equipment in different zones. The product categories of the Group II equipment are specified as following:

- **Product category 1**
  - Very high safety level. Can be used even in Zone 0 (and Zone 1 & 2).
- **Product category 2**
  - High safety level. Can be used in Zone 1 and 2 (but not in Zone 0).
- **Product category 3**
  - Normal safety level. Can be used in Zone 2 (but not in Zones 0 & 1).

In the IEC standards, the same thing is expressed using EPLs (Equipment Protection Level). EPLs are specified using nearly the same categories:

- **EPL a**
  - Very high safety level. Can be used even in Zone 0 (and Zone 1 & 2).
- **EPL b**
  - High safety level. Can be used in Zone 1 and 2 (but not in Zone 0).
- **EPL c**
  - Enhanced safety level. Can be used in Zone 2 (but not in Zones 0 & 1).

The relationship between the product categories/EPLs and hazardous zones: (***SEE PIC. 5***).

A product category 1/EPL a device (can be used in Zones 0, 1 and 2) is safe even in the event of two simultaneous faults in the device. This means that all protective safety circuits are tripled. A category 2/EPL b device has doubled safety circuits and can be used in Zones 1 and 2. Category 3/EPL c devices have single safety circuits and can be used in Zone 2 only.

According to the table above, if there is a need to use electrical equipment in a hazardous area classified as Zone 1, the product category 1 and 2 equipment can be used. If the area is Zone 0, only equipment in product category 1 is allowed. Again, if the Zone is 2, any product category (1, 2 or 3) equipment is allowed.

A product in category 1 has the number 1 in its ATEX marking , for example “II 1 G”. It also has a letter “a” in its marking for EPL, for example “Ex ia”.

Consequently, it is important to know the zones where the calibration equipment will be used and select the equipment accordingly.

Intrinsically safe equipment is designed so that in any situation, even in the case of a faulty device, the device will not provide enough energy to generate sparks or surface temperatures that are too high.

EQUIPMENT GROUPING

Electrical equipment for explosive atmospheres according to the IEC 60079-0 standard is divided into the following groups:

Group I
Electrical equipment in Group I is intended for use in mines susceptible to firedamp.

Group II
Electrical equipment in Group II is intended for use in places with an explosive gas atmosphere other than mines susceptible to firedamp.

Electrical equipment in Group II is subdivided according to the nature of the explosive gas atmosphere for which it is intended.

Group II subdivisions
- IIA, a typical gas is propane
- IIB, a typical gas is ethylene
- IIC, a typical gas is hydrogen

This subdivision is based on the maximum experimental safe gap (MESG) or the minimum ignition current ratio (MIC ratio) of the explosive gas atmosphere in which the equipment may be installed (see IEC 60079-20-1).

Equipment marked IIB is suitable for applications requiring Group IIA equipment. Similarly, equipment marked IIC is suitable for applications requiring Group IIA or Group IIB equipment.

PIC 5. The relationship between the product categories/ EPLs and hazardous zones.

PRODUCT CATEGORY LABEL	EPL MARKING	HAZARDOUS ZONE	FLAMMABLE SUBSTANCE	CAN ALSO BE USED IN HAZARDOUS ZONE
1G	a or Ga	0	Gas, vapor	1 and 2
2	b or Gb	1	Gas, vapor	2
3	c or Gc	2	Gas, vapor	–
1	a or Da	20	Dust	21 and 22
2	b or Db	21	Dust	22
3	c or Dc	22	Dust	–

TEMPERATURE CLASS	MAXIMUM SURFACE TEMPERATURE
T1	842 °F (450 °C)
T2	572 °F (300 °C)
T3	392 °F (200 °C)
T4	275 °F (135 °C)
T5	212 °F (100 °C)
T6	185 °F (85 °C)

PIC 6. Temperature Classes.

Group III
Electrical equipment in Group III is intended for use in places with an explosive dust atmosphere other than mines susceptible to firedamp.

Electrical equipment in Group III is subdivided according to the nature of the explosive dust atmosphere for which it is intended.

Group III subdivisions:
- IIIA: combustible flyings
- IIIB: non-conductive dust
- IIIC: conductive dust

Equipment marked IIIB is suitable for applications requiring Group IIIA equipment. Similarly, equipment marked IIIC is suitable for applications requiring Group IIIA or Group IIIB equipment.

TEMPERATURE CLASS

The temperature class specifies the maximum surface temperature in the equipment. The temperature class is important to take into account and assure that it matches with the flammable gas that may be present in the plant's own hazardous area.

The temperature classes and temperatures are the following: (***SEE PIC. 6***).

Some equipment may also have a maximum surface temperature specified as a certain temperature being in between the classes.

Depending on the type of flammable substance in a certain area, the flashpoint and auto-ignition temperatures will be different. The equipment selected to be used in that hazardous area must have a temperature classification that suits the substances in question.

PIC 7. Zones and Divisions.

ZONE	DIVISION	DESCRIPTION
Zone 0	Division 1	Area in which an explosive substance in the atmosphere is present all the time.
Zone 1	Division 1	Area in which an explosive substance in the atmosphere is present in normal operation.
Zone 2	Division 2	Area in which an explosive substance in the atmosphere is present only in abnormal operation.

The temperature class specifies the maximum surface temperature in the equipment. The temperature class is important to take into account and assure that it matches with the flammable gas that may be present in the plant's own hazardous area.

The temperature class of a device is included in its marking, for example "T4".

NORTH AMERICAN LEGISLATION DIFFERENCES:

Divisions

While in the IEC standard the hazardous areas are divided into zones, the North American system divides them into divisions. While numbers 0 to 2 are used in zones, numbers 1 and 2 are used in divisions. Zones 0 and 1 both are covered by Division 1.

The table to the bottom left compares the Zones and Divisions: (***SEE PIC. 7***).

The following is a brief summary of the relationship between the product categories/EPLs and hazardous area zones (IEC) and divisions (North America):

Product Category/EPL	Zone	Division
1/a	0	1
2/b	1	1
3/c	2	2

Explosion group

The North American legislation has one more explosion/ equipment group compared to the IEC. The comparison of the explosion groups (gas) of the North American and IEC are shown in the table below:

IEC	North America
IIC – Acetylene / Hydrogen	A – Acetylene B – Hydrogen
IIB – Ethylene	C – Ethylene
IIA – Propane	D – Propane

The most dangerous explosion group is identified as A in North America, while it is IIC in the IEC system.

Temperature class

In the North American system, there are more intermediate temperature classes.

The table to the right shows a comparison between the IEC/ ATEX and North American temperature classes: (***SEE PIC. 8***).

IEC/ATEX	NORTH AMERICAN	MAX TEMPERATURE
T1	T1	842 °F (450 °C)
T2	T2	572 °F (300 °C)
	T2A	536 °F (280 °C)
	T2B	500 °F (260 °C)
	T2C	446 °F (230 °C)
	T2D	419 °F (215 °C)
T3	T3	392 °F (200 °C)
	T3A	356 °F (180 °C)
	T3B	329 °F (165 °C)
	T3C	320 °F (160 °C)
T4	T4	275 °F (135 °C)
	T4A	248 °F (120 °C)
T5	T5	212 °F (100 °C)
T6	T6	185 °F (85 °C)

PIC 8. IEC/ ATEX and North American temperature classes.

ENVIRONMENTAL CONDITIONS

Finally, it is important to ensure that the equipment is suitable for the environmental conditions where it will be used. For example, the safe operating temperature of the device must match the temperature in which the equipment is used in a plant. In wet and dusty conditions, the protection rating of the equipment casing needs to be considered; this can be classified IP (Ingress Protection) or NEMA. Different protective techniques may require different classification on the casing.

It is also important to remember that the casing of some Ex equipment is made out of non-static (semi-conducting) material to avoid accumulation of any static electricity. Depending on the classification, there are limits on the size (static) of labels that can be put onto the device. For example, Group I equipment, for Zone 0, with gas Group IIC, may have a label sizing an area of maximum 4 cm^2 (0.6 $inch^2$). It is important to keep that in mind before attaching any identification labels on Ex equipment.

EQUIPMENT MARKING

HAZARDOUS AREAS

EXAMPLE OF EQUIPMENT MARKING

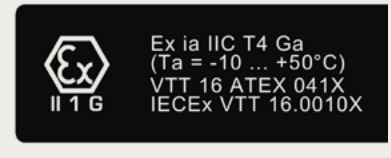
This is an example of the product markings and how to read what they mean in practice. The product in this example is **Beamex MC6-Ex** intrinsically safe calibrator and communicator, which can be used in hazardous areas.

The Beamex MC6-Ex has following product marking:

- IECEx: Ex ia IIC T4 Ga
  (Ta = –10 ... +50 °C)
- ATEX: Ex II 1 G and Ex ia IIC T4 Ga
  (Ta = –10...+50 °C)

Let's look at what this marking means in practice.

Ex	Ex-certified product
II	Equipment group II (non-mining)
1	Product category 1 (can be used in zone 0)
G	Explosive atmosphere caused by gases (not by dust)
ia	Intrinsically safe (i), level of protection ia
IIC	Application above ground (II), Gas group C
T4	Temperature class T4 (Max 135 °C surface temperature)
Ga	EPL Equipment protection level Ga
Ta	Safe operating temperature



BEAMEX
CASE STORY

Innovative CALIBRATION MANAGEMENT SYSTEM *for a new generation power plant*

EDF NATURAL GAS COMBINED-CYCLE POWER PLANT IN BOUCHAIN, FRANCE

The power plant has entered the Guinness Book of Records due to its efficiency.

As part of the modernization of EDF Energy's power plants, EDF Bouchain located in Bouchain, France became the first new generation combined cycle power plant in the world. Bouchain is the first natural gas combined-cycle plant equipped with the new 9HA combustion turbine developed by GE. It has an installed capacity of 605 MW or the equivalent of the electricity consumption of 680,000 French households.

The power plant has entered the Guinness Book of Records due to its efficiency.

The automation/electricity department is made up of 7 technicians who manage remedial and preventive maintenance for the entire power plant. In the interests of quality, safety and durability of the installations, it was essential for the automation department to be equipped with a calibration management system capable of meeting its strict requirements. The Beamex integrated calibration system was an obvious choice in terms of automation, time-saving, monitoring, traceability and confidence in the data produced.

Because the outage period at Bouchain is only 3.5 weeks, carrying out more than 400 measurement checks with a small staff is a major challenge!

The services provided by Beamex made it possible to prepare all the data, procedures and tasks to be performed so that the service provider company was operational from the first day of the outage period.

"In collaboration with Beamex, we prepared an Excel table with the data from all the instruments. Beamex integrated this directly into the Beamex CMX software, giving us a ready-to-use system. Beamex also conducted a training session to meet the needs of EDF: Time, planning and topics," explained Laurent Hernu, Automation/Elec. Manager.

> "In collaboration with Beamex, we prepared an Excel table with the data from all the instruments. Beamex integrated this directly into the **Beamex CMX software**, giving us a ready-to-use system."

The complete elimination of paper in all procedures led the team performing the calibrations to save approximately two weeks of their time. There was no longer a need to manually input data into a third-party system (Excel type).

The multifunctional features of the MC6 calibrator and communicator drastically reduced the amount of equipment that each technician needed to carry down to a single device. Indeed, the MC6 made it possible to carry out pressure and temperature calibration, as well as commu-

Calibration being performed by Cédric Demeure, Instrument technician

nication with HART and Foundation Fieldbus transmitters. As a result, handling was greatly simplified because users only needed to become familiar with one interface.

In addition, the use of the bMobile application and the Maintenance Inspection feature have made it possible to enter maintenance checks. "This is very useful because these tests are directly transferred to a smartphone so that the maintenance technician can monitor and enter the various operations," explained Laurent Hernu. After the work is completed, the data is transferred to the Beamex CMX calibration software.

The precision of the MC6 calibrator also halved the number of pressure modules needed at Bouchain. In addition, the reliability of the results transmitted will allow EDF to prepare its future audits calmly and confidently.

> As the outage period is only 3.5 weeks, carrying out more than **400 measurement checks** with a small staff is a major challenge!"

CASE STORY IN BRIEF

EDF CCG

EDF CCG
BOUCHAIN, FRANCE

DESCRIPTION

- Beamex MC6 multi-function calibrator and communicator
- Beamex CMX Calibration Management Software.
- Beamex professional service: Database conversion, support and training
- Beamex bMobile Application
- PGC and PGXH Pumps
- Beamex Care Plan maintenance program
- SSA software maintenance agreement

MAIN BENEFITS

- Turn-key solution
- Durability thanks to maintenance agreements
- Support and customization
- Ease of use
- Easy and secure access for the service provider company
- Time-saving
- Controlled maintenance cost
- Local support

CALIBRATION BEST PRACTICES
INTERACTIVE EVENT

Beamex to host a two-day

INTERACTIVE EVENT ACE 2018

BEAMEX – ANNUAL CALIBRATION EXCHANGE

Beamex is excited to host the Annual Calibration Exchange (ACE), which will be held Wednesday and Thursday September 19–20th at California Polytechnic University in Pomona, CA, USA.

The event will explore the latest insights, trends and best practices for process plant managers, engineers and technicians seeking to improve calibration quality, safety, accuracy and efficiency. Experts with a combined 100+ years of calibration experience will discuss day-to-day challenges and how best to solve them through new and innovative strategies and advances in calibration technology—all designed to save time while achieving quality metrics and improving safety. Workshop participants will benefit from a highly interactive learning approach, providing the practical skills and know-how needed to improve daily maintenance processes and tasks.

The day of personalized instruction includes:

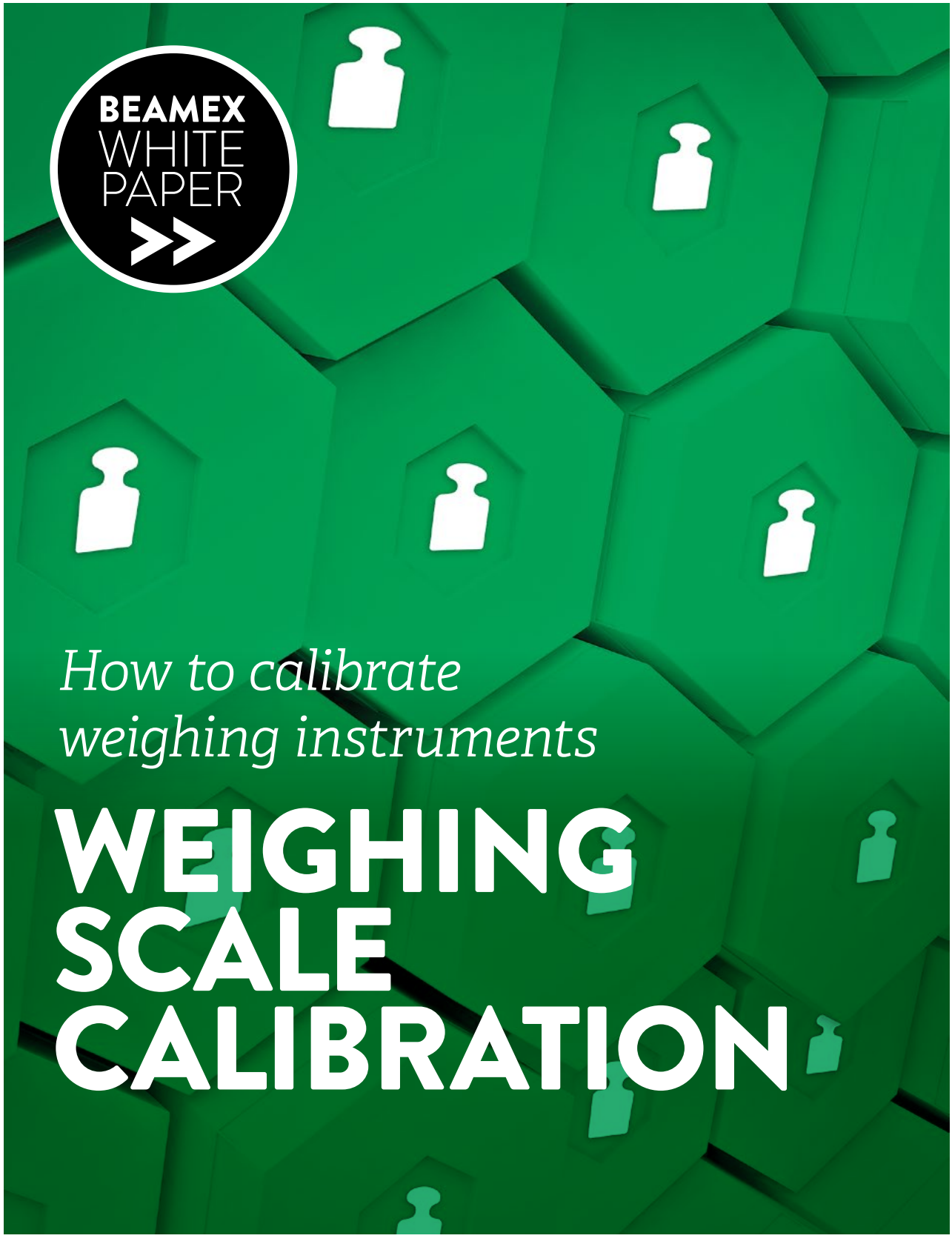
- Hands-on workshop (pressure calibration)
- How to eliminate calibration paperwork
- 5 insider secrets to integrating software systems
- Open discussion of complex calibrations

Registration includes access to all presentations, a networking event and breakfast and lunch. To reserve your spot, view details on the program, review a list of recommended hotels and more, visit the workshop website.

For more information about this and other events that Beamex is arranging, visit:

www.beamex.com/services/seminars-webinars/

CALIFORNIA POLYTECHNIC UNIVERSITY
SEPT. 19–20th


BEAMEX
WHITE
PAPER
How to calibrate
weighing instruments
WEIGHING
SCALE
CALIBRATION

Weighing scales, weighing instruments, weighing balances... different resources are using different terminology. We will be mainly using the term "weighing instrument" in this article.

Weighing instruments/scales/balances, are widely used in industry for various measurements. Some weighing instruments are small laboratory instruments measuring a few grams and are very accurate. While some industrial weighing instruments are very large ones that measure, for example, mass of trucks. We all see weighing instruments in our everyday life around us, for instance, when we visit a grocery store and weigh vegetables.

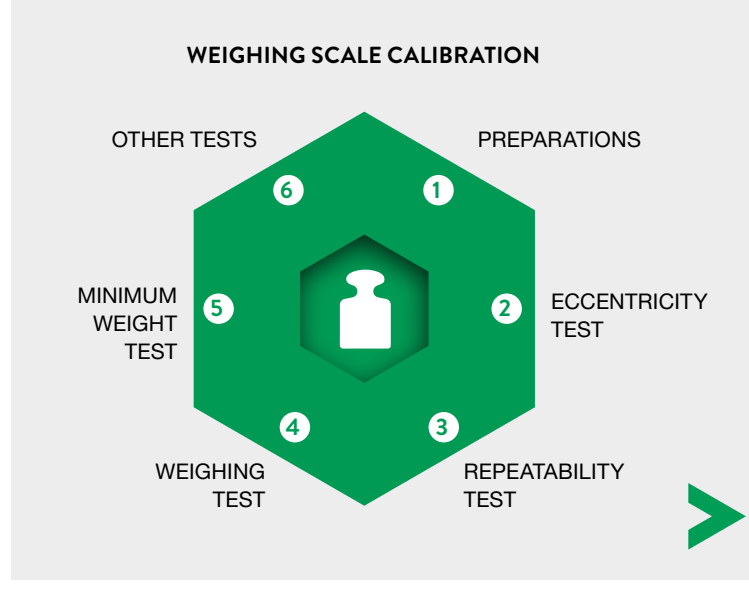
As with any measurement instruments, weighing instruments should also be calibrated regularly to assure that they are measuring correctly and accurately. A proper metrologically traceable calibration is the only way to know how accurately weighing instruments are measuring.

Many weighing instruments are used for legal measurements or measurements used as basis for monetary transfer and these are part of a legal or statutory verification program based on legislation. Often the calibration of weighing instruments is based on a quality system (such as ISO9000), health care, traffic (air, marine) safety or forensic investigation. There are dedicated regulations for weighing instruments and their calibration (EURAMET Calibration Guide, NIST Handbook 44, OIML); more on those later in the article.

CALIBRATING WEIGHING INSTRUMENTS

Let's start by looking at some of the preparations you should make before the calibration and then look at the different tests you should be doing.

Weighing instruments/scales/balances, are widely used in industries for various measurements. Some weighing instruments are small laboratory instruments measuring a few grams and are very accurate.



1. Preparations before calibration

Before you can start the calibration of the weighing instrument, you should clarify a few things and get prepared. You should find out the technical characteristics of the weighing instrument (max weight, d value), the accuracy requirement (max error allowed and uncertainty) and what to do if the calibration fails (adjustment).

Typically, the whole measurement range is calibrated and the calibration is performed in the location where the instrument is being used. Make sure you have enough weights for the calibration procedure available.

The weighing instrument should be switched on at least 30 minutes before the calibration. The temperature of the weights should be stabilized to the same temperature where the calibration is to be done.

The weighing instrument should be at a horizontal level, especially for small and accurate weighing instruments. Perform a few pre-tests by placing weights close to the maximum of the range on the instrument and to ensure it works normally.

In case the weighing instrument fails in calibration and it is adjusted, you should make an "as found" calibration before adjustment and an "as left" calibration after adjustment.

Next, let's take a look at the different tests that should be done during the calibration.

2. Eccentricity test

In normal use of a weighing instrument the load is not always placed perfectly on the center of the load receptor. Sometimes the results of a weighing instrument can vary slightly depending if the load is placed in different locations on the load receptor. In order to test how much effect the location of the load has, the eccentricity test is performed.

In the eccentricity test, the reference load is placed in a few different specified locations on the load receptor. First, the load is placed in the center of the load receptor (the load's center of gravity) and the result is observed. Next, the load is placed in four different sectors of the load receptor, as illustrated in the picture. (***SEE PIC. 1***)

The picture is for rectangular and round load receptors, but naturally in practice there are many different shapes of load receptors and the location of the load will vary. Standards OIML R76 and EN 45501 will give guidance for different load receptor shapes.

The calibration procedure should specify where to place the load during the test and calibration results (in certificate format) should also document the locations.

The test load used in an eccentricity test should be at least one third (1/3) of the max load of the weighing instrument. The test should preferably be done using just one test load, if possible. That way it is easier to be sure that the load's center of gravity is in the specified location. For a weighing instrument with multiple ranges, the eccentricity test should be done with the highest range.

As the aim of the eccentricity test is to find out the difference caused by the location of the load, it is not necessary to have an accurate calibrated load. It is naturally important to use the same load through the test.

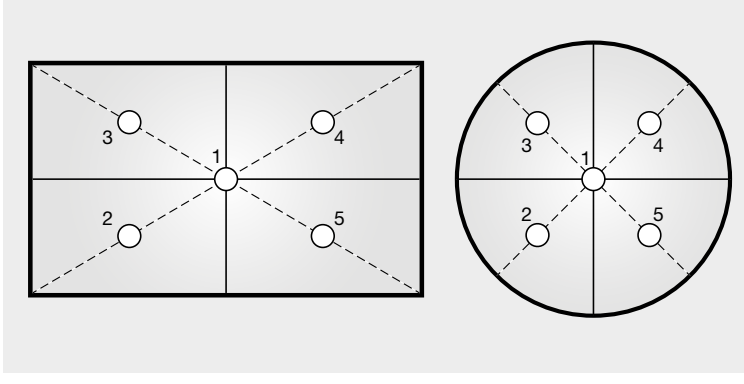
If the eccentricity test is used also to determine the errors of the indication, then a calibrated load should be used.

Procedure for the eccentricity test

The indication is zeroed before the test. The test load is placed to location 1 and indication is recorded. The test load is then moved to location 2 to 5 and indication is recorded in each location. Finally, the test load is placed again to location 1 to check that the indication has not drifted from the earlier indication in location 1.

The zero may be checked between each location to see that it has not changed. If necessary, the instrument can be zeroed in between each test.

Alternatively, you may also tare the instrument when the load is in location number 1, as this makes it easier to see any difference between locations.



PIC 1. Weighing scale load receptors

3. Repeatability test

As any instrument, also weighing instruments may suffer from repeatability issues. This means that when the same load is measured several times, the result is not always exactly the same. To find out the repeatability of the instrument, a repeatability test is done.

The repeatability test is performed by replacing the same load on the same place on load receptor (to avoid any eccentricity error) multiple times. The test should be done in identical and constant conditions and with identical handling.

The load used should be close to the maximum load of the instrument. Often a repeatability test is done with one load only, but it can be done also with several different load values separately.

The load does not necessarily need to be a calibrated load, as the aim is to find out the repeatability. If possible, the load used should be a single load (not several small loads).

A repeatability test is normally done by repeating the measurement at least 5 times in row. For instruments with a high range (over 100 kg / 220 lbs), it should be done at least 3 times.

In the repeatability test, the instrument is first zeroed, then the load is placed on load receptor and indication is recorded once it is stabilized. Next, the load is removed and zero indication is checked and zeroed if necessary. Then the load is placed again, and so on.

For a multi-range instrument, a load close to, but below the first range max is often sufficient.

4. Weighing test

The purpose of the weighing test is to test the accuracy (calibrate) of the weighing instrument throughout its whole range in several steps, with increasing and decreasing weight.

The most common practice is the following: start with zeroing the instrument without any load. Set the loads of the first test point, wait for stabilization, and record the indication. Continue increasing the loads through all the increasing test points. Once the maximum load is recorded, start decreasing the loads through the decreasing test points.

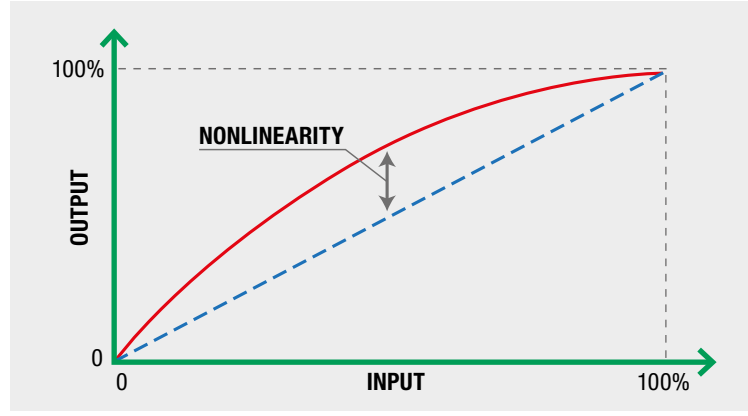
In some cases, the weighing instrument may be calibrated with increasing loads only or decreasing loads only.

Typically, 5 to 10 different loads (test points) are used. The highest load should be close to the maximum of the instrument. The smallest test load can be 10% of the maximum load, or the smallest weight normally used. Generally, the test points are selected so that they are equally distributed throughout the range. More test points can be used for the typical range of usage of the instrument.

With multi-range instruments, each range is to be calibrated separately.

Linearity

In a weighing test, using multiple points through the measurement range of the instrument helps to reveal any issues with linearity. Linearity issues means that the instrument does not measure equally accurate throughout the range. Even the zero and full span are correct, there may be errors in the middle of the range, which is referred as linearity errors, or unlinearity (or nonlinearity).



PIC 2. General illustration of unlinearity.

The piture above is a general illustration of unlinearity. Even instrument's zero and full range are adjusted correctly, there is error in the midrange due to unlinearity of the instrument: (***SEE PIC. 2***).

Hysteresis

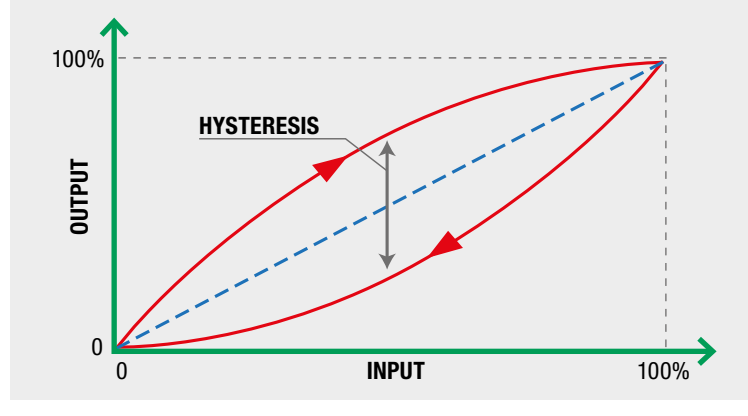
Hysteresis is the difference in the indication when a test point is approached with increasing or decreasing weight. To find out any hysteresis issues in the instrument, you need to calibrate with increasing and decreasing points.

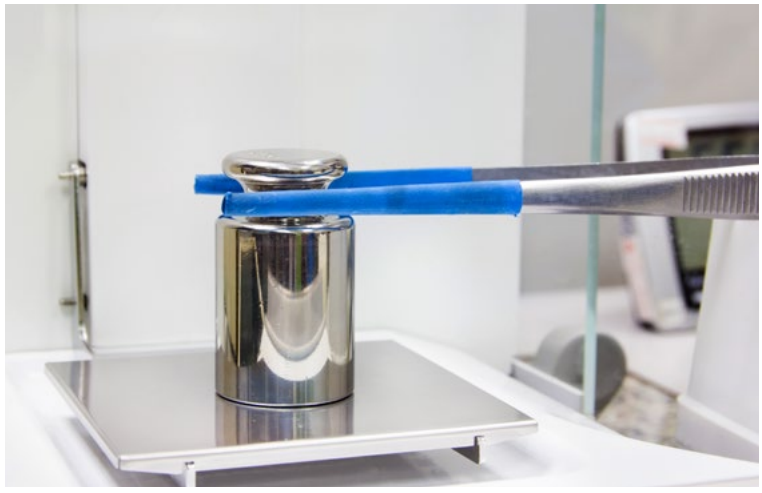
In a weighing test, when increasing or decreasing the load, it is important not to overshoot or undershoot. This means that when you increase the load, you must approach each test point with increasing weight. You should not add too much weight and then remove it, because then you lose the hysteresis information.

Likewise, with decreasing points, make sure that you approach each point with decreasing weight. Obviously, in order to be able do this, the usage of the test loads should be well planned in advance.

The picture below is a general illustration of hysteresis. When instrument is calibrated, the results are different with increasing and decreasing calibration points: (***SEE PIC. 3***).

PIC 3. General illustration of hysteresis.





Weights should be handled so that it does not change the metrological characteristics of the weights.

5. Minimum weight test

The minimum weight test is a test that is not always required, but usually is for the pharmaceutical industry.

The purpose of the minimum weight test is to find the smallest load that can be measured while still achieving reliable measurement results and fulfilling the accuracy requirements. When the measured value gets smaller, typically the relative error of the reading becomes higher. The weighing instrument should not be used to measure any loads smaller than the minimum load.

For the minimum weight test, the two main standards have different approach. Let's take a quick look at those:

The US Pharmacopeia (Chapter 41) – After the recent changes in the standard it does not refer to a minimum weigh test anymore, this has been replaced by the requirement to determinate the instrument's minimum operating range by finding the point where the instrument's repeatability (2 times standard deviation) is 0.10% of reading.

In practice, in some cases the standard deviation can be very small, but the minimum weight to be measured should anyhow not be smaller than 820 times the actual scale interval (d).

EURAMET Calibration Guide 18 (Appendix G) – Has the principle that you calculate the measurement uncertainty for each calibration point and the smallest usable load is the point where the uncertainty is still small enough for the requirements for the instrument.

In addition to the above standard requirements, the requirements in the pharmaceutical industry requires a separate minimum weighing test, where a small test load is measured multiple times to find out the accuracy of the instrument with a small load.

6. Other tests

There are also some other tests specified in the standards, although these are typically not done during a normal calibration, but can be done as a type of approval test or in the initial verification. Example of these tests are:

- Tare test
- Discrimination test
- Variation of indication over time
- Test of magnetic interaction

WEIGHTS

For the calibration, it is recommended to use classified reference weights. For example, OIML (Organisation Internationale de Métrologie Légale) recommendation R111 have recommendations for the classification of the weights (E1, E2, F1, F2, M1, M1-2, M2, M2-3 ja M3).

Handling of weights

Obviously, the weights should be handled so that it does not change the metrological characteristics of the weights. The weights should not be placed on surfaces that will cause scratches or on dirty surfaces. When cleaning weights, special attention should be paid for proper cleaning.

Smaller weights should be handled with gloves, not with bare hands, to avoid any finger grease from getting onto the weights and to avoid warming the weights to a higher temperature than the environment.

When not used, the weights should be stored in their own storage boxes. Weights should be stored so that only authorized personnel have access to them. Very large weights should be covered and stored in stabile environmental conditions. Humidity condensing on weights should be avoided.

Nominal mass / Conventional mass

The terms nominal mass and conventional mass are used when talking about weights.

- **Nominal mass** is the nominal mass of the given weight, and when the weight is accurate enough, when used in legal verification, it is enough to use the nominal mass as the true value.

- **Conventional mass** is the actual calibrated accurate mass of the weight that has been corrected with any required local corrections. To make traceable calibrations, you should always use the conventional mass.

Calibration of weights

Weight should be traceably calibrated regularly using an accredited calibration laboratory or a national calibration laboratory. Typically, the calibration period for weights is 1 to 5 years.

It is also possible that you calibrate the weight yourself, if you have a suitable weighing instrument and reference weights to do that.

For more information on traceability, please see the blog post Metrological Traceability in Calibration – Are you traceable?

Local gravity

Local gravity is slightly different in different locations around the globe. This is due to many things such as the altitude (lower gravity in higher altitudes), latitude (lower gravity closer to equator), local geology and some other factors.

Although gravity does not affect the mass of the weight, it does affect the force of the mass on the weighing instrument (Force = gravity x mass). Since a weighing instrument is measuring the force, the gravity has an effect on the instrument's reading.

If you move your weighing instrument into a new location, you may need to adjust it, depending how accurate the instrument is and how much is it moved.

Often, reference weights are calibrated in a different location than where the weights are being used, which can be in a different city and in some cases that are far away from each other. Therefore, the gravity difference needs to be considered, when you use the reference weight to calibrate/adjust your weighing instruments.

Air buoyancy

When weights are being used, air buoyancy will cause a small force that will make the force of the mass smaller. So, we can think that air buoyancy kind of lifts the weights up very slightly.

The effect of air buoyancy depends on the environmental conditions and on the differences of the density of the weights compared to air density. As the effect of air buoyancy is relatively small, and does not change that much from day to day, it is not always considered.

Effect of convection

If the temperature of the weight differs from the environmental temperature, there will be an air convection around the weight. The bigger the temperature difference is, the bigger the convection is. This convection will have a small effect on the indication of the weighing instrument.

For example, if the weight is colder than environment, the air convection around the weight will go down facing the weighing instrument and cause small additional weight to the weighing instrument. The effect of convection is more relevant with high accuracy instruments, although it is still relatively small.

Substitution load

Substitution loads are something that can be used if there are not enough weights for the calibration. For example, if you have one weight of 100 kg and two weights of 200 kg (total 500 kg) and you need to calibrate a 1,000 kg weighing instrument. What do you do? You calibrate the first points up to 500 kg using the weights you have and then you read the exact indication of the weighing instrument when the 500 kg load is on, then you remove the weights and put some kind of substitution load on the weighing instrument until the indication is exactly the same as it was with the 500 kg weights. Then you know that your substitution load has the same weight as your accurate reference weights. You can then continue adding your weights while keeping the substitution load on till you reach the 1,000 kg.

CALIBRATION CERTIFICATE

As with any calibration, an essential part of calibration is to document the results in the calibration certificate.

The certificate naturally includes the measurement results of the calibration, i.e. the mass of the weights placed on instrument and the indication of the instrument. This includes all the different measurements/tests that were done during the calibration, as mentioned earlier.

The certificate should also include the total uncertainty of the calibration, this number without related uncertainty does not tell very much about the measurement. The certificate should also include a clear description of the instrument being calibrated and the weights being used as reference. The calibration procedure that was followed should also be included. Environmental conditions during the calibration should also be included in the certificate.

To shortly summarize, certificate should include:

- measurement results
- a unique certificate number
- customer name, address and identification
- name, signature and company of the person who did the calibration
- detailed information on the instrument that was calibrated

For the calibration, it is recommended to use classified reference weights.

Accuracy class	Verification scale interval e	Number of verification scale intervals n=Max/e		Minimum capacity, Min
		min	max	(lower limit)
Special (I)	0.001 g ≤ e[a]	50 000[b]	–	100 e
High (II)	0.001 g ≤ e ≤ 0.05g 0.1 g ≤ e	100 5 000	100 000 100 000	20 e 50 e
Medium (III)	0.001 g ≤ e ≤ 2 g 5 g ≤ e	100 500	10 000 10 000	20 e 20 e
Ordinary (IIII)	5 g ≤ e	100	1 000	10 e

PIC 4. The verification scale interval.

Maximum permissible errors	For loads, m, expressed in verification scale intervals, e	
	Class I	Class II
±0.5 e	0 ≤ m ≤ 50 000	0 ≤ m ≤ 5 000
±1.0 e	50000 < m ≤ 200 000	5 000 < m ≤20 000
±1.5 e	200 000 < m	20 000 < m ≤ 100 000
	Class III	Class IV
±0.5 e	0 ≤ m ≤ 500	0 ≤ m ≤ 50
±1.0 e	500 < m ≤ 2000	50 < m ≤ 200
±1.5 e	2000 < m ≤1 0000	200 < m ≤ 1 000

PIC 5. Maximum permissible error.

Maintenance Tolerances (All values in this table are in scale divisions)				
Tolerances in Scale Divisions				
	1	2	3	5
Class	Test load			
I	0–50 000	50 001–200 000	200 001 +	
II	0–5 000	5001–20 000	20 001+	
III	0–500	501–2 000	2 001–4 000	4 001 +
IV	0–50	51–200	201–400	401 +
III L	0–500	501–1 000	*)	*)

*) Add 1 d for each additional 500 d or fraction thereof.

PIC 6. Tolerance classes.

- identification of the reference weights being used
- identification of the calibration procedure being used
- calibration date
- environmental conditions
- measurement uncertainty and its coverage factor
- mention of the case when only a partial calibration was done
- a graphical representation of the calibration results if possible (useful visual component)

If the calibration is an accredited calibration, then the regulation will stipulate the contents of the certificate.

INSTRUMENT CLASSES, TOLERANCE CLASSES, MAX PERMISSIBLE ERROR

Standard EN45501:2015 classifies weighing instruments into following four different categories (the symbol marked on the instrument is in parenthesis):

- Special accuracy (I)
- High accuracy (II)
- Medium accuracy (III)
- Ordinary accuracy (IIII)

The verification scale interval, number of verification scale intervals and the minimum capacity per EN45501:2015: (***SEE PIC. 4***).

Maximum permissible error per EN45501:2015: (***SEE PIC. 4***).

Tolerance classes according to NIST Handbook 44 (2017 edition): (***SEE PIC. 6***).

UNCERTAINTY

As in any calibration, also in weighing instrument calibration, the uncertainty of the calibration should be known.

Knowing the error of the scale indication at each calibration is not sufficient. You must also know the uncertainty (how certain you can be) about the error found at each point of calibration. There are several sources of uncertainty of the error in weighing instrument calibration, such as:

- The masses of the weights are only known with a particular uncertainty.
- Air convection causes extra force on the load receptor.
- Air buoyancy around the weights varies according to barometric pressure, air temperature and humidity.
- A substitute load is used in calibrating the scale.
- Digital scale indications are rounded to the resolution in use.
- Analogous scales have limited readability.
- There are random variations in the indications as can be seen in the Repeatability Test.
- The weights are not in the exact middle of the load receptor.

When using the weighing instruments in normal use, there are many things that differ from the calibration, and this will also cause some additional uncertainty to the usage of the instrument. These differences include for example:

- Routine weighing measurements involve random loads, while calibration is made at certain calibration points.
- Routine weighing measurements are not repeated whereas indications received through calibrations may be averages of repeated weighing measurements.
- Finer resolution is often used in calibration.
- Loading/unloading cycles in calibration and routine weighing may be different.
- A load may be situated eccentrically in routine weighing.
- A tare balancing device may be used in routine weighing.
- The temperature, barometric pressure and relative humidity of the air may vary.
- The adjustment of the weighing instrument may havechanged.

Standard and expanded uncertainties of weighing results are calculated using technical data of the weighing instrument, its calibration results, knowledge of its typical behavior and knowledge of the conditions of the location where the instrument is used. Calculating the uncertainty of the weighing results assists you in deciding whether or not the accuracy of the weighing instrument is sufficient and how often it should be calibrated.

Recommended references for the uncertainty calculation include EURAMET Calibration Guide 18 and the EA-4/02.

The Beamex CMX Calibration Management Software has dedicated functionality for the calibration of weighing instruments.

REFERENCES & PRODUCTS

WEIGHING SCALE CALIBRATION

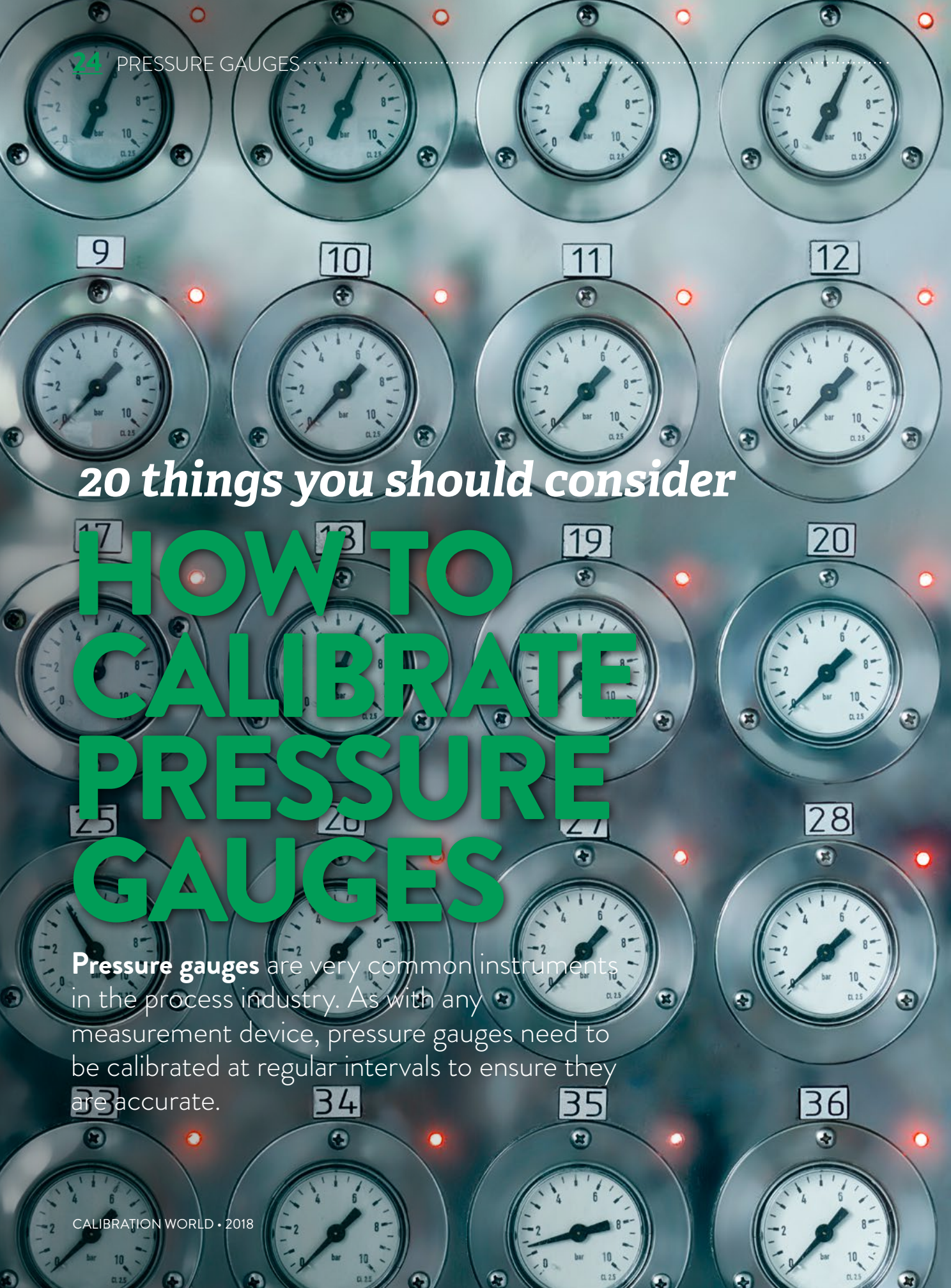
The most relevant references for this subject include, but not limited to, following:

- EURAMET Calibration Guide No. 18, Version 4.0 (11/2015)
- EN 45501:2015 – Metrological aspects of non-automatic weighing instruments
- NIST Handbook 44 (2017 Edition) – Specifications, Tolerances, and Other Technical Requirements for Weighing and Measuring Devices
- EA-4/02 (2013) – Evaluation of the Uncertainty of Measurement in Calibration
- JCGM 100:2008 – Evaluation of measurement data – Guide to the expression of uncertainty in measurement
- JCGM 200:2008 – International vocabulary of metrology – Basic and general concepts and associated terms
- OIML R76-1 – Non-automatic weighing instruments Part 1: Metrological and technical requirements – Tests
- OIML R 111 – OIML R111: Weights of classes E1, E2, F1, F2, M1, M1-2, M2, M2-3 and M3
- DIRECTIVE 2009/23/EC (2009) – Non-automatic weighing instruments

RELATED BEAMEX PRODUCTS

Among many other features, **Beamex CMX Calibration Management Software** has a dedicated functionality for the calibration of weighing instruments. It has been around for more than 10 years already. CMX supports various tests such as: Eccentricity Test, Repeatability Test, Weighing Tests and Minimum Weighing Test. Both OIML and NISH Handbook (including latest USP 41 updates) accuracy classes are supported. The functionality can be used either with a computer or a mobile device.

For more information on Beamex CMX and its weighing instrument calibration module, please visit the CMX product page and read the brochure, or contact Beamex.



20 things you should consider

HOW TO CALIBRATE PRESSURE GAUGES

Pressure gauges are very common instruments in the process industry. As with any measurement device, pressure gauges need to be calibrated at regular intervals to ensure they are accurate.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20 things you should consider

HOW TO CALIBRATE PRESSURE GAUGES

There are many things to consider when calibrating pressure gauges. This article lists **20 things** you should consider when calibrating pressure gauges.

CONTENTS

The 20 things discussed in the article are the following:

1. Accuracy classes
2. Pressure media
3. Contamination
4. Height difference
5. Leak test of piping
6. Adiabatic effect
7. Torque
8. Calibration / mounting position
9. Generating pressure
10. Pressurizing / exercising the gauge
11. Reading the pressure value (resolution)
12. Number of calibration points
13. Hysteresis (direction of calibration points)
14. "Tapping" the gauge
15. Number of calibration cycles (repeatability)
16. Adjustment / correction
17. Documentation – calibration certificate
18. Environmental conditions
19. Metrological traceability
20. Uncertainty of calibration (TUR/TAR)

Before we discuss each of the things to consider when calibrating pressure gauges, let's take a quick look into a few more basic concepts.

Pressure is the force that is perpendicular to the surface divided by the area it is affecting. So pressure equals force per area, or $p = F / A$.

There are many different pressure units used around the world and this can be sometimes very confusing. The engineering unit for pressure, according to SI system, is Pascal (Pa), being a force of one Newton per one square meter area, 1 Pa = 1 N/m^2. Since Pascal is a very small unit, it is most often used with coefficients, such as hecto, kilo and mega.

For more information on pressure and different pressure units and their background, please see the blog post Pressure units and pressure unit conversion.

For an on-line pressure unit conversion tool, please visit the page Pressure unit converter.

PRESSURE TYPES

Several different pressure types exist including gauge, absolute, vacuum, differential and barometric. The main difference of these pressure types is the reference point against which the measured pressure is being compared. Pressure gauges also are available for all of these pressure types. Also, compound gauges are available, including a combined scale for both positive gauge pressure and vacuum (negative gauge) pressure.

For more detailed information on different pressure types, please see post Pressure calibration basics – pressure types.

PRESSURE GAUGES

When talking about pressure gauges, it is normal to refer to analog pressure indicators which are provided with a pointer needle and a pressure scale. These are normally manufactured according to EN 837 or ASME B40.100 standards. Often analog pressure gauges are built with a Bourdon tube, diaphragm or capsule. There is a mechanical structure that moves the pointer as pressure increases causing the pointer move across the scale.

Pressure gauges are divided into different accuracy classes that specify the accuracy of the gauge as well as other attributes. Available pressure ranges are typically divided in steps with coefficients 1, 1.6, 2.5, 4, 6 continuing into the next decade (10, 16, 25, 40, 60) and so on. The different gauge diameters (of scales) are typically 40, 50, 63, 80, 100, 115, 160 and 250 mm (1 ½, 2, 2 ½, 4, 4 ½, and 6 inches). More accurate gauges typically have a bigger diameter.

Pressure connectors are normally parallel pipe threads (G) according to ISO 228-1, or taper pipe threads (NPT) according to ANSI/ASME B1.20.1.

There are also digital pressure gauges that have a numeric pressure indication instead of an analog pointer. This article focuses on analog gauges, but most of the principles are valid for both.

Pressure gauges are commonly used in all industries and are a very common instrument to be calibrated. As with any process measurement device, it should be calibrated at regular intervals to assure that it is measuring correctly. Gauges being mechanical instruments, adds the risk for them to drift due to mechanical stress.

For more general information on why you should calibrate instruments, please see the blog post Why calibrate?

For more information on how often instruments should be calibrated, please see the Beamex blog post How often should instruments be calibrated?

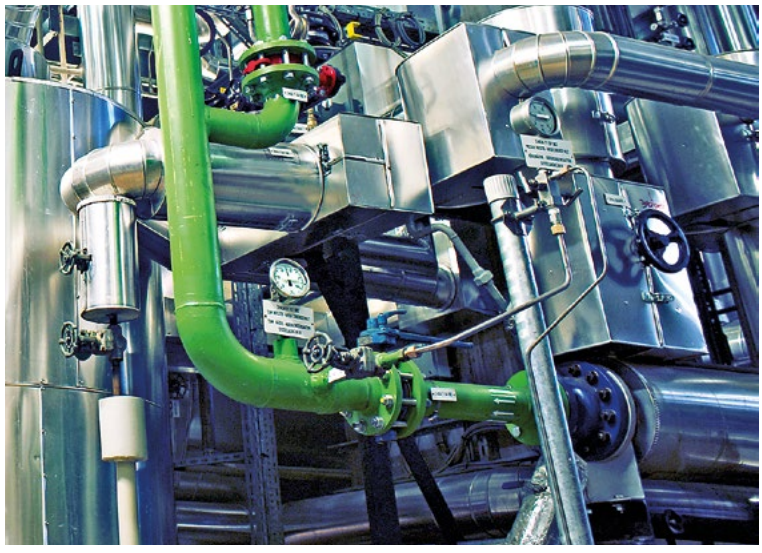
THE BASIC PRINCIPLE OF CALIBRATION

If we simplify the principle of a pressure gauge calibration, we can say that when we calibrate a pressure gauge, we provide a known accurate pressure input and read the indication on the gauge, and then document and compare these. The difference in the values is the error and the error should be smaller than the required accuracy for the gauge.

20 THINGS YOU SHOULD CONSIDER

This section lists the 20 most common things you should consider when you are calibrating pressure gauges.

Pressure gauges are very common instruments in the process industry.



As with any measurement device, pressure gauges need to be calibrated at regular intervals to assure they are accurate.

PIC 1. An example of effect of hydrostatic pressure.

1 – Accuracy classes

Pressure gauges are available in many different accuracy classes. Accuracy classes are specified in ASME B40.100 (accuracy classes from 0.1 to 5% range) as well as in EN 837 (accuracy classes from 0.1 to 4% range) standards. The accuracy class specification most often being "% of range" means that if the accuracy class is 1% and if the scale range is zero to 100 psi, the accuracy is ± 1 psi. Make sure you know the accuracy class of the gauge you are going to calibrate, as this will naturally specify the acceptable accuracy level, but it will also have other effects on the calibration procedure.

2 – Pressure media

When calibrating pressure gauges, the most common pressure media are gas or liquid. The gas is usually just air, but it can also be other gases such as nitrogen. Most commonly, the liquid is water or oil. The pressure media during the calibration depends on the media that is used in the process that the gauge is connected to. Media also depends on the pressure range. Low pressure gauges are practical to calibrate with air/gas, but as the pressure range gets higher it is more practical and also safer to use liquid as the media.

3 – Contamination

While installed in a process the pressure gauge uses a certain type of pressure media, this should be taken into account when selecting the media for the calibration. You should not use a media during the calibration that could cause problems when gauge is installed back to process. Also, the other way around, sometimes the process media could be harmful to your calibration equipment. There can be dirt inside the gauge that can get into the calibration equipment and cause harm. With a gas operated gauges, you can use a dirt/moisture trap, but for a liquid operated gauge, you should clean the gauge prior to calibration. One of the most extreme process situations is if the gauge is used in to measure the pressure of oxygen. If any grease goes into a high pressure oxygen system during the calibration of the gauge, it can be very dangerous and could cause an explosion.

4 – Height difference

If the calibration equipment and the gauge to be calibrated are at a different height, the hydrostatic pressure of the pressure media in the piping can cause errors. This normally is not an issue when gas is used as the media, as gas is light compared to liquid. But when liquid is used as media, the liquid in the piping will have a weight due hydrostatic pressure and can cause errors. The magnitude of the error depends on the density of the liquid and the difference in height, as the gravity is pulling the liquid inside the tubing. If it is not possible to have the calibrator and gauge at the same height, then the effect of height difference should be calculated and taken into account during the calibration.

As an example (***SEE PIC. 1***), if water is the media (density 997.56 kg/ m^3), local gravity is 9.8 m/s^2 and there is a 1 meter (3.3 feet) difference between the DUT and the reference equipment, this will cause an error of 9.8 kPa (98 mbar or 1.42 psi).

Note that depending on the pressure to be measured, the error caused by the height difference can be significant.

5 – Leak test of piping

If there are any leaks in the piping during the calibration, unpredictable errors can occur. Therefore, a leak test should be done prior to calibration. The most simple leak test is to pressurize the system and let the pressure stabilize for some time, and monitor that the pressure does not drop too much. Some calibration systems (pressure controllers) may be able to maintain the pressure even in case of a leak, if it has a continuous controller adjusting the pressure. In that

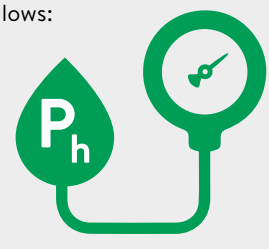
HYDROSTATIC PRESSURE EXAMPLE

Hydrostatic pressure is calculated as follows:

$P_h = \rho \times g \times h$

Where:

P_h = hydrostatic pressure
ρ = density of liquid (kg/m^3)
g = local gravity (m/s^2)
h = height difference (m)



case, it is difficult to see a leak, so the controller should be closed to enable a closed system for a leak test.

6 – Adiabatic effect

In a closed system with gas as the pressure media, the temperature of the gas affects the volume of the gas, which has an effect to the pressure.

When pressure is increased quickly, the temperature of the gas will rise, and this higher temperature makes the gas to expand, thus having a bigger volume and higher pressure. When the temperature starts to cool down, the volume of the gas becomes smaller and this will cause the pressure to drop. This pressure drop may seem like a leak in the system, but it is actually caused by the adiabatic effect due to change in the gas temperature. The faster the pressure is changed, the bigger is the effect is. The pressure change caused by this effect will gradually get smaller as the temperature stabilizes. So, if you change the pressure quickly, make sure you let it stabilize for a while before judging that there is a leak in the system.

7 – Torque force

Especially for torque sensitive gauges, don't use excessive force when connecting pressure connectors to the gauge, as it may damage the gauge. Follow manufacturer's instructions for the allowed torque force. Take the time to use proper tools, appropriate adapters and seals.

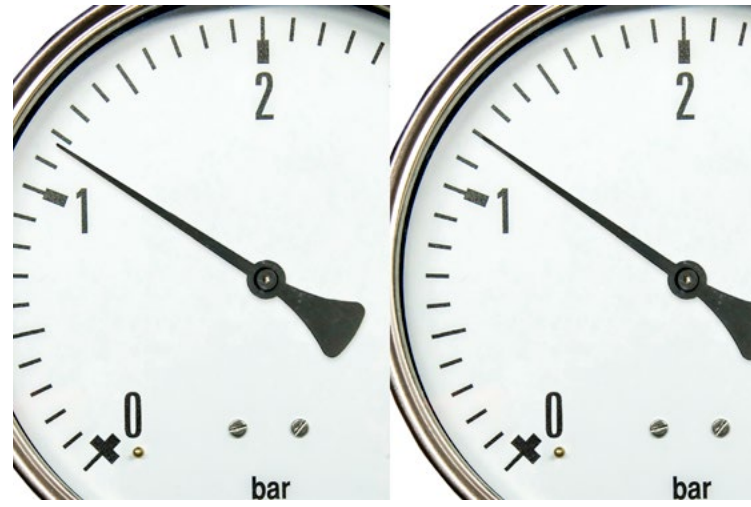
8 – Calibration / mounting position

Because pressure gauges are mechanical instruments, its position will affect the reading. Therefore, it is recommended to calibrate the gauge in the same position as it is used in the process. Manufacturer's specifications for the operation/mounting position should also be taken into account.

A typical specification for a mounting position is that a change of 5 degrees in position should not change the gauge indication more than half (0.5 times) of the accuracy class.

9 – Generating pressure

To calibrate a pressure gauge, you need to source the pressure applied to the gauge. There are different ways to do that: you can use a pressure hand pump, a pressure regulator with a bottle or even a dead weight tester. A dead weight tester will provide a very accurate pressure and you don't need a separate calibrator to measure the pressure, but dead weight tester is expensive, not very mobile, requires a lot of attention to use and it is sensitive to dirt. It is more common to use a pressure calibration hand pump to generate pressure and an accurate pressure measurement device (calibrator) to measure the pressure. A pressure controller can also be used to supply the pressure.



Left indicator in the above picture is difficult to read accurately as the indicator is between scale marks, while the right one is easy to read since the applied pressure is adjusted so that pointer is exactly on scale mark.

10 – Pressurizing / exercising the gauge

Due to its mechanical structure, a pressure gauge will always have some friction in its movement, and may change its behavior over time, therefore you should exercise it before calibration. This is especially the case if the gauge has not been applied with pressure for a while. To exercise, supply the nominal max pressure and let it stay for a minute, then vent the pressure and wait a minute. You should repeat this process 2–3 times before starting to do the actual calibration cycle.

11 – Reading the pressure value (resolution)

The scale in pressure gauges have limited readability. It has major and minor scale marks, but it is difficult to accurately read the pressure value when the indicator is in between the scale marks. It is much easier to see when the needle is exactly at a scale mark. Therefore, it is recommended to adjust the input pressure so that the needle is exactly at an indication mark, and then record the corresponding input pressure. If you just supply a certain accurate input pressure and then try to read the indicator, it will cause errors due to limited reading accuracy.

Also, it is important to look at the indication perpendicular to the gauge scale. Many accurate gauges have a reflecting mirror along the scale, behind the needle pointer. This mirror helps you read it, and you should read it so that the mirror reflection of the needle is exactly behind the actual needle. Then you know that you are looking perpendicular/straight at the gauge.

If the gauge has a digital indicator, then the resolution (reading accuracy) is totally different. You can read the digital indicator equally accurate at any point of its range.

Sometimes a mechanical pressure gauge may need **a gentle tapping** in order to make sure that it is released from any friction or lost flexibility, especially if it has not been exercised in normal use.

12 – Number of calibration points

The different accuracy classes of gauges will determine the number of calibration points.

For the most accurate gauges (better than 0.05%) you should use the "comprehensive calibration procedure" and the calibration should be performed 11 calibration points across the range (zero point plus 10% steps) with 3 cycles in rising and falling pressure. For the medium accuracy class gauges (0.05 to 0.5%), use a "standard calibration procedure" with 11 points, but less repeated cycles. The less accurate gauges (class equal or greater than 0.5%) are to be calibrated with the "basic calibration procedure" with 6 calibration points (zero point plus 20% steps) with rising and falling pressure.

In practice, gauges are sometimes calibrated with less of calibration points. Naturally the number of calibration points and cycles depends also on the application, criticality and accuracy requirement.

13 – Hysteresis (direction of calibration points)

Again, due to its mechanical structure, a pressure gauge may have some hysteresis. This means that the indication is not exactly the same when a pressure point is approached with an increasing pressure compared to a decreasing pressure. In order to find out the amount of hysteresis, you should calibrate the gauge with increasing and decreasing calibration points, i.e. to go first up and then down with pressure. While doing this, it is important to make sure that the pressure moves only to desired direction. For example, when you calibrate with increasing pressure you must make sure that you don't decrease the pressure at any point when fine adjusting the pressure, as this will cause you to lose the hysteresis information. If you overshoot the target point with increasing pressure, you need to come way back down and then increase the pressure again to target point.

14 – "Tapping" the gauge

Sometimes a mechanical pressure gauge may need a gentle tapping in order to make sure that it is released from any friction or lost flexibility, especially if it has not been exercised in normal use. During the calibration, once the input pressure is stabilized, you can gently tap the gauge to see if the indication changes. Of course, you need to be gentle in tapping not to damage the gauge.

15 – Number of calibration cycles (repeatability)

During calibration, the cycles are repeated several times in order to determinate the repeatability of the gauge under calibration. If the gauge to be calibrated has bad repeatability, it will give different results during different calibration cycles. If you only calibrate it with one cycle, you will miss the repeatability information and part of the truth. As mentioned earlier, the most accurate gauges should be calibrated with 3 calibration cycles. In practice the repeatability is often tested as a type test for certain instrument types (make/model) and once the typical repeatability is known, the actual calibration is carried out in practice with just a one calibration cycle, taking the typical repeatability into account.

16 – Adjustment / correction

If the As Found calibration shows that the gauge is not within the accuracy requirements, something needs to be done. In most cases the gauge should be adjusted so that it will be within the allowed tolerance levels. After adjustment, the gauge needs to be calibrated again (As Left) to verify the condition it was left.

If it is not possible to adjust the gauge in question, then a correction coefficient can be calculated and this coefficient must be taken into account in normal usage. This will, of course, make the usage more difficult.

If the gauge has a big error, then it is best to repair/replace it and not try to adjust it, as most likely it will not stay stable in the future.

17 – Documentation – Calibration Certificate

One crucial aspect for calibration is, of course, to document calibration results in a calibration certificate. The certificate should document the applied pressure and the indication of the gauge as well as an error calculation (difference of applied pressure and indication). Certainly, the certificate needs to contain other information also, as stipulated with standards/ regulations, including calibration uncertainty.

If you make the certificate manually, it means that you write the gauge's indication and the applied pressure on paper and then calculate the error manually. You can also use automated calibration equipment that will perform the documentation and calculations automatically and also transfers the results to the computer for calibration software to store/print the results.

For more information on what a documenting calibrator is, please read the blog post What is a documenting calibrator and how do you benefit from using one?

18 – Environmental conditions

Most gauges have temperature effect specified and this should be taken into account. Most often you calibrate the gauge in normal room temperature, but the gauge may be used at a different temperature in the process. This difference in temperatures may cause differences in gauge accuracy between calibration and process usage.

Environmental conditions (temperature and humidity) during the calibration should be recorded in the calibration certificate.

19 – Metrological traceability

As with any calibration, you must ensure that the reference standard you are using to measure the applied pressure to the pressure gauge has a valid calibration certificate and that its calibration is traceable to the appropriate national standards (metrological traceability) (***SEE PIC. 1***).

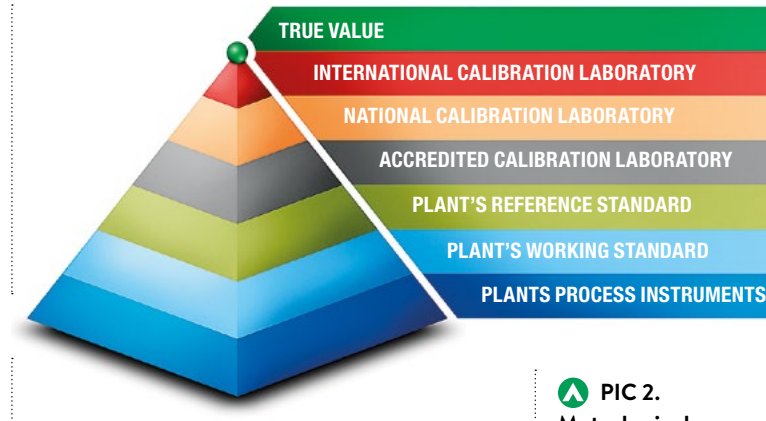
For more detailed information on what the metrological traceability means in calibration, please see the blog post Metrological traceability in calibration.

20 – Uncertainty of calibration (TUR/TAR)

With any calibration, you should be aware of the total uncertainty of the calibration measurements, otherwise the result will not have much value. The awareness of calibration uncertainty seems to be rising and it is also more and more included in relevant standards and regulation. In some areas the TUR (Test Uncertainty Ratio) or TAR (Test Accuracy Ratio) is something that is used instead of the uncertainty calculation. The concept of this is to make sure that you have a calibrator (or reference standard) that is several times more accurate that the instrument to be calibrated, and if you know this, you don't need to calculate uncertainty. One of the most commonly used ratio is 1:4, meaning that the calibrator's specs are four times better than the specs of the gauge to be calibrated.

It is good to notice anyhow that using this TUR/TAR ratio method, you are not aware of all the relevant uncertainty components of your calibration process and you don't know how good the calibration really is. Therefore, calculating the total uncertainty of the calibration is the recommended method.

For more information and a practical approach to measurement uncertainty and calibration uncertainty, please take a look at the Beamex blog post Calibration Uncertainty for Dummies.



PIC 2. Metrological traceability in calibration.

RELATED RESOURCES

PRESSURE GAUGE CALIBRATION

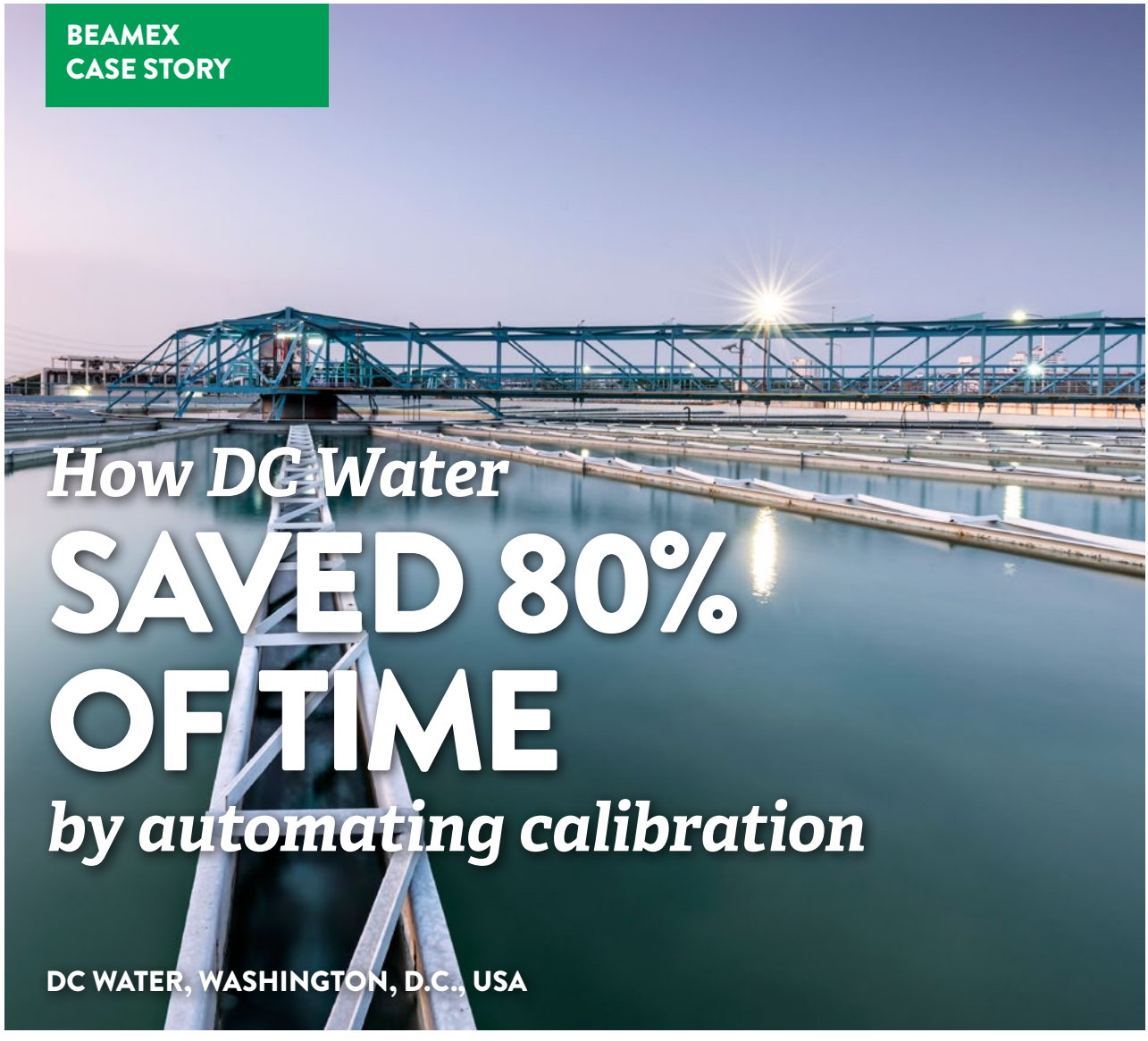
Beamex products suitable for pressure calibration, including pressure gauge calibration:
www.beamex.com/calibrators/pressure-calibrators/

An online tool for pressure unit conversion on the Beamex website:

- Pressure unit converter

Related Beamex blog posts:

- Why calibrate?
- How often should instruments be calibrated?
- Calibration uncertainty for dummies
- Pressure calibration basics – pressure types
- Pressure units and pressure unit conversion
- Metrological traceability in calibration
- What is a documenting calibrator and how do you benefit from using one?



BEAMEX
CASE STORY

How DC Water
SAVED 80% OF TIME
by automating calibration

DC WATER, WASHINGTON, D.C., USA

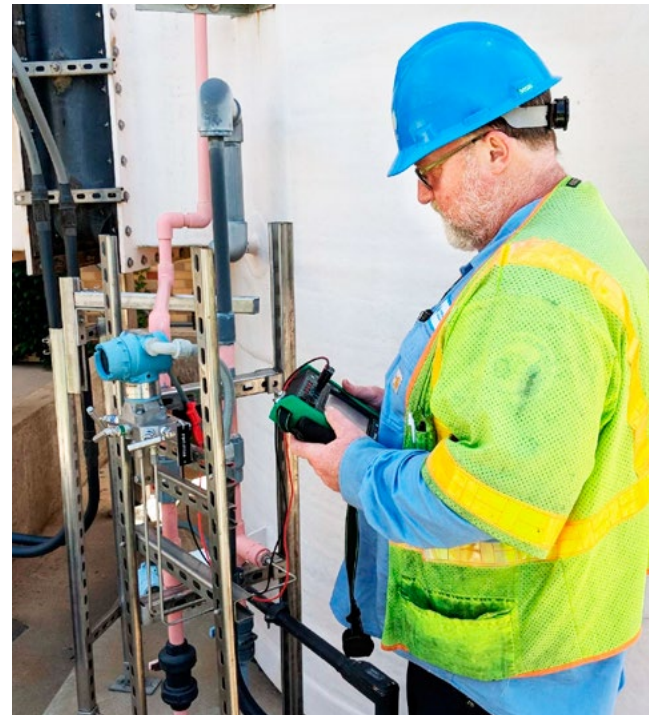
At one of the **largest wastewater treatment plants in the world**, DC Water's Blue Plains Plant's Process Engineering Maintenance Group has a crucial responsibility of calibrating over 1,000 instruments to help ensure proper water treatment.

The Beamex Integrated Calibration Solution, comprised of Beamex equipment and software, they have improved the quality and accuracy of calibrations, while achieving a 75% time savings on the entire pressure calibration process. Furthermore, using the Beamex MC6 field calibrator and communicator for pressure calibrations has decreased the time it takes to conduct the calibration procedure itself in the field by over 80%.

All in all, the plant has experienced a dramatic time savings and implemented a more reliable calibration strategy while realizing a 100% return on investment in the first year. This short article explains how the Process Engineering Maintenance Group was able to achieve these accomplishments.

ABOUT DC WATER

DC Water's Blue Plains Advanced Wastewater Treatment Plant opened in 1937. Currently it treats wastewater from the District of Columbia, Maryland and Virginia and is considered the largest treatment plant of its kind in the world. On an average day, close to 300 million gallons of raw sewage flows into the Blue Plains Advanced Wastewater Treatment Plant to be treated. After treatment, the cleaned water flows into the Potomac River which leads to the Chesapeake Bay. To protect our waterways, DC Water is under strict requirements to dramatically reduce the amount of nitrogen and phosphorous in the cleaned water we discharge into the Potomac. In fact, these permit limits are some of the most stringent in the country.



Joel Gregory, DC Water, Process Control Systems Specialist

PROCESS INSTRUMENTATION AND MAINTENANCE

Running a facility of this size is no ordinary task and ensuring proper maintenance of the plant's process instrumentation is essential to operating the plant safely and efficiently. The Process Engineering Maintenance Group consists of 18 people who are responsible for maintaining approximately 5,000 assets and calibrating 1,000+ of the mid to highly critical pressure, flow, level, and temperature instruments. As a part of the preventative maintenance (PM) program, a portion of the 1,000+ instruments are calibrated weekly based on instrument criticality, which is vital to the PM program.

Prior to implementing a Beamex solution, there were no standardized procedures or tools for calibration. The plant categorized technicians into 4 different levels, each using different equipment. Work results were inconsistent and the best calibration practice was based on the level the technician's experience and their preferred toolset. These factors compounded into inconsistent quality of work and results. The lack of standardized practices also presented challenges to planning and scheduling activities because of the variability of man-hours required to perform calibration tasks.

Furthermore, hand-written documentation was generated only for the assets with the highest criticality factor and calibration of non-critical instruments had no written record. The lack of documentation led to calibrations being mistakenly re-scheduled, which resulted in duplication of work and diminishing productivity of maintenance resources. Conversely, some instruments weren't being calibrated at all and ran to failure, which adversely impacted reliability.

A BETTER WAY WITH BEAMEX AND PROCESS STANDARDIZATION

With the control system expansion and upgrades, there was a need for calibrating more instrumentation, competently calibrating smart transmitters with higher accuracy, and most importantly, better data for performance reporting was required by the Engineering Group. The Maintenance Group needed to make substantial improvements to the calibration program to accomplish these objectives while keeping resources at current levels. A key component for success was automation. They invested in the Beamex integrated calibration solution comprised of Beamex CMX calibration software and Beamex MC6 advanced field calibrator and communicator, and pumps.

A foundation to the solution was defining and documenting the calibration procedures for all calibratable assets into a database inside of the Beamex CMX software. These centralized and

> All in all, the plant has experienced a dramatic time savings and implemented a more reliable calibration strategy while realizing a **100% return on investment** in the first year.

Robert Hopkins, DC Water, Process Control System Specialist

well-defined procedures could now drive methods that ensured measurement data is captured, measurement errors are calculated and compared to defined tolerances, and data is organized for easy access and reporting. Building information assets provided the Engineering Group the information they needed for analysis, and the transparency and visibility greatly increased confidence levels for both upper management and third party stakeholders.

PLANNING AND QUALITY IMPROVEMENTS

Planning calibration work is now streamlined using CMX, yielding substantial time savings. The Maintenance Group uses fully electronic and paperless workflows by utilizing the MC6. Established procedures are downloaded to the MC6 directly from CMX for in situ calibration work. Procedures are programmed into the MC6, measurement errors are calculated and presented in real time, and all measurement data is captured electronically, providing completely automated calibration workflows. This level of automation closed the gap between junior and senior technicians allowing them to re-deploy senior technicians to QA/QC activities that include reviewing the calibration work of the more junior technicians. When performing calibrations in the field, the time savings has been over 80% from automating calibrations using the Beamex MC6 field calibrator and communicator.

In addition to time savings, there has also been substantial improvements to the quality of calibration. Prior to implementation of the Beamex integrated calibration solution, a calibration test strategy was based on a simple 2 or 3 point test up the span. With the more streamlined workflow and automated documentation, they could now justify a more thorough strategy consisting of additional test points, as well as up and back down the span. This allowed them to now identify and capture critical hysteresis errors indicating potential instrument failures that they were unable to identify before.

Previously, for documentation, they had to hunt down whoever performed the calibration last to find the paper records. With the CMX software, they automatically generate calibration certificates and attach these certificates inside of their maintenance management system, Maximo. This provides transparency and visibility to management. The electronic documentation also minimized the opportunity for human error. For instance, when they hook up to a HART or

Planning calibration work is now streamlined using CMX, yielding substantial time savings. The Maintenance Group uses **fully electronic and paperless workflows** by utilizing the MC6.

Beamex PGC

Fieldbus instrument they can easily identify the instrument and link the results to it, where as in the past, some records were mixed up or missing altogether. In result, when calibrating a pressure transmitter, for example, the entire calibration process, from planning, to performing calibrations and finally documenting the results, the Beamex integrated calibration solution has generated a 75% time savings.

LOWER TOTAL COST OF OWNERSHIP

Another area of savings realized is in the cost of ownership for measurement standards. There were many different tools in service as each technician employed their tool of choice for calibration work. Standardizing on a multi-functional tool like the MC6 allowed them to reduce the number of tools to maintain and certify each year. Configuring the MC6 units with HART communication capability also improved reliability of new instruments. New instrumentation is now calibrated prior to installation and some have required trimming to improve measurement accuracy provided to the control system.

RELIABLE COMMISSIONING

Beamex integrated calibration solution has also improved their process when installing new instruments. For example, for a pressure ring assembly, prior to Beamex, the units were specified and installed. There was no verification or calibrating at all – they just relied on the manufacturer's word. Now, they test new instruments prior to installation. They have found that some out of the box were not meeting their specifications, so they were able to correct the instrument or replace it before installing it into the process.

CASE STORY IN BRIEF

DC WATER

BLUE PLAINS ADVANCED WASTEWATER TREATMENT PLANT WASHINGTON, D.C., USA

DC Water has been able to meet the increasing requirements associated with control system upgrades and evolving compliance. Implementing a paperless solution enabled the automation of manual work processes and these streamlined workflows enables them to accomplish more work with the same or less resources with a total return on their investment within the first year

KEY PLAYERS

- Bill Adams – *Supervisor for the Process Controls Systems Group*
- Elkin Hernandez – *Process Control Manager*
- Joel Gregory – *Process Control Systems Specialists*
- Robert Hopkins – *Process Control Systems Specialists*
- Francisco Morales – *Lead Process Control Systems Specialists*

BEAMEX SOLUTIONS

- Beamex MC6 calibrator and communicators
- Beamex CMX calibration software
- Beamex PGXH
- Beamex EX160
- Beamex PGC
- Beamex PGPH
- Beamex PGV & PGM
- Onsite Beamex training

LATEST NEWS

BEAMEX INTRODUCES THE MC6-EX

INTRINSICALLY SAFE CALIBRATOR AND COMMUNICATOR

More info: **www.beamex.com/calibrators/beamex-mc6-ex**

■ Beamex has been producing calibration equipment for more than 40 years and intrinsically safe process calibrators already for over 30 years.

In many process industries, there are certain areas in the plant that are classified as a "Hazardous Area" or "Ex area" which contains or may contain flammable substances, gas, vapor or dust.

Typical industries with hazardous areas include chemical and petrochemical industries, offshore and onshore oil and gas, oil refining, the pharmaceutical industry, food and beverage, energy production, paint shops and mining.

If you want to take a normal, non-Ex calibrator into a hazardous area, you will need a hot-work permit – this takes time, effort and bureaucracy. Then, you will need to make a risk analysis and carry additional safety equipment with you such as gas analyzers. Using an Ex certified intrinsically safe calibrator in an Ex area is the safest and easiest choice.

An ideal device for field use

Now, Beamex introduces a new calibrator called Beamex MC6-Ex.

It is important to note that some Ex calibrators/devices on the market are not suitable for all Ex areas in the plant - potentially causing dangerous situations.

The Beamex MC6-Ex is an advanced, high-accuracy calibrator and communicator with outstanding functionality. It is a documenting, multifunction calibrator and communicator that offers calibration capabilities for pressure, temperature and various electrical signals. It also contains a field communicator for HART, FOUNDATION Fieldbus and Profibus PA instruments.

MC6-Ex is an IEC and ATEX certified calibrator and can be used in any Ex Zone / Division, even in the most demanding – Zone 0 / Division 1. The certification classification is Ex II 1 G and Ex ia IIC T4 Ga.

The robust, IP65-rated dust- and waterproof casing, ergonomic design, and ease-of-use make the MC6-Ex an ideal device for field use.

The MC6-Ex communicates with Beamex calibration management software, enabling fully automated and paperless calibration and documentation. The MC6-Ex can also be part of the paperless integration to the customer's own ERP system.

Other features include: internal loop supply, up to three internal pressure measurement modules and external modules, large 5.7-inch backlit color display with touchscreen and multilingual user interface, smart field-replaceable battery pack, built-in field communicator, documenting capability and a data logger functionality. Also, communication with pressure and temperature controllers is possible in a safe area.

"We are really excited to bring out the new MC6-Ex calibrator and communicator. We feel that this is the first intrinsically safe calibrator on the market without any compromises in functionality or usability", says Jan-Henrik Svensson, CEO of Beamex.

MC6-Ex sets a new standard for intrinsically safe process calibrators.

BEAMEX INTRODUCES LOGiCAL – A FREE OF CHARGE, CLOUD-BASED CALIBRATION SOFTWARE

LOGiCAL – CALIBRATIONS MADE SIMPLY, LOGICAL!

IN THE PROCESS INDUSTRY, most calibrations performed need to be documented in a calibration certificate. It is notable that many sites manually document calibrations using paper and pen, making it an inefficient process that is prone to errors.

As a solution to the industry's needs, Beamex has launched a new calibration software product called LOGiCAL.

LOGiCAL is a free of charge, cloud-based calibration certificate generation software, developed to offer an easy-to-use, modern way of documenting calibration results.

"LOGiCAL reads the calibration results from Beamex documenting calibrators, such as the Beamex MC6 or Beamex MC4, and hence does not store any critical data in the cloud. When you perform calibrations using these calibrators, they automatically store the calibration results in their memory. LOGiCAL software can read these results and convert them into a PDF calibration certificate that you can either store or print," Product Manager Antti Mäkynen describes.

The LOGiCAL cloud communicates with the calibrators using a web service technology, meaning that the calibration certificate can be generated using any device connected to the internet and a web browser, given that the calibrator is connected to the computer and running LOGiCAL. It is compatible with most browsers, such as Chrome, Internet Explorer or Safari.

"To start using LOGiCAL, all you need to do is to visit the Beamex LOGiCAL product page and navigate from there to register. After the registration, you can start using it right away. You will need to have a Beamex MC6 or Beamex MC4 calibrator with the Documenting Calibrator option to utilize LOGiCAL," Antti Mäkynen continues.

The initial use of LOGiCAL will be available at no cost while further capabilities will become available as chargeable options. Beamex is committed to developing additional functionality in LOGiCAL based on user feedback and market requirements.

"We are excited to bring LOGiCAL to the market as it delivers a very high value to customers that today use pen and paper for calibration. LOGiCAL makes it easy for everyone to take their first steps towards a streamlined calibration process since it's safe, has a small carbon OR environmental footprint and requires minimal IT support," says Jan-Henrik Svensson, CEO of Beamex Group. Beamex continues to develop its market leading CMX calibration software; an excellent choice for even the most demanding and regulated companies.

LATEST NEWS

BEAMEX GMBH APPOINTS NEW CEO

ANTONIO MATAMALA JOINS BEAMEX GMBH

■ Antonio Matamala has joined Beamex GmbH on June 1st, 2018 as CEO, after holding similar positions in the technology industry working for Dutch and German based companies. Matamala has more than 20 years of experience in the hardware and enterprise software industry, with a strong focus on IIoT (Industrial Internet of Things) solutions. With his successful business development background, Matamala will continue to develop and strengthen Beamex's market presence in Germany. "The German IIoT market, with its wide-ranging and innovative industry is one of the main Industry 4.0 (the German term for IIoT) markets in the world", Matamala says. "IIoT is shaping the sensor market as sensor data is becoming more and more important in industrial processes. The digitalization of our economy has just begun and we can expect the cyber-physical world, where sensor data is absolutely key, to emerge as a result", he adds.

According to a recent article published by Automation World (www.automationworld.com) industrial sensors account for 37% of the sensor end-market. "If you consider that by 2022, pressure and temperature sensors will account for 62% of all globally enabled IoT sensors, then it is easy to understand the crucial role that Beamex plays as an IIoT enabler."

Having worked for companies that specialize in data management and analytics of sensor data he says: "Data quality not only affects the automation of industrial processes, but reaches far beyond that, e.g. in predictive maintenance of machines based on artificial intelligence and in building the so called Digital Twin of industrial plants. This is widening the scope, penetration and therefore the importance of sensor data within companies. A large number of existing and upcoming IT companies are relying on good quality data to run their predictive models on."

Beamex has a unique value proposition as it offers seamless vertical solutions that cover the complete calibration process: from the actual calibration to software that improve and optimize work processes. Spending his whole career in information technology and automation he states: "Beamex is the perfect partner to help customers find better ways to calibrate. So, I am looking forward to meeting customers to understand their calibration processes better and work on both current challenges and be a knowledgeable partner when it comes to taking the IIoT journey".

> "Beamex is the perfect partner to help customers find **better ways to calibrate**."

In August 2017, Beamex acquired Germex GmbH incorporating Germex as its new subsidiary in Germany. The new subsidiary, named Beamex GmbH, will strengthen Beamex's presence and ensure continued high-quality customer service to Beamex's users in Germany.

SHORT BIO

- Antonio Matamala was born in Chile and grew up in the Netherlands. He has Dutch nationality and has been living in Germany for 20 years. He speaks German, Dutch, English and Spanish.
- He studied Environmental Technologies (MSc) in the Netherlands where he focused on industrial water treatment processes and information technology. He holds an MBA degree of the Open University Business School (UK).
- He has a passion for "things that work" and "have great esthetic value" at the same time.

BEAMEX LAUNCHES INTUITIVE AND POWERFUL bMOBILE 2

MULTI-PLATFORM SOLUTION FOR EXECUTING AND DOCUMENTING CALIBRATIONS AND MAINTENANCE INSPECTIONS

THE CONCEPT of a paperless calibration process is not new, yet many companies still use paper-based solutions for executing and documenting calibration events, ignoring the many improvements that a paperless solution can bring, such as efficiency and data quality improvements.

Beamex has long provided paperless calibration solutions such as CMX calibration software and Beamex documenting calibrators. bMobile 2.0 complements both the CMX software and the documenting calibrators providing a new, powerful and intuitive online and offline application for Windows Mobile or Android based tablets or smart phones.

"Today's process calibrations are often completed in areas of an industrial plant that cannot be covered by reliable WiFi IT networks – bMobile provides an ultra-modern application to empower our customers to benefit from paperless calibration and maintenance inspection in all areas of their plant," says Beamex CEO Jan-Henrik Svensson.

The Beamex bMobile application can be downloaded from Google Play or the Microsoft Store. bMobile 2.0 works with Beamex CMX Software V2.11 but can also be used for free in demo mode without CMX for anyone that wishes to evaluate it.

Outlining the significance of this new bMobile application, Beamex Product Manager Antti Mäkynen comments "Beamex customers can now choose if they use the bMobile application for calibration documentation or use our range of documenting calibrators such as the Beamex MC6 or the newly launched Beamex MC6-Ex. I expect that bMobile will be frequently used for executing calibration events that cannot easily be performed on a documenting calibrator such as: calibrating weighing instruments, and calibrating analytical instruments such as pH and humidity." Mäkynen adds, "I can also see the bMobile application being used for calibrating process instruments together with non-documenting calibrators and references from Beamex and other manufacturers."

The bMobile application also offers improved calibration data integrity using Beamex Mobile Security Plus technology – enabling our customers who select Beamex calibration software, bMobile 2.0 application, portable calibrators, and comprehensive launch and support services for their calibration solution to connect and share calibration data with their maintenance system or instrument and asset management system to achieve end-to-end paperless calibration, streamlined processes, and truly mobile working while maximizing the integrity of the data to achieve the highest levels of security compliance.

LATEST NEWS

BEAMEX RELEASES MOBILE SECURITY PLUS

ENSURES DATA INTEGRITY AND REVOLUTIONIZES CALIBRATION IN THE PHARMA INDUSTRY

■ Today's pharmaceutical industry is forced to alter its approach to calibration data integrity due to significant changes to regulation. New regulations, like those released by MHRA and FDA, will be the main focus of auditors and will have a profound effect upon companies maintaining compliance.

"A clearer regulation is a very important step towards improved data integrity and patient safety. That is why Beamex decided to gather some of the largest and most influential pharmaceutical companies in the world to give guidance in developing a new solution meeting the global needs of the industry. This solution is truly unique," proudly explains Beamex CEO, Jan-Henrik Svensson.

> "A clearer regulation is a very important step towards improved **data integrity** and **patient safety**."

Beamex has over 40 years of experience in process instrument calibration. Through the combination of calibrators and calibration software, Beamex customers experience major benefits from a paperless and automated calibration process, while significantly reducing the opportunity for human errors. With the release of Beamex Mobile Security Plus, the automated calibration process can now be completed offline using mobile devices while continuing to fulfill data integrity requirements. This new feature for mobile devices now includes user authorization and prevents any calibration data from time tampering, manual errors, false signatures, illegibility, inaccuracy and much more.

Beamex continues to lead the calibration industry with the launch of this new revolutionary solution that provides pharmaceutical companies the tools to achieve greater levels of calibration data integrity, ultimately improving patient safety.

"Our CMX Calibration Software has always fulfilled the requirements of 21 CFR Part 11 and other relevant regulations. Together CMX and the latest enhancements to our portable off-line mobile devices, essential to meet the needs of our customers, deliver today's necessary levels of data integrity," describes Beamex Product Manager Antti Mäkynen. "These mobile off-line devices include our portable documenting multifunction calibrators MC6 and MC6-Ex as well as our bMobile application for tablets and mobile phones," Mäkynen adds.

Many Beamex customers have selected Beamex calibration software, portable calibrators, and comprehensive launch and support services for their enterprise-wide solution. Calibration data has been connected and shared with their globally deployed ERP, maintenance system or instrument and asset management system to achieve end-to-end paperless calibration, streamlined processes, and truly mobile working while ensuring integrity of the data and regulatory compliance.

SHAPING THE FUTURE –4th ANNUAL PHARMA USER GROUP MEETING

Participating in this year's UGM were around 20 people from different pharmaceutical companies.

As in previous years, the biggest expectation was to be able to share **best calibration practices** and real-life cases within the group.

■ Since 2015, Beamex has arranged annual User Group Meetings for their users in the pharmaceutical industry. In April 2018, the 4th Annual Pharma User Group Meeting was arranged in Basel, Switzerland. This year's meeting was hosted by Novartis Pharma AG.

To ensure that the participants got the most out of the meeting, the agenda for the two-day event was decided together with the participants. As in previous years, the biggest expectation was to be able to share best calibration practices and real-life cases within the group. Sharing practical knowledge and experiences has proven to be the most valuable part for the participants at these User Group Meetings.

Another hot topic at the meeting was the future of the pharmaceutical industry and how Beamex is able to help pharmaceutical companies meet the needs and demands put upon them. The development of Beamex's Integrated calibration solutions and cloud-based calibration software, as well as the utilization of smart multifunctional, mobile devices, are areas that the participants considered to be especially valuable for the pharmaceutical industry.

Beamex's latest addition to its product portfolio, Mobile Security Plus, is developed specifically for the pharmaceutical industry to help companies meet changes in regulations that concern data integrity requirements. The new functionality was said to be a "game changer for the industry" by one of the participants at the meeting.

The close and straightforward relationship between Beamex and the pharma group resulted in many interesting discussions during the two days, discussions that were fruitful for all parties and helped strengthen the cooperation. Another outcome of the close relationship, is that the whole group expressed a motivation to continue developing new calibration solutions, together with Beamex, that will benefit the pharmaceutical industry in the future.

Participating in this year's UGM were around 20 people from different pharmaceutical companies. Boehringer Ingelheim, Astellas, GlaxoSmithKline and Lonza are a few of the companies that were represented at the meeting.

Where the next meeting will take place is yet to be decided, but both Beamex and the pharma group look forward to another meeting that will help bring the future of Beamex and the future of the pharmaceutical industry closer together.

BEAMEX IN BRIEF

BEAMEX IS A LEADING worldwide provider of calibration solutions that meet even the most demanding requirements of process instrumentation. Beamex offers a comprehensive range of products and services – from portable calibrators to workstations, calibration accessories, calibration software, industry-specific solutions and professional services. Through Beamex's partner network, our products and services are available in more than 80 countries.

Learn more about Beamex calibration solutions
www.beamex.com

Find your local Beamex sales office
www.beamex.com/contacts

Interested in submitting an article to Calibration World?
Contact: henrika.granholm@beamex.com

PRODUCTS AND SERVICES

Portable calibrators

Beamex's range of portable MC calibrators for field calibration is known for accuracy, versatility and meeting both high and uncompromised quality standards.

- MC6 advanced field calibrator and communicator
- MC6-Ex intrinsically safe multifunction calibrator
- MC2 series
- MC4 documenting process calibrator
- FB/MB temperature dry blocks
- POC8 automatic pressure controller

Workstations

A workstation can be considered ideal when most of the maintenance and calibration tasks are performed in the workshop.

- MCS200 calibration workstation
- MC6 Workstation

Accessories

Beamex's calibration accessories complete your investment in calibration equipment.

- External pressure modules
- Calibration hand-pumps
- Spare parts

Calibration software

Plan, manage and document all your calibrations efficiently and safely using Beamex's calibration software.

- CMX Light
- CMX Professional
- CMX Enterprise

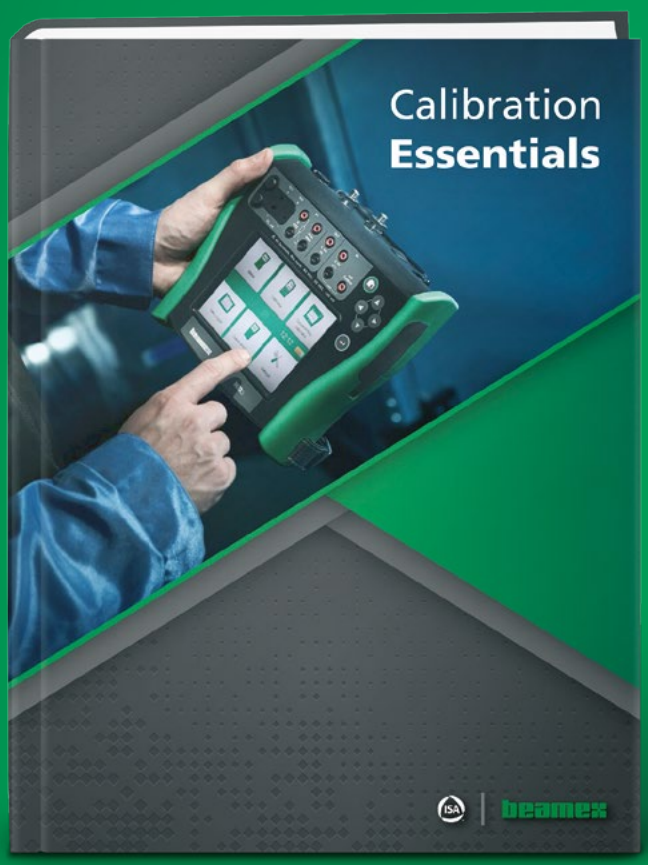
Professional services

An essential part of a complete calibration solution is professional services – service and re-calibration, installation and training, software support, validation services and integration services.

- Re-calibration and service
- Installation and training
- Software service agreement (SSA)
- Validation services (pharmaceutical industry)
- Integration services

Calibration Essentials is an informative eBook brought to you by ISA and Beamex.

In 60 detailed pages, it provides vital information about calibrating process instruments today



Calibration Essentials contains guidelines, practice scenarios and how to manage them, and much more. Topics include:

- Comprehensive guide on how to manage a facility-wide calibration program
- Overviews of calibration considerations, such as tolerance errors, and calibrat ion uncertainty
- An in-depth look at some of the new smart instrumentation and WirelessHART instruments and how to effectively calibrate them
- Pros and cons of anindividual instrument calibration strategy versus a loop calibration strategy
- Detailed guidelines to ensure facility and employee safety and security, as well as compliance with standards

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info@beamex.com

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