HKAS Information Notes No. 3

Guidance on Calibration and Performance Verification of Temperature Chambers *(Informative)*

This document serves as a general guidance on calibration and performance verification of temperature chambers of volume not greater than 2,000 litres with air circulation [1, 2]. This document is not applicable for temperature verification of furnace, nor for circulating oil/water baths. For chambers with other design for specific applications, relevant international standard(s) should be referred to. Measurement uncertainty shall always be taken into consideration when there is a statement of conformity to a specification.

A. Calibration or Verification Procedure

Calibration or verification of performance of a temperature chamber should be conducted at a condition as close to routine operation as possible. Nine temperature sensors are placed inside the chamber under test at positions shown in Figure 1. The temperature at each sensor, which will exhibit cyclic behaviour, is measured at a time interval which can detect the change of temperature with time. The duration of temperature measurement should cover at least one complete temperature cycle.

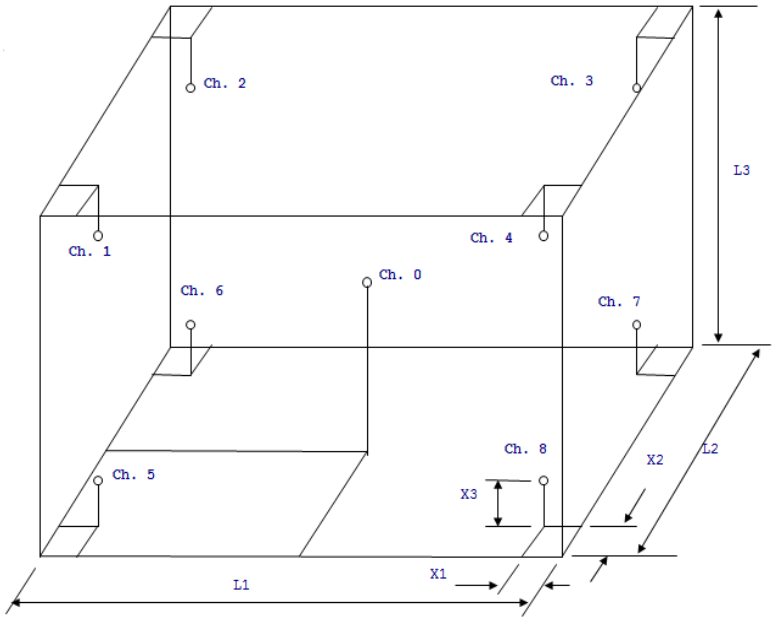

Figure 1

Sensors at each vertex (Ch. 1 to Ch. 8) should be positioned with a clearance specified in the following table.

Volume of chamber (litre)	Clearance
< 1 000	L/10 or 50 mm, whichever is larger
1 000 to 2 000	L/10 or 100 mm, whichever is larger

where L is the corresponding dimension of the chamber.

If certain region(s) of a chamber is specified as 'not used for certain application' and the remaining working space is not in form of a cubic lattice, other relevant reference shall be consulted as the verification is beyond the scope of application of this document.

For chambers of small volume [e.g. less than 100L], the number of sensors used can also be reasonably reduced. The positions of the measuring points and the procedure used to evaluate the temperature gradient must be given in the calibration certificate or kept in the laboratory's record if in-house calibration/verification is carried out.

B. Measurand

The measurand of this procedure is temperature deviation (w) of the temperature chamber which is given by:

$$w = |x| + y/2 + z/2$$

where x is the error of the set point of the chamber,
y is the temperature fluctuation of the chamber, and
z is the temperature gradient of the chamber

(a) Error of the set point of a chamber (x): The average of all temperature data recorded by the nine sensors over the measurement time is the mean temperature of the chamber. The absolute value of the difference between the mean temperature and the set point is the error of the set point x.

(b) Temperature fluctuation of a chamber (y): The temperature variation (maximum – minimum) recorded over the measurement time at the centre position is the temperature fluctuation y.

(c) Temperature gradient of a chamber (z): The temperature variation (maximum – minimum) among the nine sensors at any particular instance is the instantaneous temperature gradient of the chamber. The maximum value of the instantaneous gradient is the temperature gradient z.

C. Measurement Uncertainty

The expanded measurement uncertainty *M* can be evaluated as follows:

$$M = 2.0\sqrt{2.0 * u^2(t) + u_{tset}^2}$$

where *u(t)* is the standard uncertainty of the measured temperature and is assumed to be similar for all nine temperature sensors

$$u(t) = \sqrt{\left(\frac{U_{cal}}{2}\right)^2 + \left(\frac{U_{drift}}{\sqrt{3}}\right)^2 + \left(\frac{U_{resl}}{\sqrt{3}}\right)^2}$$

U_{cal} is the expanded calibration uncertainty of the temperature sensor,

U_{drift} is the range of the drift of the temperature sensor
U_{resl} is the semirange of the resolution of the temperature sensor;

u_{tset} is the standard uncertainty due to setting resolution of the chamber

For chambers with analogue setting dial,
$u_{tset} =$ (U_{grad} is the graduation of the dial)

For chambers with digital setting,
u_{tset} is 0

D. Acceptance Criteria

For a temperature chamber claiming an accuracy of ±*A*, the performance of the chamber is acceptable only when

$$w + M \leq A$$

where *w* is the temperature deviation, and
M is the expanded measurement uncertainty of *w*

The expanded measurement uncertainty *M* should not be greater than *A/3*.

E. Recalibration Interval

When determining the recalibration interval, the laboratory should consider a number of factors including the usage frequency, temperature being exposed, the condition of use, specification requirement, history of drift, etc. Details are given in Clause 6.1(d) of HOKLAS Supplementary Criteria No. 2 – "All Test Categories – Equipment Calibration and Verification". For more information for determination of equipment recalibration intervals, please refer to ILAC-G24 / OIML D 10.

F. Reference

1. IEC 60068-3-5 'Environmental testing – Part 3-5: Supporting documentation and guidance - confirmation of the performance of temperature chambers'
2. Guideline DKD-R 5-7 'Calibration of climatic chambers'
3. ILAC G24 / OIML D 10 'Guidelines for the determination of calibration intervals of measuring instruments'