VAISALA

Spot-checking and calibration with handheld devices

eGuide

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Table of contents

Anything worth measuring is worth measuring right

In today's knowledge-centric world we want to understand and control things based on real data, and measurement has a key role to play in helping us to gather this data. However, it is only part of the story. The data gathered by the measurement equipment we use must be reliable and accurate.

The purpose of this eGuide is to provide practical advice and tips that will help readers to ensure that their handheld measuring devices provide high-quality, accurate measurements to support their activities.

Handheld measuring devices are typically used for measuring environmental or process conditions directly, or as reference instruments for spot-checking or calibrating a fixed instrument in the field. In this guide we discuss the rationale behind device calibration and the factors that affect the need to calibrate. The guide also provides some more detailed information on the calibration and spot-checking of relative humidity, dew point temperature, carbon dioxide, temperature, and moisture in oil measurements.

Gather the data you need to make informed decisions

A lack of data and poor-quality data are the biggest hurdles to overcome. Without accurate data, processes cannot be properly controlled, and end-product quality suffers as a result. Trusting the measurement reading of an uncalibrated instrument can have unintended consequences, the root cause of which can be hard to determine. A handheld instrument is a perfect tool to address these challenges.

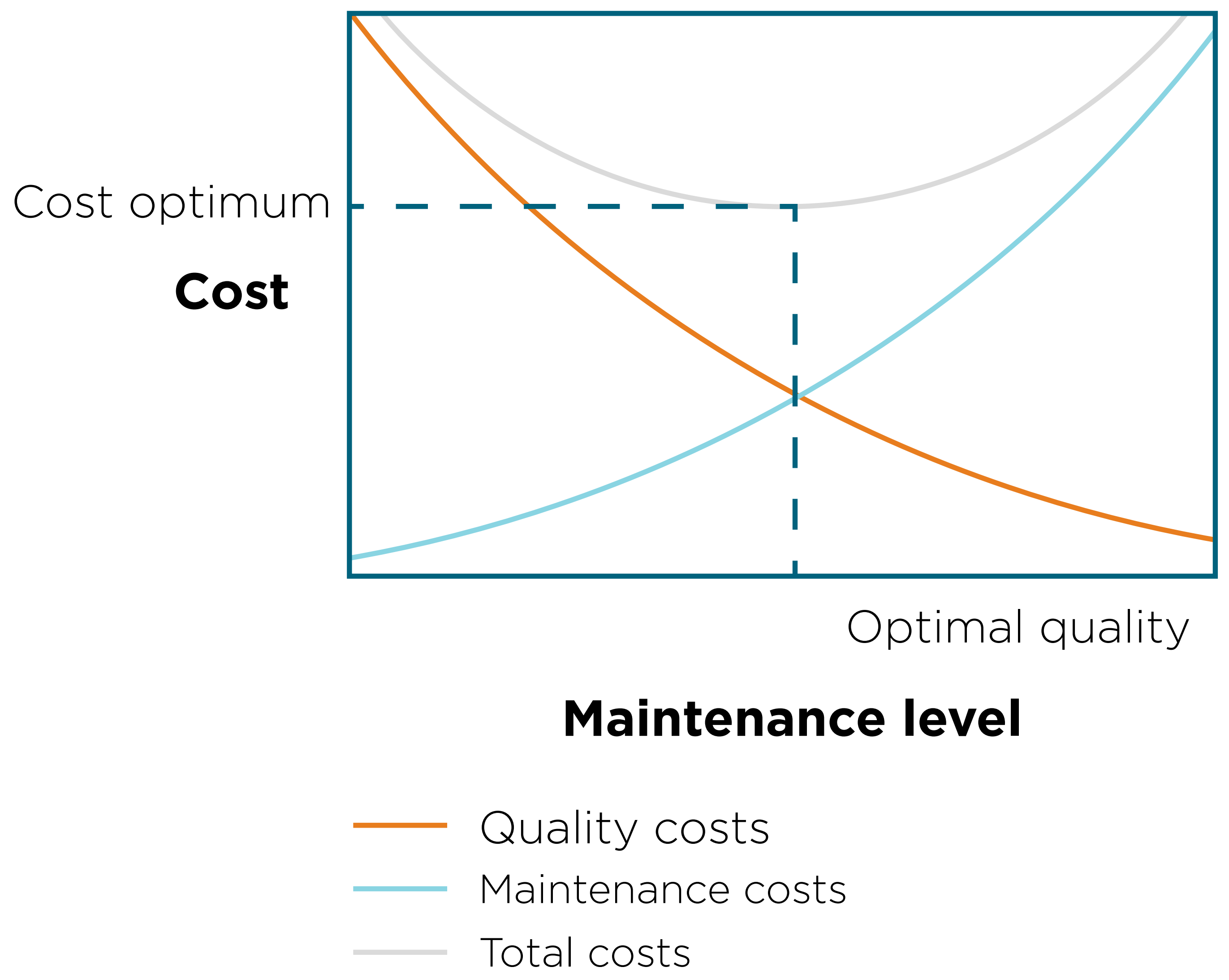
With a handheld device you can easily take measurements at different points in the process or environment. In applications where conditions are variable, gaining better control over the conditions is the key to optimizing quality and saving energy. A handheld device with data-logging capability will help you to better understand your process and how to control it, and will also reveal the minimum, maximum, and average conditions for the parameters you are interested in measuring. This kind of information is extremely valuable when making investment decisions relating to instrumentation and process control for your application.

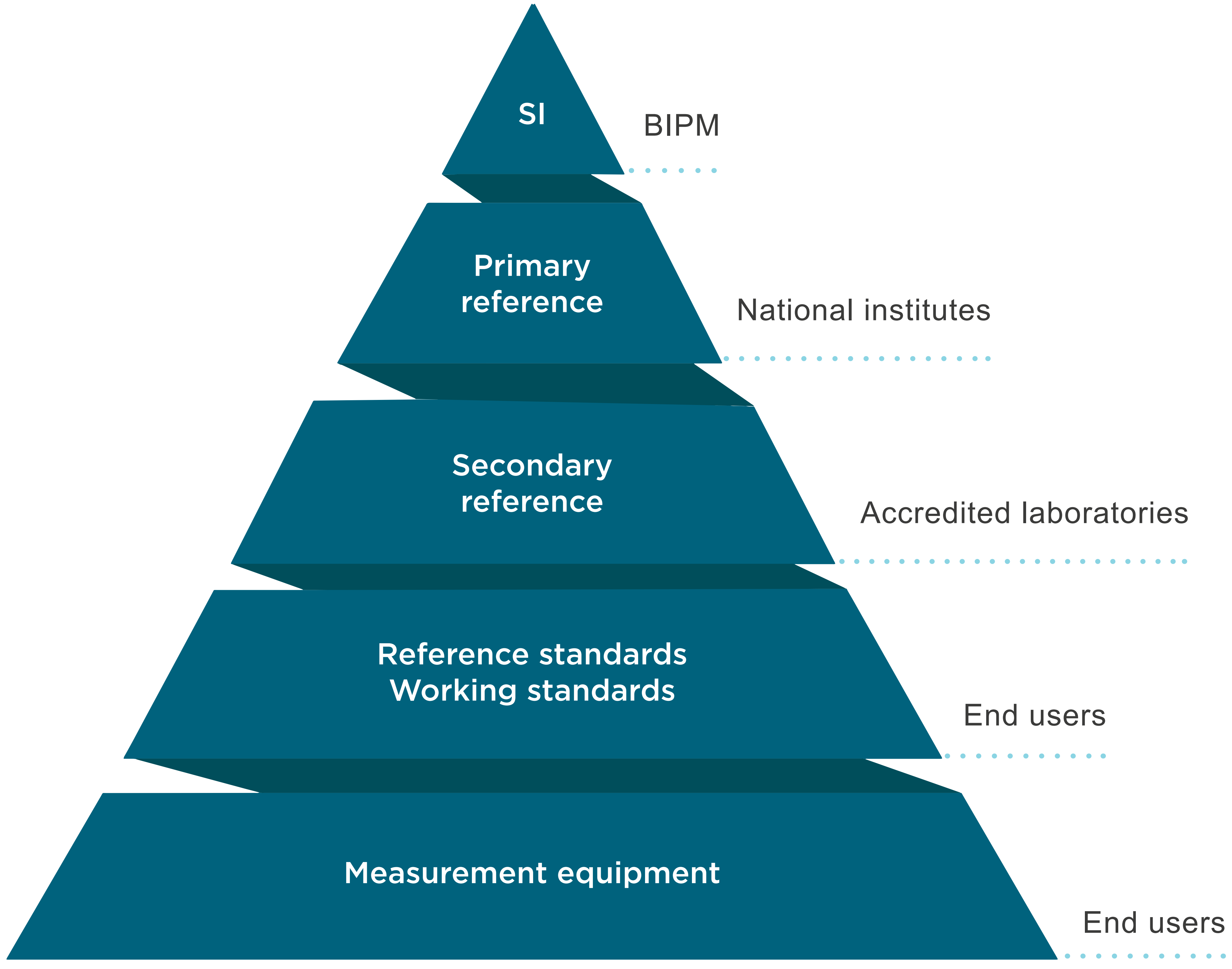
In the initial decision-making stages, a handheld device is a valuable tool for troubleshooting and identifying where the gaps are. In the later stages it can be used to gather information to support continuous process improvement, and as a reference instrument when calibrating fixed instrumentation.

Balancing quality and usability

Your goal should be to identify the optimal way to calibrate your measurement devices according to your application. Although larger and more expensive equipment will provide the highest possible calibration accuracy, it might be impractical and unnecessary for some use cases and locations. Depending on your application, portable reference devices might be the optimal choice for field calibration.

Optimization of cost and quality





Traceability chain

To find the right balance between quality and usability, you need to determine the level of accuracy and uncertainty needed in your application. In some cases, it's justified to use a fixed instrument in continuous operation, meaning that laboratory calibration may not be an option. A handheld device with an accredited calibration may be sufficient to ensure traceability in the field with acceptable uncertainty.

Field calibration

With field calibration you can quickly and easily calibrate an instrument in situ, without having to remove it from the process or premises. This avoids the labor, downtime, and costs associated with removing and reinstalling an instrument.

Equipment required for field calibration

Field calibration requires a working standard as a reference, which can be a handheld device or other type of equipment. The working standard should ideally be used for calibration, not for monitoring the process in question. Care should be taken when handling the working standard, and it should be stored under the correct conditions to ensure it remains functional and accurate. A calibrator can also be used in the field to perform a multi-point calibration. Some calibrators can be used as standalone reference standards, meaning there is no need for a separate working standard. Working standards are generally calibrated at a higher confidence level in a laboratory.

Laboratory vs. field calibration

Laboratory calibration is the most accurate method of calibrating measurement equipment. It offers lower uncertainties than field calibration, environmental effects are minimal, and the number of factors that can influence the calibration process is significantly reduced. Field calibration provides the opportunity to perform rapid checks and diagnostics without the need to remove measurement equipment.

The pros and cons of field calibration

+ No need to remove and reinstall measurement equipment
+ No process downtime
+ Calibration performed under real process conditions
− Higher uncertainty compared to laboratory calibration
− Changing process conditions may be a challenge

Single-point or multi-point field calibration?

Handheld devices are especially good for quick pass/fail checks, but with a bit of extra care and attention, they can also be used to perform single-point calibration and adjustments in the field.

In single-point calibration, the calibration is performed at one point against the working standard by placing the reference instrument as close to the unit under calibration (UUC) as possible. It is important to allow sufficient stabilization time so that there is a temperature equilibrium between the working standard and the UUC. Other factors that could influence the calibration results also need to be considered, including:

- the proximity of the working standard to the UUC
- temperature gradients
- air flow
- pressure differences

The pros and cons of single-point field calibration

Single-point calibration is an effective way to maintain a sensor's performance in applications where the operating conditions do not vary greatly. Sensors that operate at a stable temperature, humidity, pressure, and so on are ideal candidates for single-point field calibration.

Field calibrations with the instrument installed in the process limit the calibration curve to a single point. In processes where conditions vary, single-point calibration limits the curve over a small portion of the operating conditions.

Multi-point field calibration

It is possible to perform multi-point calibrations in the field by using a working standard capable of reproducing various conditions. The difference between single-point and multi-point field calibration is that the UUC must be removed from the process. The time saved performing multi-point calibration in the field compared to in a laboratory can be significant; however, it comes at the cost of increased uncertainty due the uncontrollable factors often present in the field.

Spot-checking

Why spot-check in the field?

Field spot-checking is a quick and easy way to determine the process conditions or status of a fixed measurement instrument. Spot-checking should not be confused with field calibration. They are very similar in that a reference is placed close to the sensor being checked and the readings are compared to that of the installed instrument. Spot-checking is a less time-consuming process because stabilization time is not as crucial as it is in field calibration.

Spot-checking is a good way to enhance your measurement equipment maintenance processes. For example, if a unit is calibrated annually in a laboratory, it could be subject to spot-checking every three months. Guidelines should be defined before starting to spot-check instruments and there should be pre-established limits to determine potential actions to take on the basis of the results.

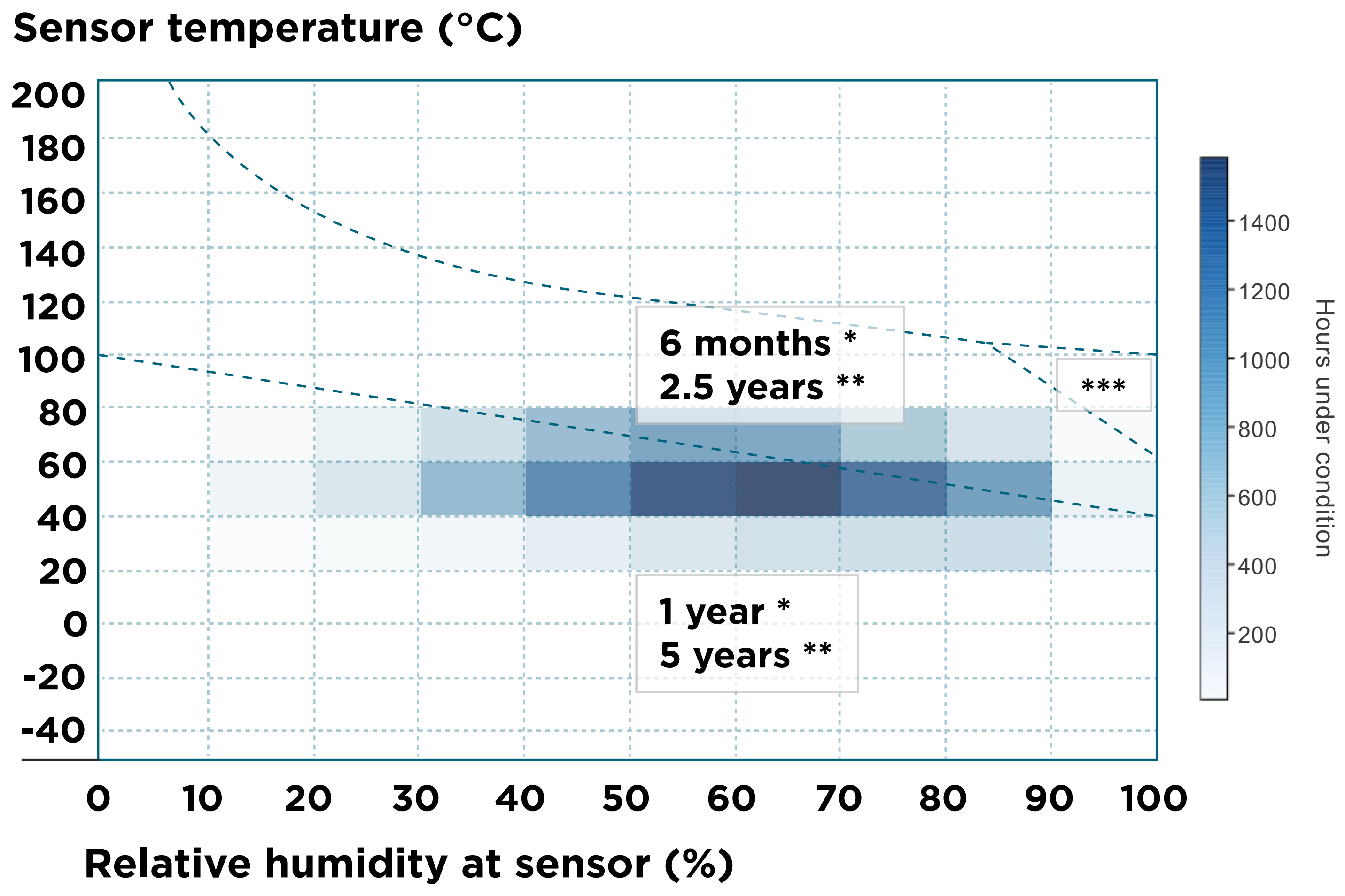
Read more >

The pros and cons of spot-checking

- + Quick and easy measurement from the point of interest
- + Helps to determine the optimal calibration interval
- + Provides better visibility over the health of measurement instruments
- + Improves the proof of measurement quality
- – Requires proper planning, expertise, and record keeping

Determining the field calibration interval

The decision on the calibration interval must always be made by the end user; however, there are some general guidelines to help you.
While the manufacturer's recommendation is a good place to start, the measurement conditions of the application in question must also be considered. Good practice is to start with frequent calibration and optimize the interval as you go along. A handheld device provides a quick and easy want to gather the data you need.



* +/- 1...2 %RH accuracy requirement
** +/- 3...5 %RH accuracy requirement
*** HMP7 with probe warming recommended

Graph right: Example of a calibration recommendation for a humidity instrument. The darkness of the blue color indicates the length of time spent in the corresponding condition.

Optimizing the field calibration interval

After multiple calibrations have been performed, a calibration interval can be determined. The interval can be extended when at least three calibrations have been performed in a 12-month period and the unit has remained within specifications. The calibration interval should not be extended over the manufacturer's recommendations for critical equipment.

The calibration interval can also be extended if the equipment being calibrated is used with other, more stable measurement equipment, or if the application allows lower accuracy than stated in the manufacturer's specifications for the normal calibration interval.

Top tip! You can use the same calibration interval guidelines for both fixed and handheld devices.

Unnecessary adjustments may add noise to your measurements

It is important to understand calibration uncertainty when deciding whether or not to make adjustments to your measurement equipment. To do this, it is necessary to clarify the difference between calibration and adjustment. Calibration means comparing the instrument reading with a reference. Adjustment is correcting the instrument to minimize deviation from the calibration reference.

The amount of calibration uncertainty varies depending on multiple factors, including temperature differences, the thermal mass of the instrument, and the measurement technology used. It can often be so that the readings from the reference and the UUC are both within the uncertainty band and there is no way to determine which reading is the most accurate.

Accuracy error comes in many flavors, and often it is hard to differentiate between systematic and random error. For this reason it may not be wise to make small adjustments, because you may end up adjusting the random error and adding noise to your measurements as a result.

Practical tips for taking accurate measurements with handheld meters

HUMIDITY

Relative humidity is an important parameter for human and animal comfort. Controlling relative humidity is also a vital part of climate control in a wide variety of applications in the process and storage industries.

Using a handheld meter to measure humidity and temperature provides valuable information about the conditions in the surrounding environment. Measurements are performed to collect basic information about the environmental conditions, to check the operation and calibration of fixed humidity instruments, and to verify the operation of humidifying and/or dehumidifying equipment.

The key to performing successful environmental measurements starts with the selection of a measurement spot that is representative of the surrounding environmental conditions. After selecting an optimal measurement location, the humidity reading should be allowed to stabilize before taking the measurement.

This is best done by following the stabilization of the humidity reading on the graphical display of the humidity meter. Alternatively, the humidity meter can be left to stabilize in the measurement environment and the reading can be checked after a sufficiently long stabilization period – the larger the temperature difference between the probe and the measurement environment, the longer the stabilization time required.

When performing a humidity measurement, it is good to remember that the measurement is highly temperature dependent. For example, in conditions of 50 %RH (relative humidity), a 1 °C (1.8 °F) change in temperature changes the humidity reading by 3 %RH. In environmental conditions of 50 %RH and 20 °C (68 °F), a 3 °C (5.4 °F) rise in temperature (to 23 °C/73.4 °F) causes the humidity reading to drop to 41.6 %RH. Avoiding non-representative temperature variations is therefore essential if an accurate humidity measurement is to be obtained.

Do's and don'ts – measuring humidity with handheld meters

- The measurement location should be representative of the conditions in the measurement environment. Also, be sure to get close enough to the device being checked to mitigate the impact of temperature gradients.
- Make sure that humidity sensors are not installed close to sources of heat or moisture. Avoid locations close to the discharge of supply air ducts, near exterior doors and windows, and inside walls that are exposed to solar radiation. Ensure that air flows freely around the humidity sensor.
- Some wall-mounted sensors give off a lot of heat, so be sure to take the measurement from below the sensor.
- Avoid heating the handheld sensor with your hand, and avoid breathing on the sensor and the device you are checking.
- Allow enough time for the temperature to stabilize. Remember that a 1 °C (1.8 °F) temperature difference can mean a 6 %RH difference. Graphical displays are a good way to follow stabilization.
- Avoid situations where water might condense on the probe – a humidity sensor will not operate correctly when wet.

How to choose the right instrument for measuring humidity and dew point? Read our application note to learn more.

Read more >

Some things to consider before taking measurements

- Ensure that the environmental settings of your handheld meter are correct.
- If your probe includes a chemical purge option, remember to use it regularly to keep the probe free from contamination.
- If there is a risk of condensation, use the preheat function when installing the probe, if available.
- For duct sensors it is good to plan for field checking in advance. During installation make a second sealed hole next to the duct sensor to insert a handheld probe future calibration.

Better results from regular maintenance

A reliable humidity meter provides valuable support when making decisions about equipment investments or maintenance. In order to ensure reliable measurements, it is essential to carry out regular instrument maintenance, including calibration and filter replacement. Vaisala recommends a one-year calibration interval for all its humidity meters.

Calibration can be performed on site with a handheld humidity meter or combined with the Vaisala HMK15 Salt Calibration Kit for multi-point calibrations. Alternatively, the instrument can be sent to a local Vaisala Service Center for calibration. Vaisala recommends a one-year calibration interval for their handheld humidity meters.

Some Vaisala handheld meters incorporate exchangeable measurement probes. These probes can be swapped with new factory-calibrated probes for convenience.

In addition to regular calibration, maintaining the sensor's protective filter is also critical to ensure accurate humidity measurements. If the filter gets dirty, there is a risk of inadequate gas exchange between the sensor and the surrounding environment. This creates a microclimate around the sensor that is independent of the surrounding humidity conditions. A quick filter change is enough to fix this problem. To avoid damage when changing the filter, the sensor element should not be touched.

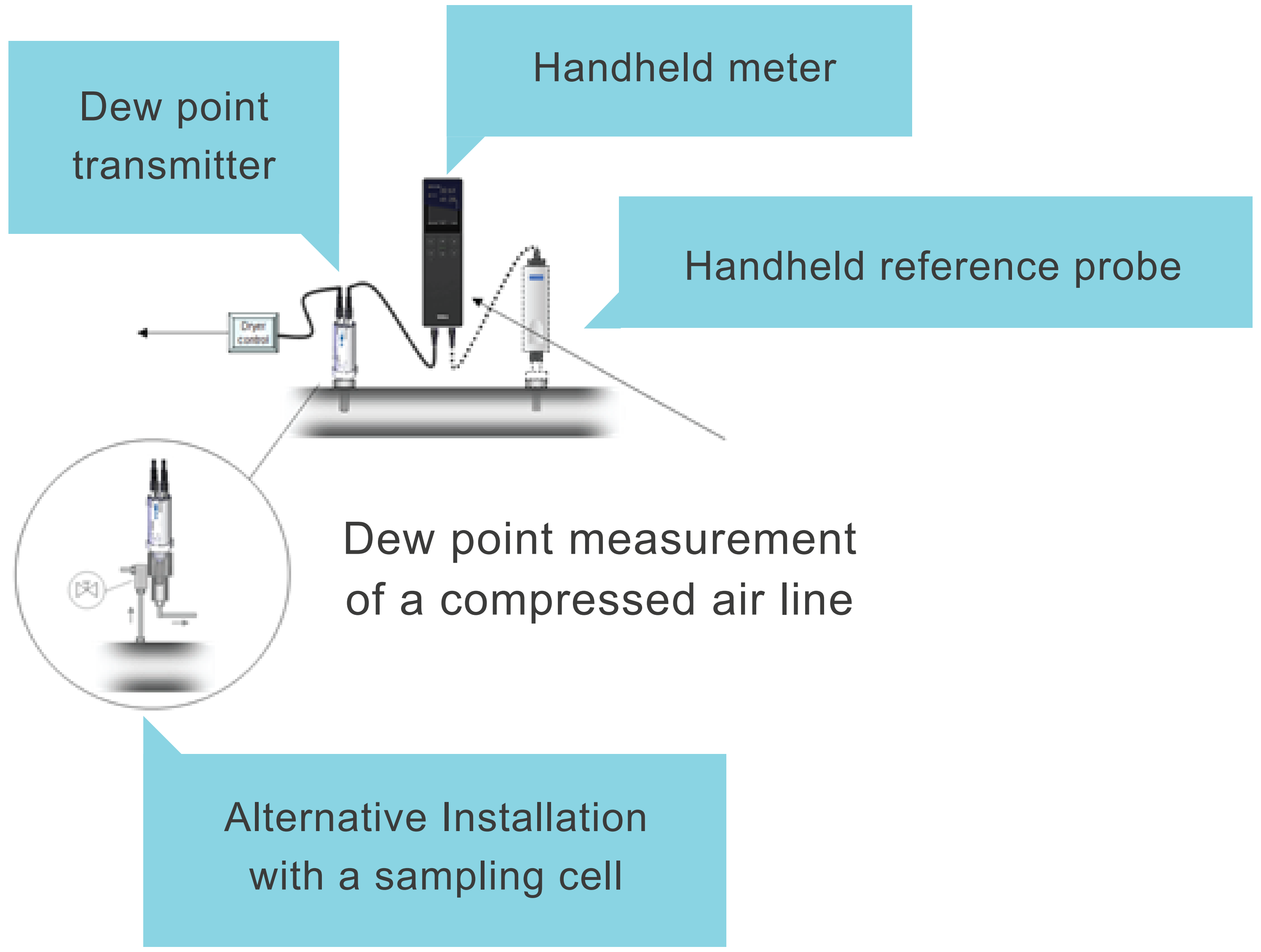
Practical tips for taking accurate measurements with handheld meters

DEW POINT

Increasing the pressure of a gas increases its dew point temperature. Consider an example of air at atmospheric pressure of 1013.3 mbar with a dew point temperature of -10 °C (14 °F). If the pressure of water vapor is 2.8 mbar and the air is compressed and the total pressure doubled to 2026.6 mbar, then according to Dalton’s law, the partial pressure of water vapor, e, is also doubled to 5.6 mbar. The dew point temperature corresponding to 5.6 mbar is approximately -1 °C (30 °F), so it is clear that increasing the pressure of the air has also increased the dew point temperature of the air.

Conversely, expanding a compressed gas to atmospheric pressure decreases the partial pressures of all of the component gases, including water vapor, and therefore decreases the dew point temperature of the gas. The relationship of total pressure to the partial pressure of water vapor, e, can be expressed as follows: $P1 / P2 = e1 / e2$. By converting dew point temperature to the corresponding saturation vapor pressure, it is easy to calculate the effect of changing total pressure on the saturation vapor pressure. The new saturation vapor pressure value can then be converted back to the corresponding dew point temperature. These calculations can be done using Vaisala’s online calculator.

Use the calculator >



Sample cell hardware, such as quick connect fittings, a cooling coil, and welded compression fitting makes it easy to install a dew point sensor in any process.

Do’s and don’ts – measuring dew point with handheld meters

A dew point sensor should be installed so that it can be isolated from the compressed air line. This is accomplished by isolating the port using a shut-off valve, or by connecting a sample cell to a “T” in the compressed air line at the point of interest. Within the sample cell, a small amount of compressed air is then bled past the sensor. The cell should be made of stainless steel and connected to the “T” with tubing (1/4" or 6 mm). Installing an isolation valve between the cell and the air line ensures that the sensor can be installed and removed easily.

Due to the very low level of humidity typically found in compressed air and gas systems, dew point measurements are highly sensitive to even the smallest leaks in the system. Consequently a leak-tight sampling system is critical, with all connections tight and sealed correctly. For tapered threads like NPT, the use of Teflon tape is recommended. For straight thread connections such as G 1/2", the sealing washer provided with the instrument should be installed between the probe and the sampling cell. Careful consideration should always be given to what the sampling system is made of, since water vapor diffusion through the pipe or tubing walls can occur. The piping should preferably be made of metal, e.g. stainless steel with a good surface finish. Hygroscopic materials such as rubber hose and plastics are undesirable and should be avoided. PTFE or Teflon is one exception as it is a rather vapor-tight plastic and can be used down to a dew point level of about – 40 °C (-40 °F). Sample tubing should be as short in length as possible and “dead ends” should be avoided. Minimizing the number of connections also helps to prevent leaks. A regulating device such as a leak screw or valve is necessary to control the airflow past the sensor; a minimum flow rate of 1–2 liter/min (0.035–0.7 ft3/min) is recommended. To measure the pressure dew point, the regulating device should be installed downstream of the sensor so that when the isolation valve is opened, the sensor is at the process pressure. To measure dew point at atmospheric pressure, the regulating device should be installed upstream of the dew point sensor.

Sampling in still air should be avoided, however low air flow is okay. Do not exceed the recommended flow rate either. When measuring the pressure dew point, a flow rate that is too high will create a local pressure drop around the sensor. Because dew point temperature is pressure sensitive, this will result in inaccurate measurement.

When the process gas temperature exceeds the operating temperature limit of the dew point sensor, sampling is required. To avoid condensation, the dew point must be below the ambient temperature in the sampling line. This prevents water vapor in the sample from reaching saturation and liquid water forming in the sample line. Vaisala dew point products can withstand exposure to condensation.

It is important to keep in mind that changing the gas pressure changes the dew point temperature of the gas. If the sensor is at a different pressure than the process itself, an error of several tens of degrees dew point may be apparent. The measurement should typically be made at the actual system pressure in order to avoid pressure drops in the sampling system. Otherwise, compensation values should be factored into the reading.

It is possible to reduce installation costs for permanent dew point measurement instruments by installing the sensor directly in the compressed air line. In these cases it is important to choose a location where there is adequate airflow around the sensor.

How is dew point in compressed air reliably measured?

Some principles of dew point measurement apply to all types of instruments, regardless of manufacturer:

- Select an instrument with the correct measurement range. Some instruments are suitable for measuring high dew points but not low dew points. Similarly, some instruments are suitable for very low dew points but are compromised when exposed to high dew points.

- Understand the pressure characteristics of the dew point instrument. Some instruments are not suitable for use at process pressure. They can be installed to measure compressed air after it is expanded to atmospheric pressure, but the measured dew point value will have to be corrected if the pressure dew point is the desired measurement parameter.

- Install the sensor correctly, following the manufacturer's instructions. Do not install dew point sensors at the end of stubs or other "dead end" pieces of pipe where there is no airflow.

- Vaisala manufactures a family of instruments that are ideal for measuring dew point temperature in compressed and ambient air. Vaisala's DRYCAP® sensor technology provides fast dew point measurements from ambient levels down to -80 °C (-112 °F).

How often should a dew point sensor be checked or calibrated?

Vaisala suggests a one or two-year calibration interval, depending on the instrument and the application. Sometimes a simple field check against a calibrated portable instrument is sufficient to verify correct operation of other instruments. Vaisala provides detailed calibration information in the user guide for each instrument. If you have any doubts about the performance of your dew point instruments, it is wise to check their calibration.

Read more about Vaisala calibration services

Practical tips for taking accurate measurements with handheld meters in HVAC applications

CARBON DIOXIDE

Carbon dioxide is a good indicator of indoor air quality. The typical atmospheric CO_2 level is around 400 ppm, but in confined spaces the concentration will vary according to ventilation and occupancy. Too much ventilation wastes energy, while too little means that the indoor air quality will suffer. To find the right balance, it is important to measure the CO_2 level of indoor air and use this information as an input for a controlled ventilation system (demand-controlled ventilation) that adapts to the changing occupancy level of the indoor space. As our breathing is the main source of elevated CO_2 levels in buildings, it can also be used as an indirect indicator of other air quality factors such as airborne viruses.

A handheld CO_2 instrument is a powerful tool for diagnosing the health of indoor air. It can be used to spot-check CO_2 levels in different locations, to determine the optimal locations for fixed CO_2 instruments, and to calibrate these fixed sensors.

A typical challenge when deciding on the location for fixed CO_2 instruments is aesthetics. Building designers usually avoid placing instruments at eye level. Instead, these instruments are often installed higher up on walls close to exhaust air valves. In this case, a handheld device can be used to reveal if the fixed instrument is providing a representative reading from the environment.

A fixed instrument that is installed near an exhaust air valve should be calibrated by placing the hand-held reference probe close to the UUC. The readings should be allowed to stabilize. Remember to keep your distance from both devices – depending on the air flow, your breath may be one of the biggest uncertainty sources.

When the fixed instrument is calibrated, it's equally important to assess the impact of the installation location. Check that it is providing measurements that are representative of the level where people breathe. The best way to do this is to perform spot checks at various building occupancy levels.

Practical tips to help you take high-quality CO_2 measurements with handheld meters

- Calibration against a freshly calibrated handheld device gives the most accurate results
- By adding additional probes, you can simultaneously check humidity and temperature with the additional meter
- Give yourself enough time to perform the calibration
- Perform the calibration in a stable environment
- Take a note of the temperature and pressure settings, and compensate for these if possible
- In environments such as incubators or other confined spaces, it may be more convenient to draw a sample and measure it with a sampling system

How to measure carbon dioxide? Read our application note to learn more.

Read more

When to calibrate / check?

The time between calibration/checking is determined by your target accuracy and your quality system. For environments such as office buildings and schools, a five-year interval is typically sufficient. For a lab with a rigorous quality system, annual calibration might be mandatory.

MOISTURE-IN-OIL

Water contamination in lubricating and insulating oils deteriorate performance, and the oil's ability to protect equipment from corrosion and damage. On-line monitoring of moisture-in-oil is an important step in avoiding costly failures and unscheduled downtime.

Water activity vs. ppm

Water activity (aw) indicates the moisture (water) content in a fluid on a scale of 0…1 (0 being completely dry, 1 being completely saturated). This is directly proportional to relative saturation (%RS), which uses the familiar 0...100% scale.

Just like air, every fluid (such as lubricating oil, hydraulic fluid, or jet fuel) can hold water in its dissolved state when it is below the saturation point. Once the saturation point of that fluid has been reached, any additional water that enters the fluid will separate out into "free water" which can be seen as a distinct layer – usually below the oil.

The saturation point of most fluids is affected not only by the base oil type, additives, emulsifiers, and antioxidants, but also by the fluid's age and temperature, as well as the chemical reactions that take place over the life of the fluid. Water activity, or relative saturation, will always indicate how close a fluid is to reaching its saturation point.

PPM can give you the same indication provided that the saturation point of the fluid is known and remains constant.

For example, take a new oil with a temperature of 90 °C (194 °F), an absolute water content of 500 ppm, and a saturation point of 1000 ppm. This oil can hold another 500 ppm before it becomes saturated. After six months of use the same oil with a temperature of 35 °C (95 °F) still has an absolute water content of 500 ppm but a saturation point of 550 ppm. This oil can only hold another 50 ppm before it becomes saturated.

Things to consider when taking moisture-in-oil measurements with a handheld meter

The probe should be installed in a location that provides a representative sample of your entire oil system (e.g., a high flow feed line or return line to the reservoir). The sensor can only read what it is directly in contact with. Install the probe directly into the circulation system and not into the oil reservoir. Locations to avoid include the bottom of oil reservoirs, where free water may settle out, and areas where air bubbles could form due to turbulence caused by pumps or agitators.

The ball valve installation is preferable when connecting the handheld probe to a pressurized process or pipeline. When the ball valve assembly is used, the pipe does not have to be emptied or shut down to install or remove the probe. Install the sensor head transversely against the direction of the process flow and avoid installing into a bend in the pipe.

Oil should circulate freely around the sensor; a rapid oil flow is recommended. The flow limitation of the sensor is affected by the shear force applied by a high flow oil with significant viscosity. If high enough, this force could bend or damage the sensor contacts. We recommend a maximum linear flow rate of 1 m/second (3.3 fps).

Water activity and relative saturation readings can directly indicate whether there is a risk of free water formation. The measurement is independent of oil type, age, or temperature. You do not need to program or calibrate your sensor according to each specific fluid. Vaisala sensors are delivered with a ISO9001 traceable calibration certificate. Since the sensor measures moisture content based on an absorption principle, it does not need to know the saturation point of the fluid. The sensor simply absorbs or releases water to establish equilibrium with the surrounding oil/water solution.

Vaisala sensors have an embedded model for expressing moisture as ppm in mineral transformer oil. For additional accuracy, the oil-specific calculation model can be used both for mineral and silicon-based oils.

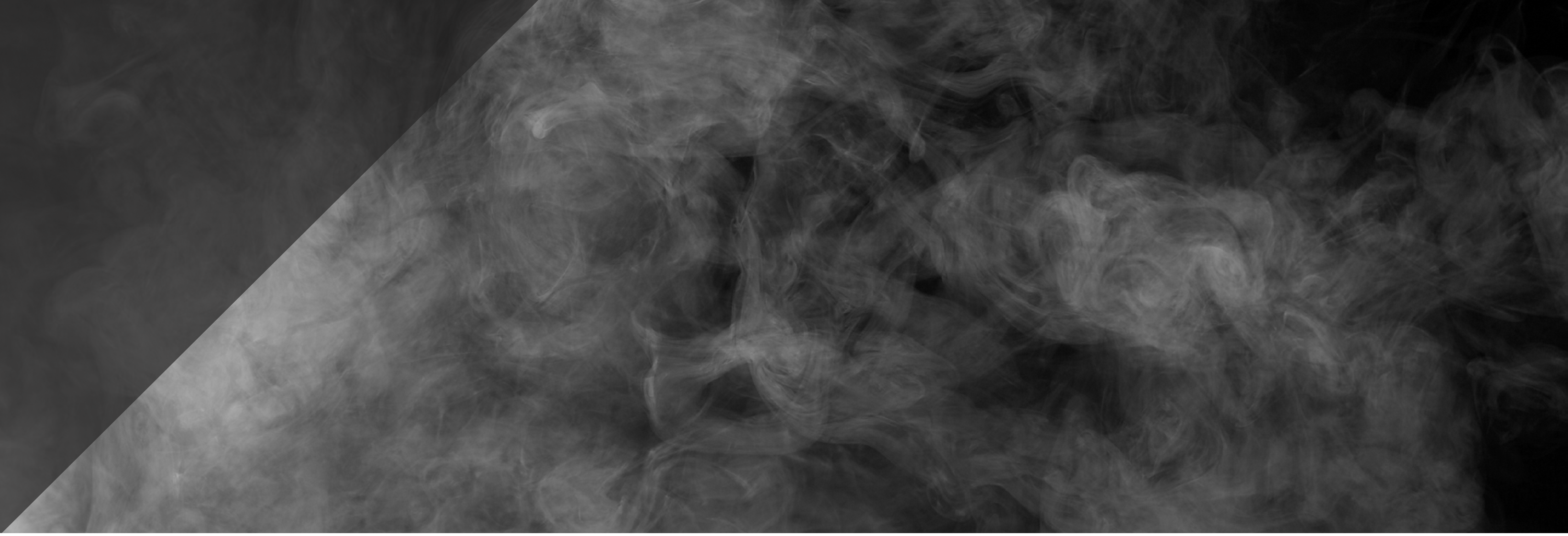
Vaisala moisture-in-oil transmitters have a proven track record in transformer oil, lubricating oil, and hydraulic fluid applications. They have also been used to measure moisture content in jet fuel and phosphate ester fluids.

How often should a moisture-in-oil sensor be checked or calibrated?

Vaisala sensors are fully calibrated when shipped from the factory. Adjustment should be carried out if there is a reason to believe that the device is not within the accuracy specifications. The recommended calibration interval is one year.

Do you want to know more about the calibration? Contact our experts for more information

Contact us >



Vaporized H_2O_2

Hydrogen peroxide vapor is an effective bio-decontamination method in many applications.

Vaisala's PEROXCAP® sensor technology is based on two HUMICAP® humidity sensors, one with and one without a catalytic layer. While the sensor without a catalytic layer senses the air mixture with both hydrogen peroxide vapor and water vapor, the sensor with a catalytic layer removes the H_2O_2 vapor. The HPP270 series probe technology calculates the difference between the measurements to provide accurate data on bio-decontamination cycle conditions.

The Indigo80 handheld indicator with the HPP272 probe is an excellent combination for bio-decontamination cycle development and validation. The dual probe capability of Indigo80 enables easy comparisons between two instruments simultaneously, ideal for performing on-site calibrations. In addition, data logging with Indigo80 is a convenient way to record the footprint of bio-decontamination processes and to check on seasonal effects to process conditions.

On-site calibration is easy to perform for the HPP270 series probes with any humidity chamber, or with Vaisala's HMK15 calibration kit. The HPP270 probes can also be connected to an Indigo host device, such as the Indigo80 handheld meter, for spot-checking and calibration. A freshly calibrated HPP270 series probe can also be used as a reference device during on-site calibration if stable conditions are available.

With Vaisala's Insight PC software, the functionality of the probes can be checked with the "Sensor Vitality". The sensor vitality function allows you to perform sensor diagnostics and view information on the HPP270 probes. A new HPP270 probe sensor will have a sensor vitality of 100 % and a sensor at the end of its life cycle will have a sensor vitality of 0 %.

We recommend replacing HPP270 series probes when the sensor vitality value reaches ≤ 40%. With Vaisala's factory calibration, you ensure the measurement performance of the HPP270 probe and the efficacy of your vH_2O_2 bio-decontamination processes.

Read more >

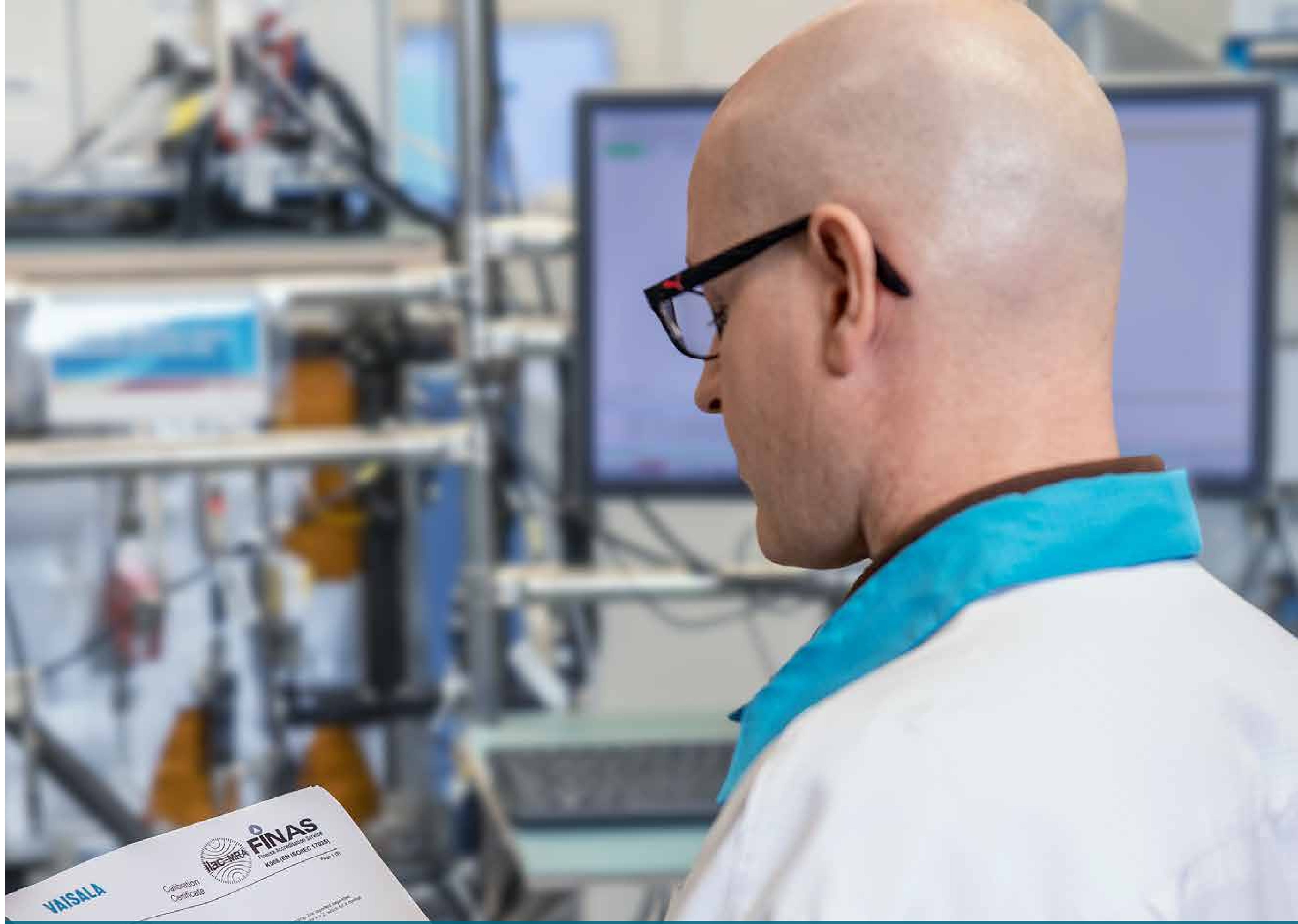
Calibration and repair

Regular calibration of all measurement instruments is essential to ensure accuracy. We recommend sending your instruments to the original manufacturer for calibration whenever possible, especially handheld reference meters.

As a manufacturer, Vaisala offers a wide range of high-quality calibration and repair services that meet the strictest quality standards.

All our calibrations include:

- Functional testing
- Traceable calibration
- Instrument adjustment as needed
- Filter replacement as needed
- Calibration certificate and service report
- Calibration due-date update



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Customer stories

Humidity
Discover how Ms. Kikuko Iwai, a Japanese painting restorer, ensures that the art is maintained in good condition with portable Vaisala humidity measurement device.

Read more

Carbon dioxide
Find out why scientists at Wageningen University & Research in the Netherlands have employed Vaisala carbon dioxide sensors in their research greenhouses for over a decade.

Read more

Dew point
Learn how CompAir, a manufacturer of compressed air and gas systems, uses the Vaisala DRYCAP® Hand-Held Dew Point Meter DM70 for measuring pressure dew points.

Read more

Moisture in oil
Read how Powercor Australia has been using permanently installed and portable moisture-in-oil probes, including the Vaisala HUMICAP® Moisture Meter MM70, for on-line moisture monitoring of transformers.

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Get in touch

Thank you for taking the time to read this eGuide.

Contact our application experts