Sensors Calibration

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Calibration

The formal definition of calibration by the International Bureau of Weights and Measures (BIPM) is the following:

"Operation that, under specified conditions, in a first step, establishes a relation between the quantity values with measurement uncertainties provided by measurement standards and corresponding indications with associated measurement uncertainties (of the calibrated instrument or secondary standard) and, in a second step, uses this information to establish a relation for obtaining a measurement result from an indication."

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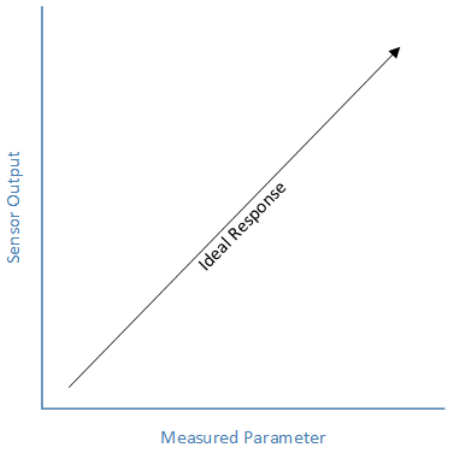
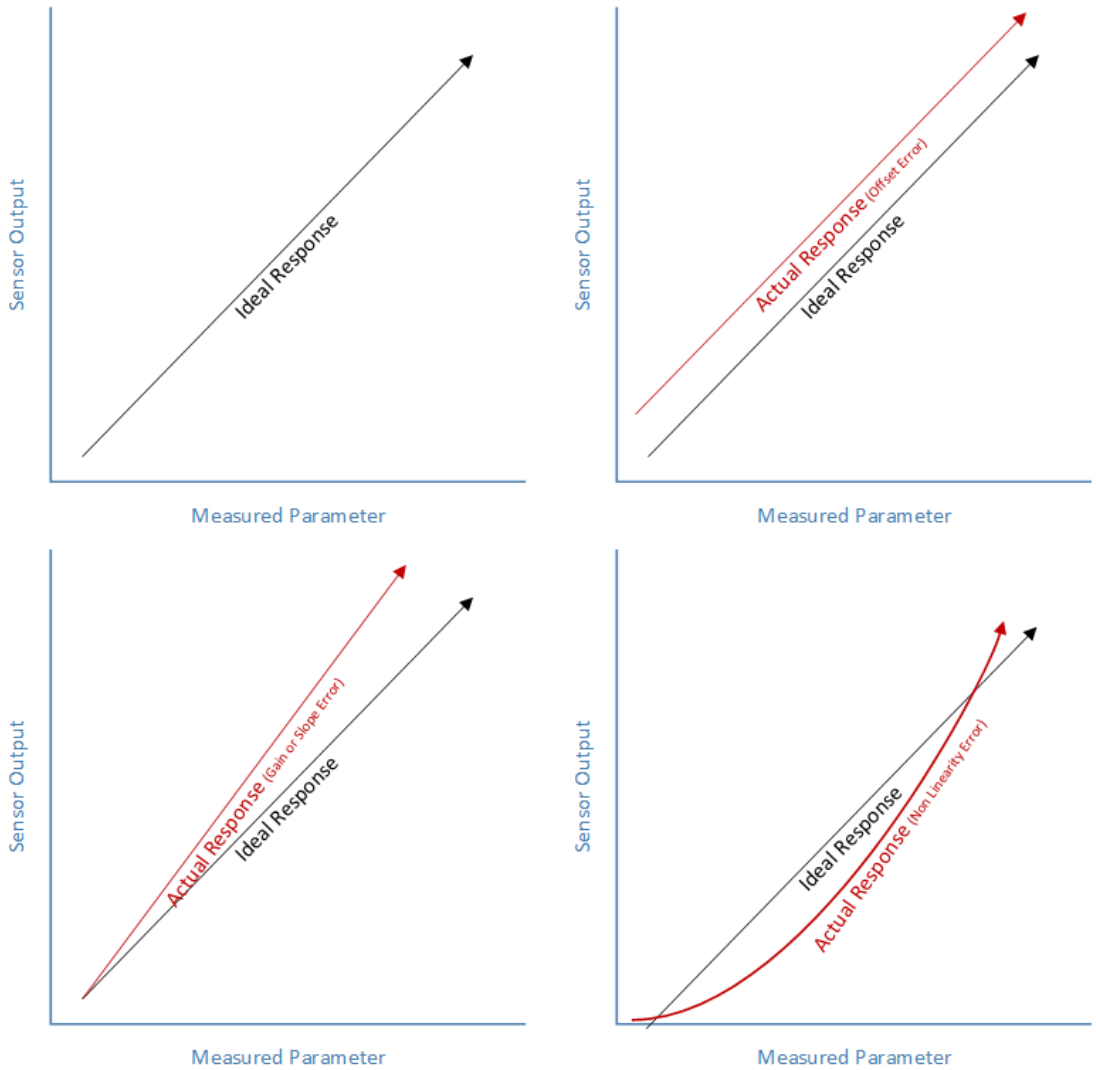
"Opération qui, dans des conditions spécifiées, établit en une première étape une relation entre les valeurs et les incertitudes de mesure associées qui sont fournies par des étalons et les indications correspondantes avec les incertitudes associées, puis utilise en une seconde étape cette information pour établir une relation permettant d'obtenir un résultat de mesure à partir d'une indication."

What is it?



- No sensor is perfect:
  - Manufacturing variations means two sensors from same manufacturer may provide different readings
  - Different sensor designs will respond differently in similar conditions
  - Sensors could be affected by change in heat, cold, humidity…
  - Sensors age and their response will change over time

Example: Whenever observations appear questionable or instrument indications do not match the output of similar instruments



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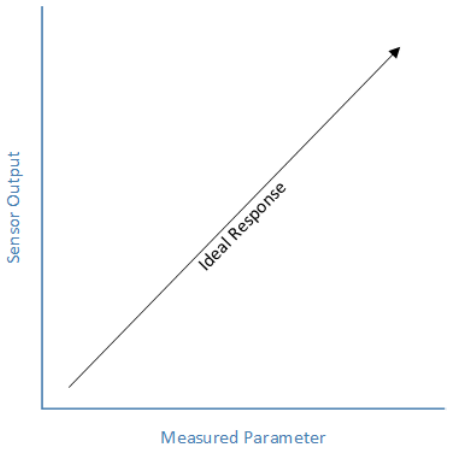

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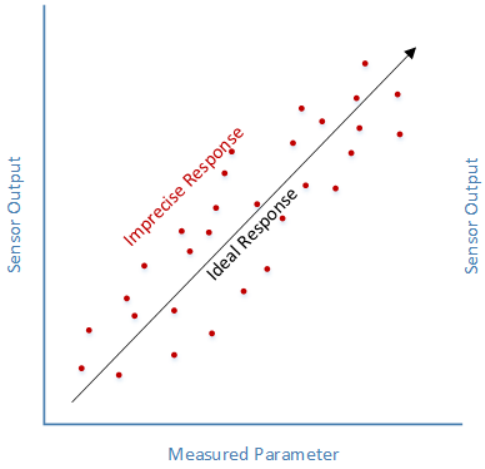

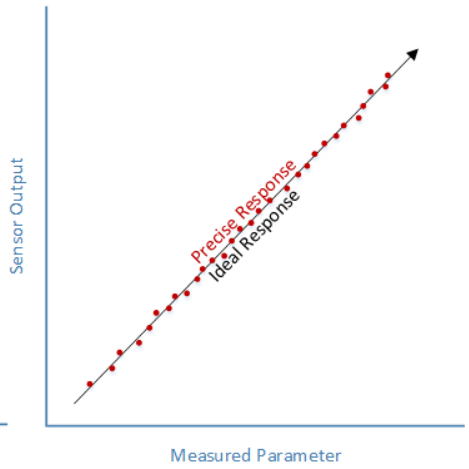

Why does it matter?

- The goal of calibration is to minimize any measurement uncertainty by ensuring the accuracy of test equipment.
- Calibration quantifies and controls errors or uncertainties within measurement processes to an acceptable level.

To Calibrate or Not to Calibrate?

Calibration may be required for the following reasons:

- Purchase of a new instrument;
- After repair;
- When a specified time period has elapsed;
- When a specified usage (operating hours) has elapsed;
- Before and/or after a critical measurement;
- Whenever observations appear questionable or instrument indications do not match the output of similar instruments
- As specified by a requirement, e.g., instrument manufacturer recommendation.

Example: instrument manufacturer recommendations

Data Logger:

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- LI-COR: …..
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Example: instrument manufacturer recommendations

RTDs:

- Temperature calibration should be accurate for the life of the probe (per RM Young Instruction Sheet 41342V-90 Rev 09-97, page 1)

HMP:

- Recommended calibration interval is one year (per Vaisala User Guide, page 57)

Barometer:

- Vaisala recommends recalibration every two years under normal use. In areas where a lot of contaminants are present, recalibration every year is recommended" (per Campbell Instructions, rev 8/12, page 15)

Example: instrument manufacturer recommendations (continued)

SPN1:

- recalibration recommended every 2 years (per SPN1 user manual v1.0, page 21)

PAR:

- Kipp & Zonen: Recalibrate every 2 years (per Kipp and Zonen Instruction sheet v1008)

CNR4:

- The CNR4 should be recalibrated every two years.

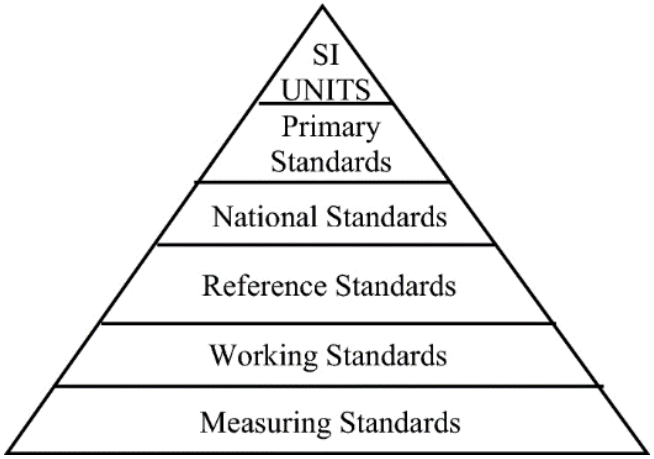
The manufacturer recommends that this drying cartridge be replaced every 6 to 12 months." (per Campbell Sci manual rev11/10, page 30)
or
"We suggest recalibration ... to be performed every two years"
"The drying cartridge needs to be replaced every 2 years."
(per Kipp and Zonen Instruction Manual, ver 1107, page 27-28)

Traceability

- All calibrations should be performed traceable to a nationally or internationally recognized standard.

- For example, in the United States, the National Institute of Standards and Technology (NIST), formerly National Bureau of Standards (NBS), maintains the nationally recognized standards.

- *Traceability* is defined by ANSI/NCSL Z540-1-1994 (which replaced MIL-STD-45662A) as "the property of a result of a measurement whereby it can be related to appropriate standards, generally national or international standards, through an unbroken chain of comparisons."



Thank you

Contact: SCBiraud@lbl.gov