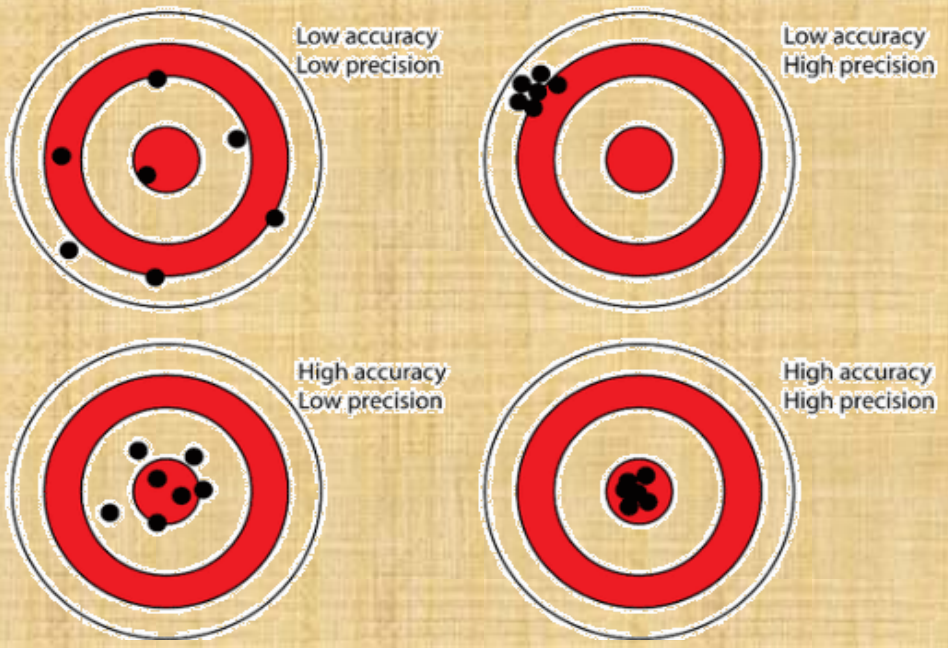
دورة تدريبية حول :

معايرة الأفران الجافة

Calibration of Dry Block

Definition

* Metrology
* Mapping
* Measurement method
* Measurement procedure
* True value
* Accuracy
* Precision



Definition

* Error
* Correction
* Repeatability
* Reproducibility
* Verification
* Validation
* Uncertainty
* Traceability

Calibration Conditions

1- Staff (Training-Experience ….)

2- Equipment (Specifications-Calibration ..)

3- Standard (International-In House Method)

4- Environmental Conditions (Temp.-Hum. ….)

Calibration Scope

- Temperature range from –100 °C to +660 °C
- Temperature range from +660 °C to +1300 °C

• Equipment for Dry Block Calibration

- A dry block calibrator, also known as a dry-well, is used in accurate, liquid-free calibrations of temperature devices, such **thermostatic switches, RTDs, thermistors, thermocouples, thermometers and additional temperature sensing equipment**.
- A dry block or dry-well design features a heated block, which contains a consists of a heatable and/or coolable metallic block, controller, an internal control sensor and optional readout for external reference sensor temperature-controlling sensor.

Dry Block Calibrator

- A new type of calibrator with dual-zone control, named “Metrology Wells,” was developed
- Many new technologies are applied in the Metrology Wells, and overall performance is improved dramatically over dry-wells.
- The biggest improvement comes from the excellent axial temperature uniformities across each Metrology Well’s entire temperature range.
- This improvement comes from technology that automatically adjusts the temperature at the top zone to minimize the differential temperature between the two zones at any temperature setting.

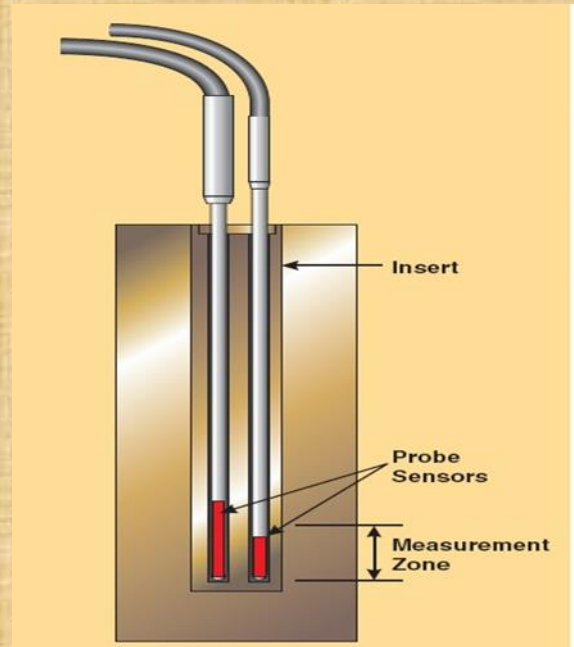


Figure 1 Probe sensors location in the block

Specifications of Dry Block

Accuracy

- An expression of how closely a measured value agrees with the true or expected value of the quantity of interest
- With respect to a dry-block, the accuracy statement is an expression of how closely the instrument's display temperature agrees with the actual temperature in the heated well.
- Tip, be sure your dry-block is calibrated by a lab that uses appropriate high accuracy temperature standards, and that can document traceability to primary temperature standards.

Stability

- The tendency of an attribute to remain within tolerance
- When a dry-well reaches its set point, there is some ± deviation as it maintains control.
- These temperature fluctuations around the set point can cause the well temperature to vary in the temperature block.
- Instability can cause spikes in temperature during your calibration and cause additional errors.
- Stability adds to accuracy in determining overall system uncertainty

Specifications of Dry Block

Uniformity

- Temperature homogeneity of the heat source throughout the test zone.
- Every dry-well has a **vertical temperature gradient**, which is the difference in temperature from the bottom of the test well to the top, and a **horizontal temperature gradient**, which is the difference in temperature from one calibration well to the next (in a multi-well block).

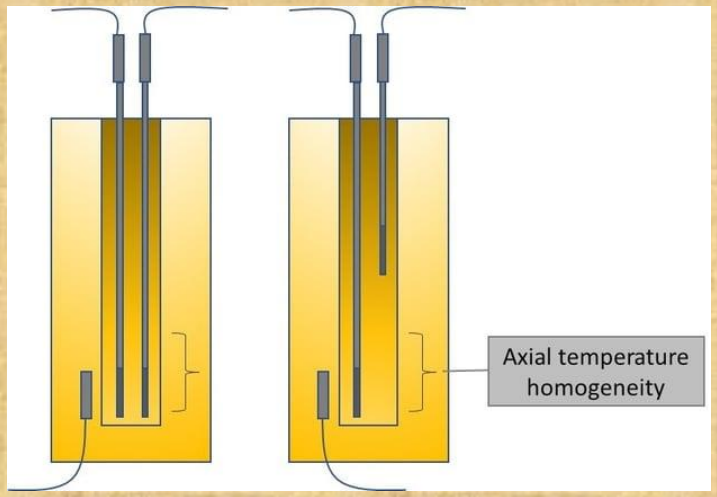
Dry Block Calibration: Sources of Measurement Error

- Main topics are
- – Display accuracy
- – Axial uniformity
- – Radial uniformity
- – Loading
- – Stability over time
- – Hysteresis

Axial uniformity

The influence of the temperature distribution in the measurement zone along the borings (axial temperature distribution in each boring) is to be determined in such a way that it can be taken into account in the uncertainty budget of the calibration.

The necessary investigations are to be carried out at the operating temperature showing the greatest difference from the ambient temperature (both positive and negative).

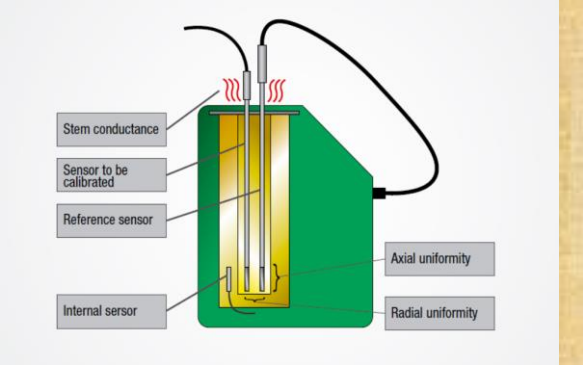


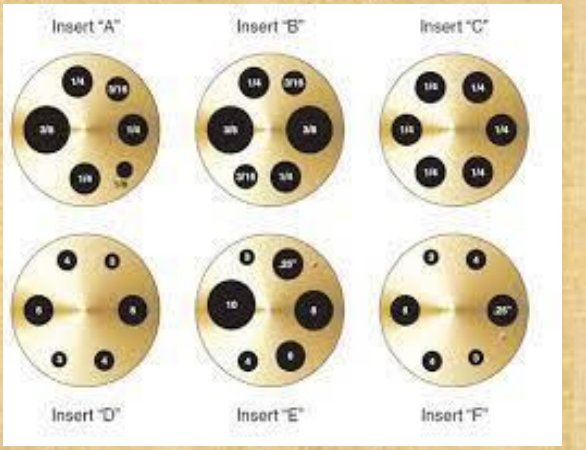
Axial uniformity

- Immersion depth of the UUT is critical
- Dry block are generally calibrated by fully inserting a reference probe
- By adding a reference probe, we can lessen the concerns with the control probe location.
- We can compare a unit under test (UUT) to an external reference thermometer in a dry well.
- dry well in this case as a medium or a heat source, or an environment for the probes to be in while we do that comparison, This helps us to be less concerned with the overall depth of the probes
- This allows you to move it to different heights, obviously.
- immersion depth should still be something to be considered
- fifteen times the probe diameter, plus the sensor length of that probe

Radial uniformity

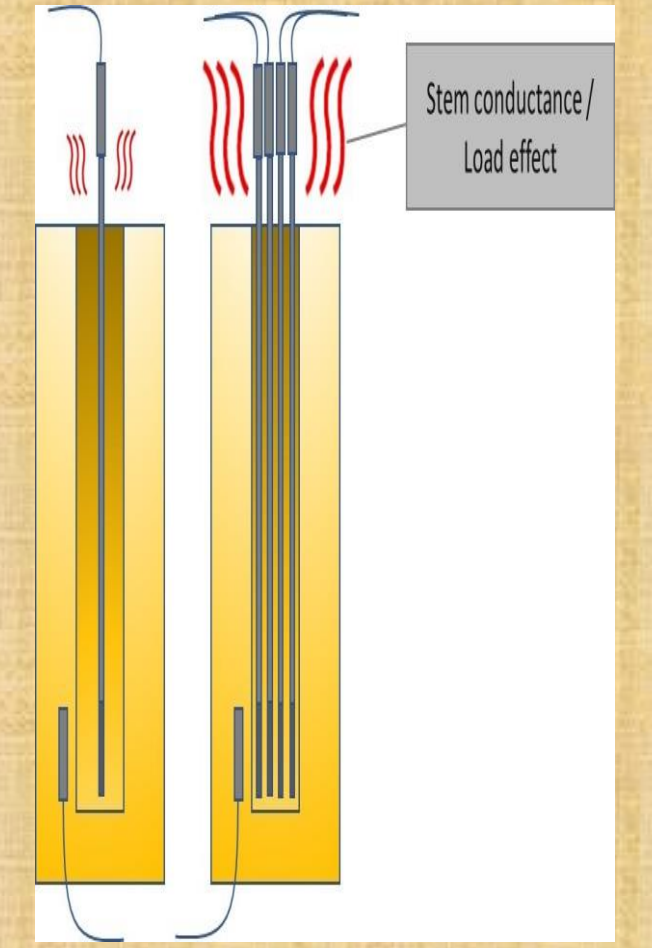
The greatest temperature difference occurring between the borings is to be determined. At least the measurement of the temperature difference between (opposite) borings situated at as great a distance from each other as possible is to be determined. To eliminate the influence of temperature variations with time, the temperature differences with respect to an additional test thermometer in the temperature block calibrator could be determined.





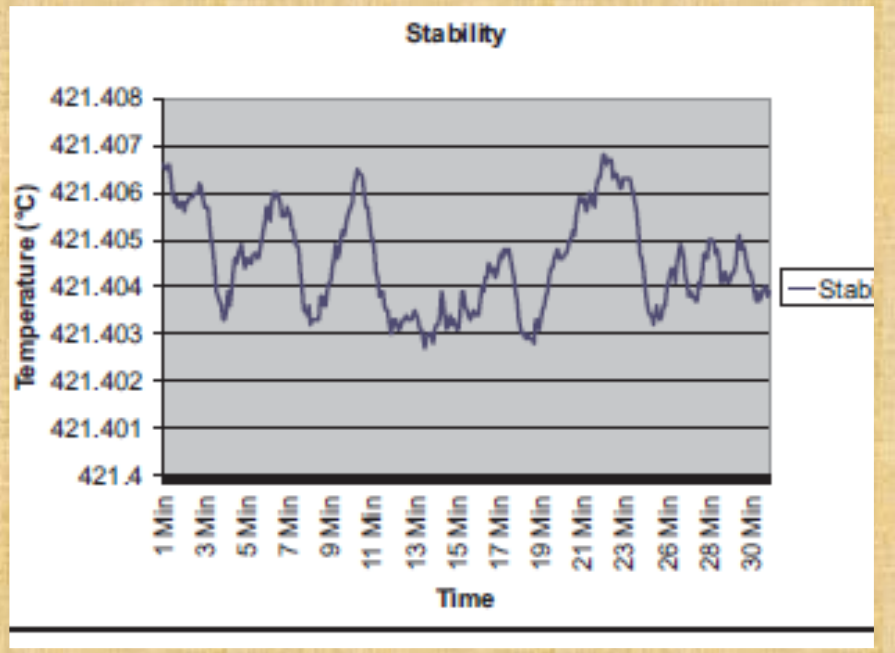
Loading effect

In the case of use of several borings in the dry block, more detailed investigations into the influence on the temperature in the measurement zone due to different loadings can be made upon customer request. In this case, the results for loading with only one thermometer and with all borings loaded are compared. Loadings with thermometers can be simulated by loadings with metal or ceramic tubes. The measurements are to be carried out at least at the temperature with the largest temperature difference from the ambient temperature (both positive and negative).



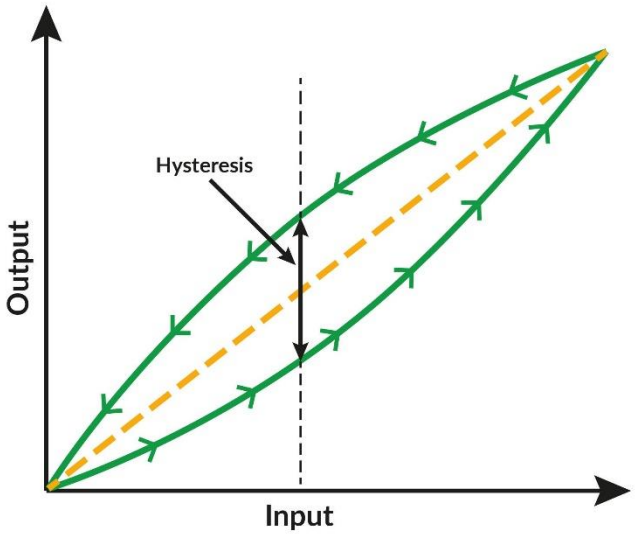
Stability over time

Depending of the temperature, a sufficient time to reach the thermal equilibrium must be reserved in order to make proper measurements. This point is particularly important in case of on-site use. The maximum range of temperatures indicated by a sensor in the measurement zone over a at last a 30 minute period, when the system has reached equilibrium, shall be determined. Measurements are to be performed at the highest and at the lowest test temperature



Hysteresis

Hysteresis is the difference in a Metrology Well's actual temperature resulting from the direction from which that temperature was approached. It is greatest at the mid-point of a Metrology Well's range.



Uncertainty

Symbol	Source of Uncertainty	Value ± °C	Probability Distribution	Divisor	Sensitivity Coefficient	Method of estimation
ts	Uncertainty of standard		Normal	1	1	Calibration certificate
td	Drift of standard		Rectangular	√3	1	Max. Difference between two successive calibrations of the standard
tuut	resolution of UUT		Rectangular	√3	1	digital indicator = 0.5 of resolution
tl	Loading		Rectangular	√3	1	Loading of the block with other thermometers.
tA	Axial		Rectangular	√3	1	max difference between different depth sensors
tR	Radial		Rectangular	√3	1	max difference between sensors
T_{stab}	Hysteresis		Rectangular	√3	1	Hysteresis in the increasing and decreasing branches of the measuring cycle
trep	Repeatability of UUT		Normal	1	1	Standard deviation of measurements
	Combined Un.					
	Expended Un.					

QUESTIONS?

Thank you