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Calculation of Stated Thermometer Accuracy

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Far too often we see suppliers and customers making incorrect assumptions about the accuracy of various devices and systems. The reasons can be many but common problems are persons using ice baths to do calibrations and assuming these are at 0C. In most cases this is an incorrect assumption. We also see persons using devise that are no acute enough to calibrate other devices leading to the secondary devices being decalibrated. This is all solved by using systems and devices that are accurate and stable enough for the calibration at hand.

The basic formula we all learned in college or university for use in calculating the true accuracy of a calibration is:
$E= \sqrt{E_1^2+ E_2^2+ E_3^2+\dots}$
Where E =the error of the system
E_1 = the accuracy of the reference device.
E_2 = the accuracy of the calibration system.
E_3= the repeatability of the device being calibrated.
If other errors are significant, they should be added. However, when using a good calibration system, the remaining errors will be so small as to be insignificant.

So, for example if your reference thermometer is +/-0.1C accurate and the calibrator is +/-0.1C and the pocket thermometer is +/-0.5C repeatability
The Error=$\sqrt{(0.1^2)+(0.1^2)+(0.5^2)}$= 0.5C which is the accuracy claim that can be made after completing the calibration even if you calibrate it to read exactly the same as the Reference.

But if your reference thermometer is+/- 0.1C accurate and the calibrator is +/-0.5C and the pocket thermometer is +/-0.5C repeatability
The Error=$\sqrt{(0.1^2)+(0.5^2)+(0.5^2)}$= 0.7C
The bottom line is that if the Master reference is 0.1C or better it does not affect the final error/accuracy

BUT if the calibrator is not accurate enough then it will still decrease the final accuracy of the pocket thermometer. So, using a reference thermometer that is +/-0.1C or better and a thermometer that is +/-0.5C

E.g., 1 using an ice bath (+/-1.0C)
The Error= $\sqrt{(0.1^2)+(1.0^2)+(0.5^2)}$= 1.1C

E.g., 2 using a dry block (+/-0.4C)
The Error=$\sqrt{(0.1^2)+(0.4^2)+(0.5^2)}$= 0.6C

E.g., 3 using a precision bath (+/-0.05C)
The Error= $\sqrt{(0.1^2)+(0.05^2)+(0.5^2)}$= 0.5C

As you can clearly see, the accuracy of the calibration system being used can seriously affect the final stated accuracy of the device being tested and decrease the stated accuracy of the device.

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