Cannes 2018
IECEx ExTAG Training

Calibration of Humidity Chambers

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WHEN YOU NEED TO BE SURE

What are we measuring?
An extreme example

Glass Temperature on an HID Floodlight:

Round Robin test amongst European Notified Bodies about 20 years ago

Preliminary results showed a spread of 100K between the maximum and minimum temperatures declared by the various laboratories

The coldest results?

- These test laboratories had made a false assumption that the hottest place on the glass would be in the centre and did not check elsewhere!
- Because of the shape of the reflector, the hotspots (significantly hotter) were actually at about 25% and 75% of the height of the glass
- A preliminary check just by placing a sheet of paper on the upward facing glass showed scorching of the paper in two lines, not in the centre

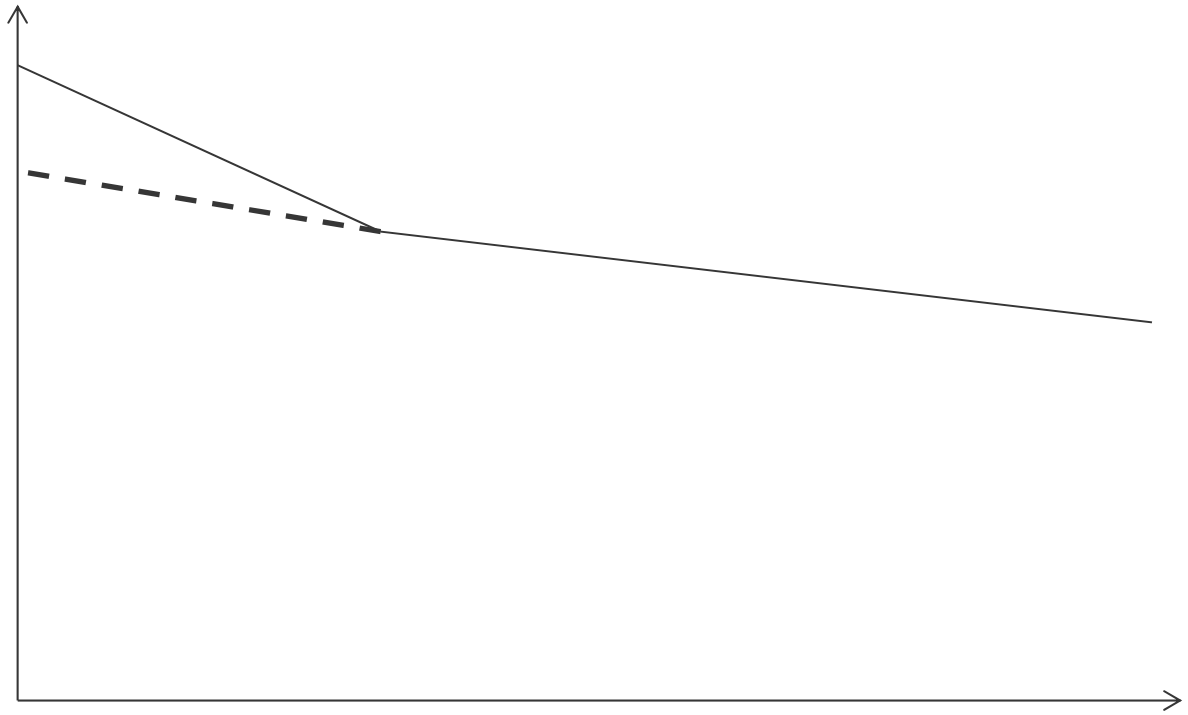
The hottest results?

- These test laboratories made certain their thermocouple was robust and well attached to the glass by a large blob of glue
- The measurement was of the temperature of the large blob of glue, and not the glass. This was inevitably higher because of the direct absorption of the radiated energy by the glue, whereas most of the radiated energy passed through the glass, without being absorbed

The result?

- Publication of ExNB Clarification Sheet ExNB 00/06/23/CS in June 2000
- This provided significant guidance but did not include the last tweak used by Baseefa:
  - If a cooling curve is plotted from the moment of switch-off, this can be examined and the initial very rapid cool-down (say the first five or ten seconds) can be judged to be the cooling of the thermocouple to match the glass temperature. The remainder of the cooling curve can be extrapolated to indicate the temperature of the glass at time “0”
  - The less the mass of the thermocouple and its method of attachment, the less adjustment is needed

Cooling Curve



The lesson?

- There is more to temperature measurement than having a calibrated thermocouple and meter
- Hopefully, following the Proficiency Testing exercise on temperature measurement, none of the laboratories within the IECEx system would make the mistakes revealed 20 years ago
- Similarly, there is a lot more to humidity chamber calibration than having calibrated sensors

Humidity Chambers
The Questionnaire

- The initial reason for posing the questions was an apparent discrepancy between the views of SGS Baseefa and another laboratory in respect of calibration of a manufacturer's humidity chamber to be used under an OD 024 agreement
  - Because of loose wording, we cannot be certain what the other laboratory had requested, but it was reported to us that, whereas we would insist on the chamber being calibrated, the other laboratory was happy if the chamber manufacturer calibrated the sensors

The answers

- Because of the various ways that the questionnaire was answered, it is not appropriate to give statistical meaning to the answers
- Among the points are:
  - Most laboratories quoted calibration accuracies appropriate to the chamber sensors, and not to the actual conditions experienced by the EUT
  - Approximately half the laboratories had performed nine-point temperature measurement at some stage
  - Not all had calibrated for the maximum condition used for testing

IEC TC31 WG22 (Maintenance of 60079-0)

- The most recent edition of the general requirements has added an alternative test which, effectively, allows testing at 90 C 90%RH as an alternative to 95C 90% RH, provided that the exposure time is extended to 150%
- WG22 decided to introduce this alternative, in recognition that it was extremely difficult to get accurate measurement of humidity at 95C
- The closer to the boiling point of water, the greater the difficulty

Standards for humidity chamber calibration

- IEC 60068-3-5
  - Confirmation of the performance of temperature chambers
- IEC 60068-3-6
  - Confirmation of the performance of temperature/humidity chambers (relies on -3-5)
- IEC 60068-3-7
  - Measurements with load
- IEC 60068-3-11
  - Calculation of uncertainty of conditions in climatic chambers

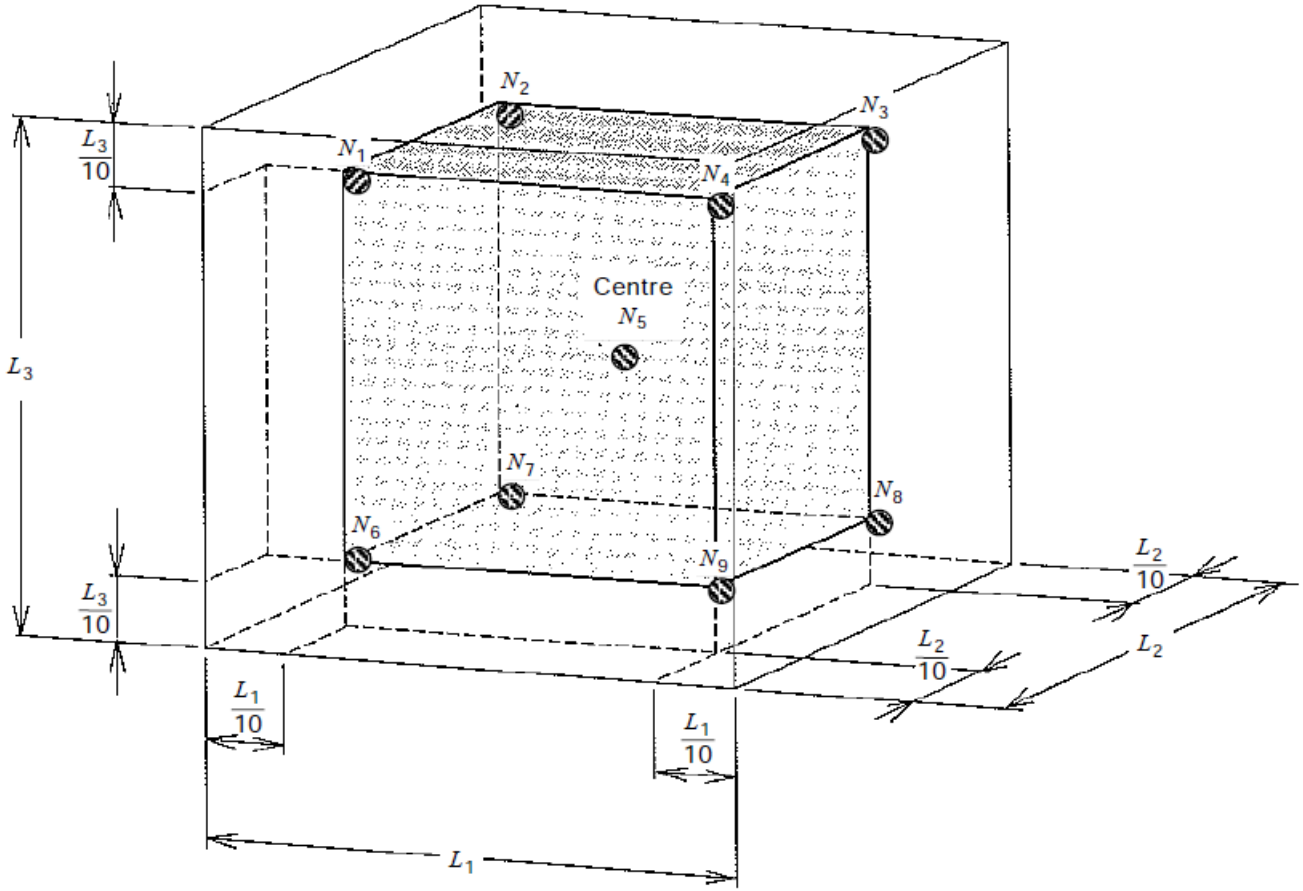
IEC 60068-3-11
Introduction

"The performance of climatic test chambers is a key concern in environmental test engineering.

To comply with any test specification, the performance of the chamber needs to be characterized to decide whether the generated conditions fall within the specified limits. This characterization can be a difficult task, and the analysis of uncertainties in chamber performance is often surrounded by confusion.

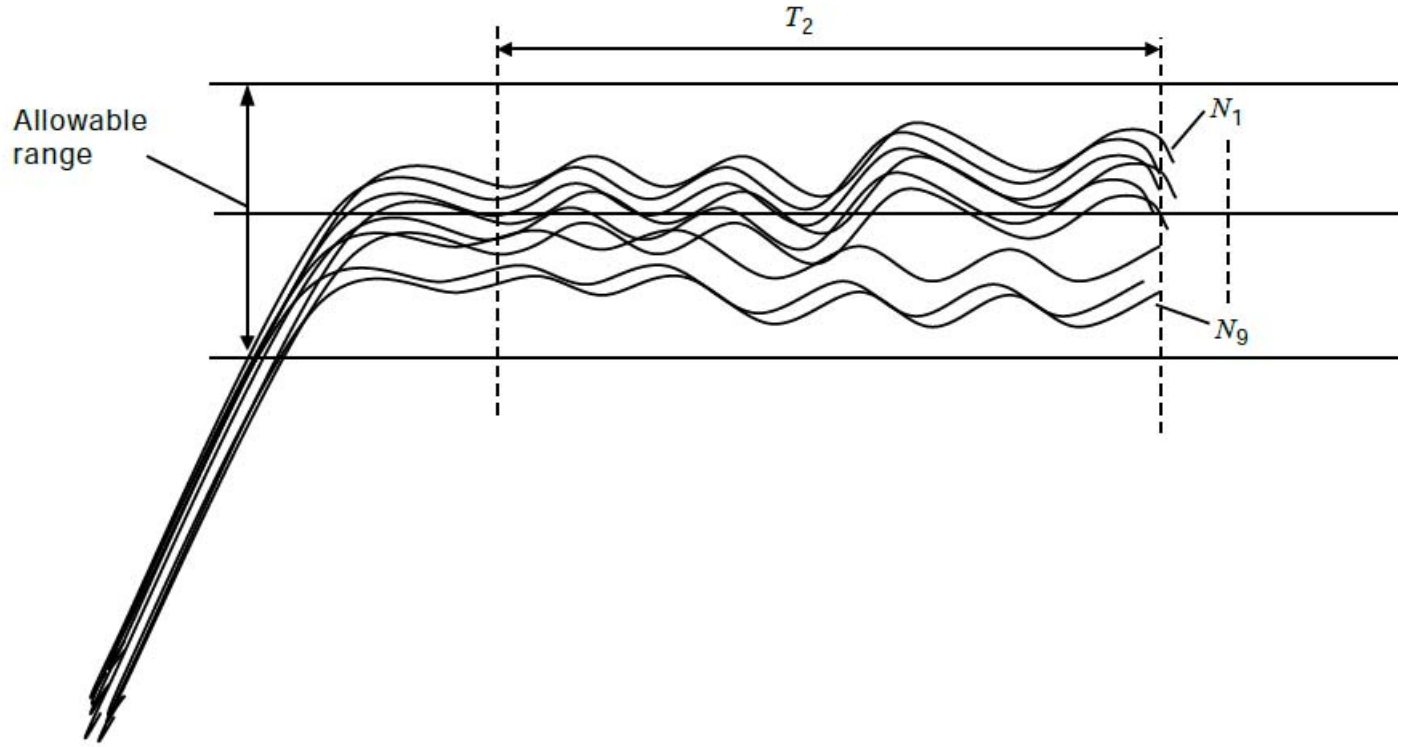
This publication is intended to ease that process."

IEC 60068-3-5
The nine point method



Above 2000 litres, six additional sensors on centre of each side

Stabilisation



Absolute vs Relative Humidity

- Absolute Humidity relates to the amount of moisture in the air. This is unlikely to vary greatly throughout the chamber
- Relative Humidity varies with temperature for any given Absolute Humidity
  - If Relative Humidity is measured at the centre of the chamber, the Absolute Humidity can be calculated based on the temperature at the same point.
  - Relative Humidity at the other eight points in the chamber can be calculated from the Absolute Humidity and the actual measured temperature
  - If the nine temperatures are not identical, the Relative Humidity is varying throughout the chamber

After nine point calibration

- Unless the chamber has been altered, the differences in the nine temperatures are not likely to vary much, but it is recommended that an occasional check is done
- Therefore for routine calibration, it is appropriate to use a combined temperature/relative humidity probe, located near the centre of the chamber
  - This will track any variation with time of the calibration of the chamber sensors (which are not located in the centre of the chamber)
  - There will almost certainly be a difference between the chamber sensors and the probe

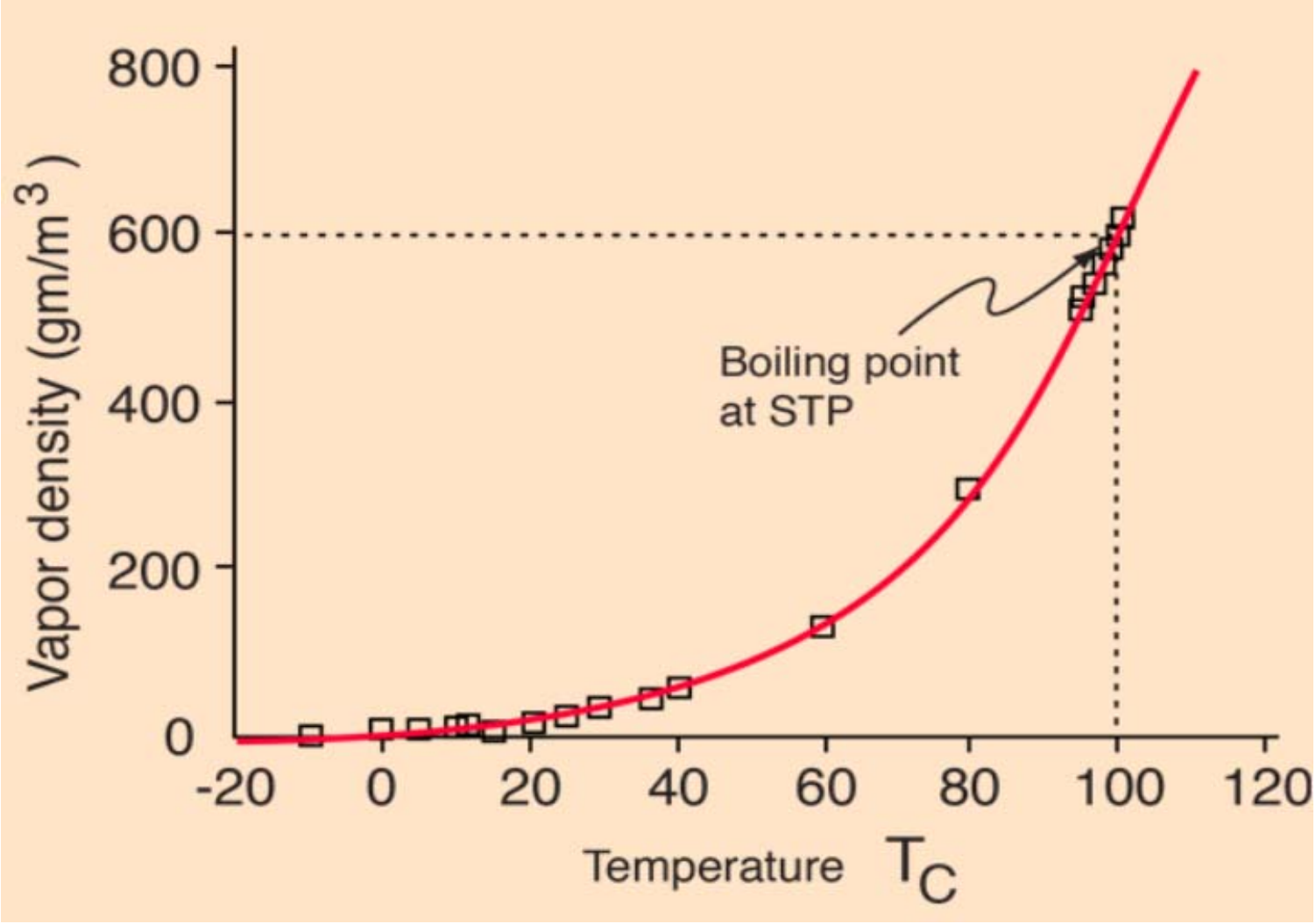
Three larger chambers in regular use at SGS Baseefa

Requirement as measured by calibrated probe at centre of chamber	Chamber Controller setting to achieve the requirement
95C 90%RH	94.7C 97.0%RH
95C 90%RH	96.0C 90.8%RH
80C 90%RH	79.5C 80.5%RH

Tolerances in 60079-0

- Temperature + or – 2K
- Humidity + or – 5%RH
- The problem is that if the chamber is varying within the 4K range around 95C, the relative humidity will vary outside the 10%RH range if the actual absolute humidity remains constant
  - In contrast, a 4K range on temperature around 40C will cause significantly less than a 5%RH variation for a constant absolute humidity
  - Note the figures are approximate, having been taken from published graphs and not calculated accurately

A published graph



Tolerances in 60079-0

- The conclusion is that the temperature control of the chamber set for 95C has to be much better than + or – 2C, and the temperature gradient (between the highest and lowest temperatures measured in the 9 point system) also has to be significantly less than 4K in order to achieve 90%RH throughout the chamber with a tolerance of + or – 5%RH
- It is much easier to achieve these tolerances at 90C

The way forward?

- It seems that IECEE are also wrestling with similar problems, though most of their environmental conditions are well below 95C 90%RH
- If the work in IECEE is relevant to our situation, it seems reasonable to make use of it rather than have a separate attempt to resolve the problems
- Katy Holdredge will now bring us up to date on the work within IECEE