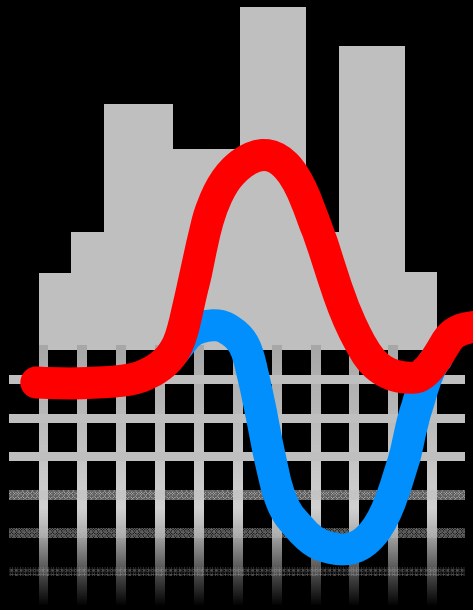

Facility Dynamics
ENGINEERING

Inputs and Outputs – The Field Perspective

Sensor Issues

Presented By:

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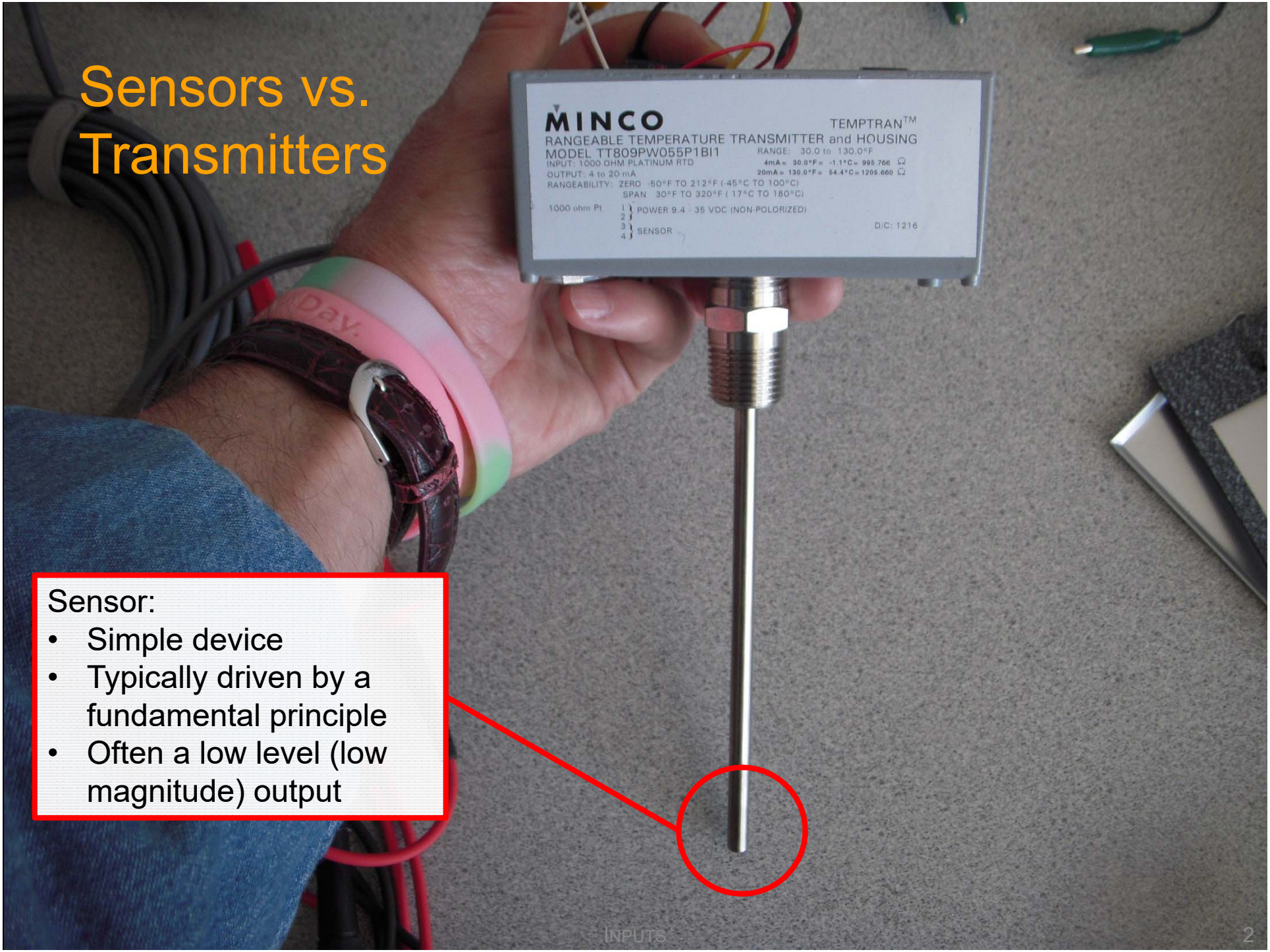
Senior Engineer

NAVFAC, San Diego

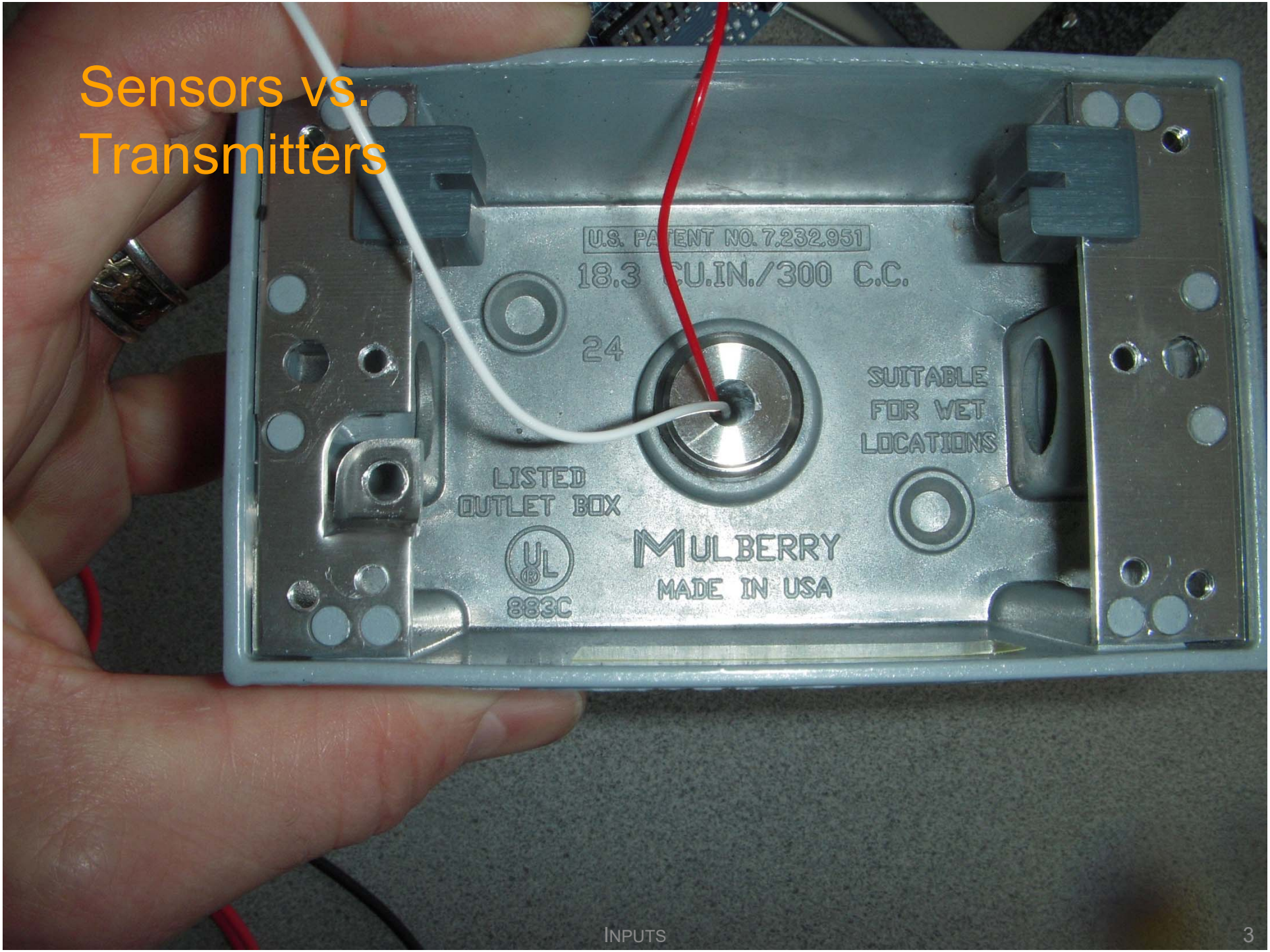
Sensors vs. Transmitters



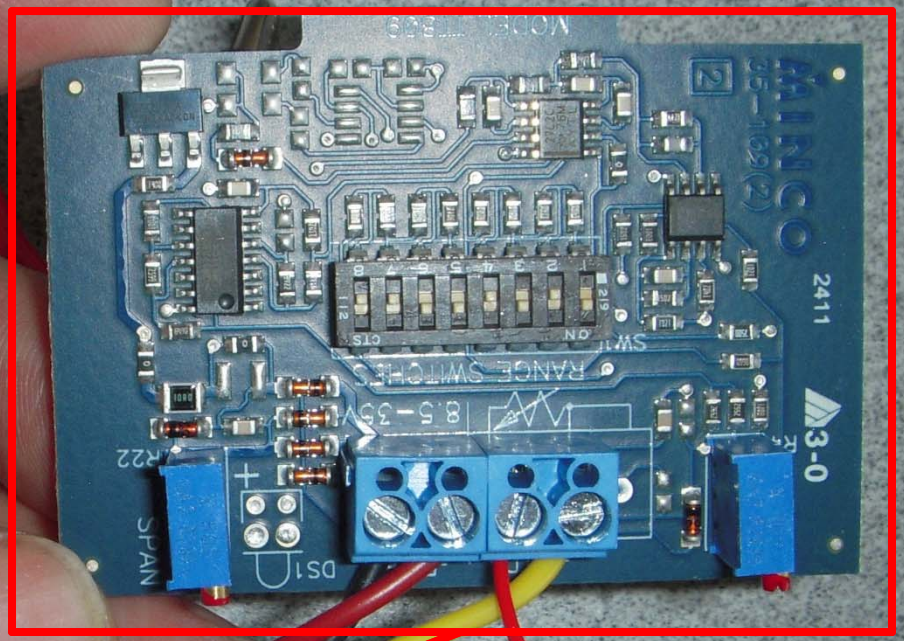
Sensor:

- Simple device
- Typically driven by a fundamental principle
- Often a low level (low magnitude) output

Sensors vs. Transmitters



Sensors vs. Transmitters



Transmitter:

- Complex device
- Scales up the low level signal
- May “condition” it (set a span, linearize it, etc.)
- Typically provides a standard output (4-20 ma, 1-5 vdc, 2-10 vdc, 3-15 psi, etc.)

Why Transmitters?

Effect of length of lead wire on RTD measurements

- Distance to the sensor - 100 ft
- Wire size - 22 AWG
- Specific resistance - 0.0165ohms per foot at 25°C
- Total lead length in series with the RTD – 200 ft

The added resistance from the length of wire is 3.3 ohms.

With an average RTF sensitivity of 4.7880 ohms per°C, the equivalent temperature associated with lead resistance is 1.24 °F

Why Transmitters?

Effect of temperature change on RTD measurements on a rooftop unit where the conduit is run outdoors in the Midwest

- Minimum temperature - minus 20°F
- Maximum temperature - 105°F (assuming no solar effects)
- Temperature change - 125°F or 69°C
- Resistance temperature coefficient for copper - 0.0043 ohms per ohm per °C

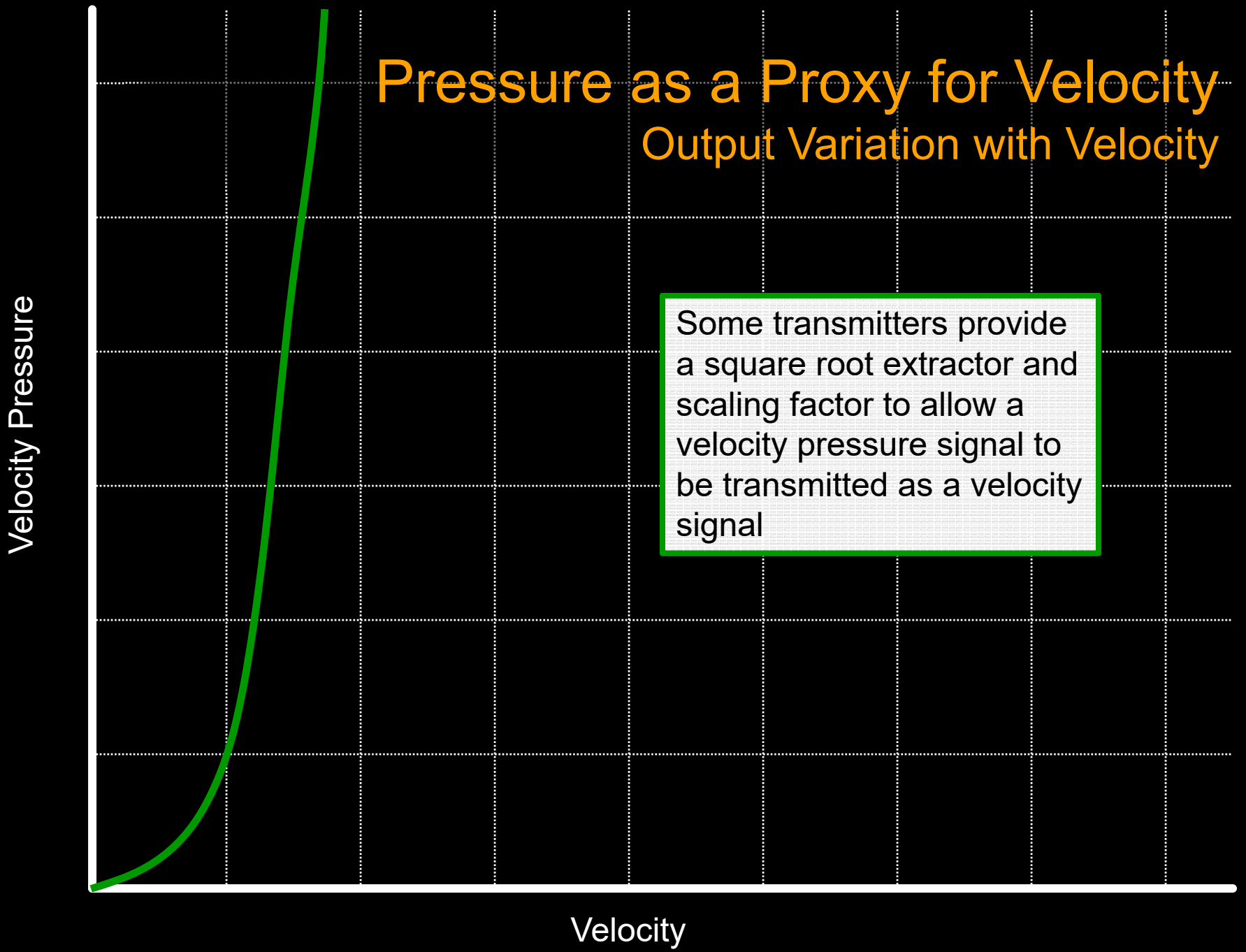
For the temperature variability stated, the corresponding change in RTD resistance is 0.98 ohms.

This change in resistance translates to a 0.37°F change in indicated temperature due to the outdoor temperature change

A High End RTD with Transmitter

Pressure as a Proxy for Velocity

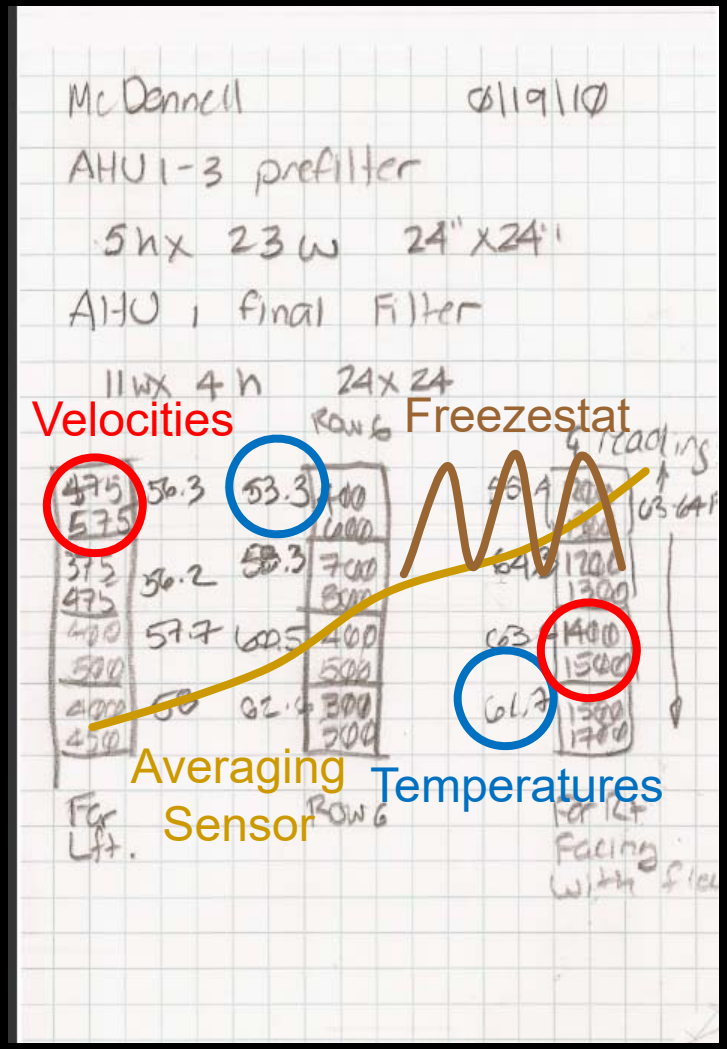
Output Variation with Velocity

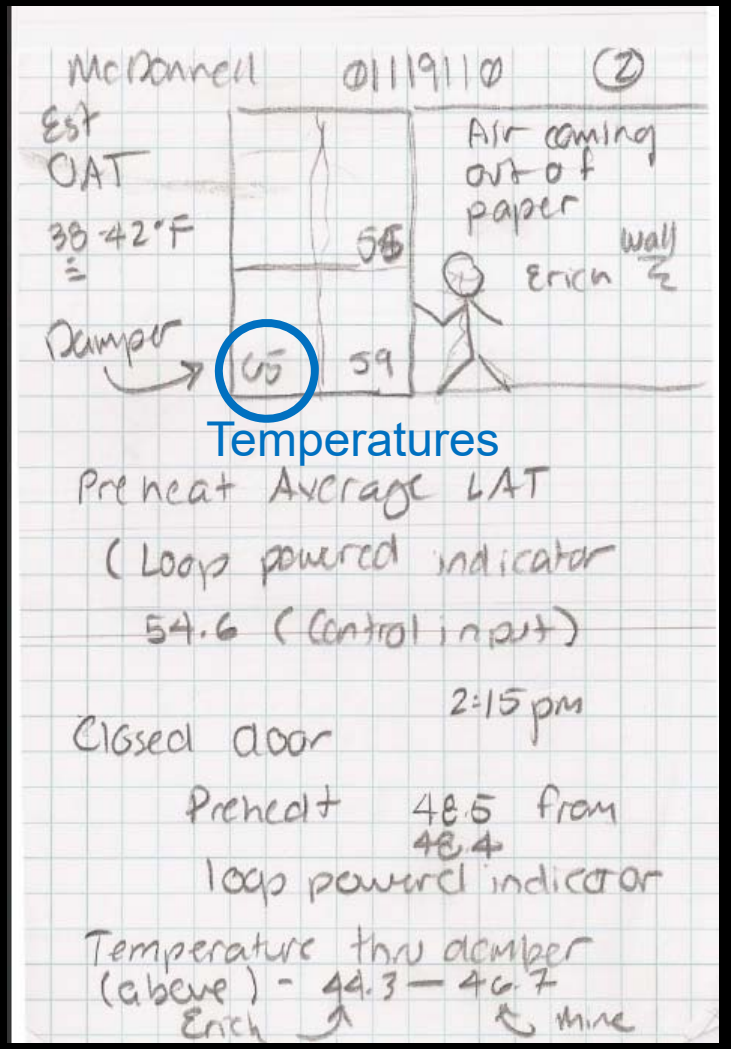


Some transmitters provide a square root extractor and scaling factor to allow a velocity pressure signal to be transmitted as a velocity signal

Sensing What is Really Going On

Sensing What is Really Going On





Sensing What is Really Going On

Another Thing:

If you mix 1 gallon of 50°F water with 99 gallons of 100°F water, do you get 75°F water?

Sensing What is Really Going On

Another Thing:

If you mix 1 gallon of 50°F water with 99 gallons of 100°F water, do you get 75°F water?

The Answer:

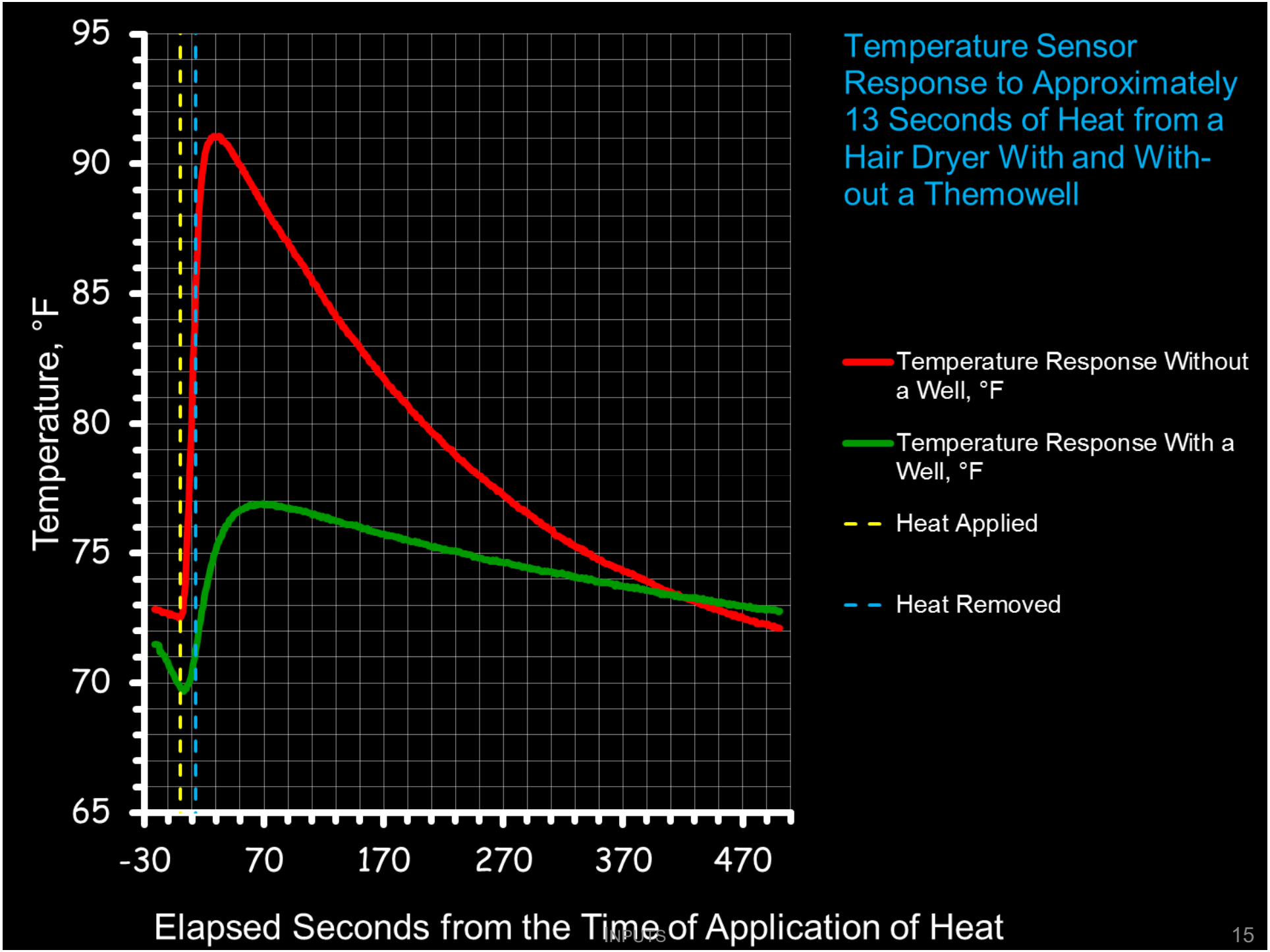
No, you get 100 gallons of water at about 99.5°F (even though the average of the temperatures is 75°F) because the mass of the water comes into play

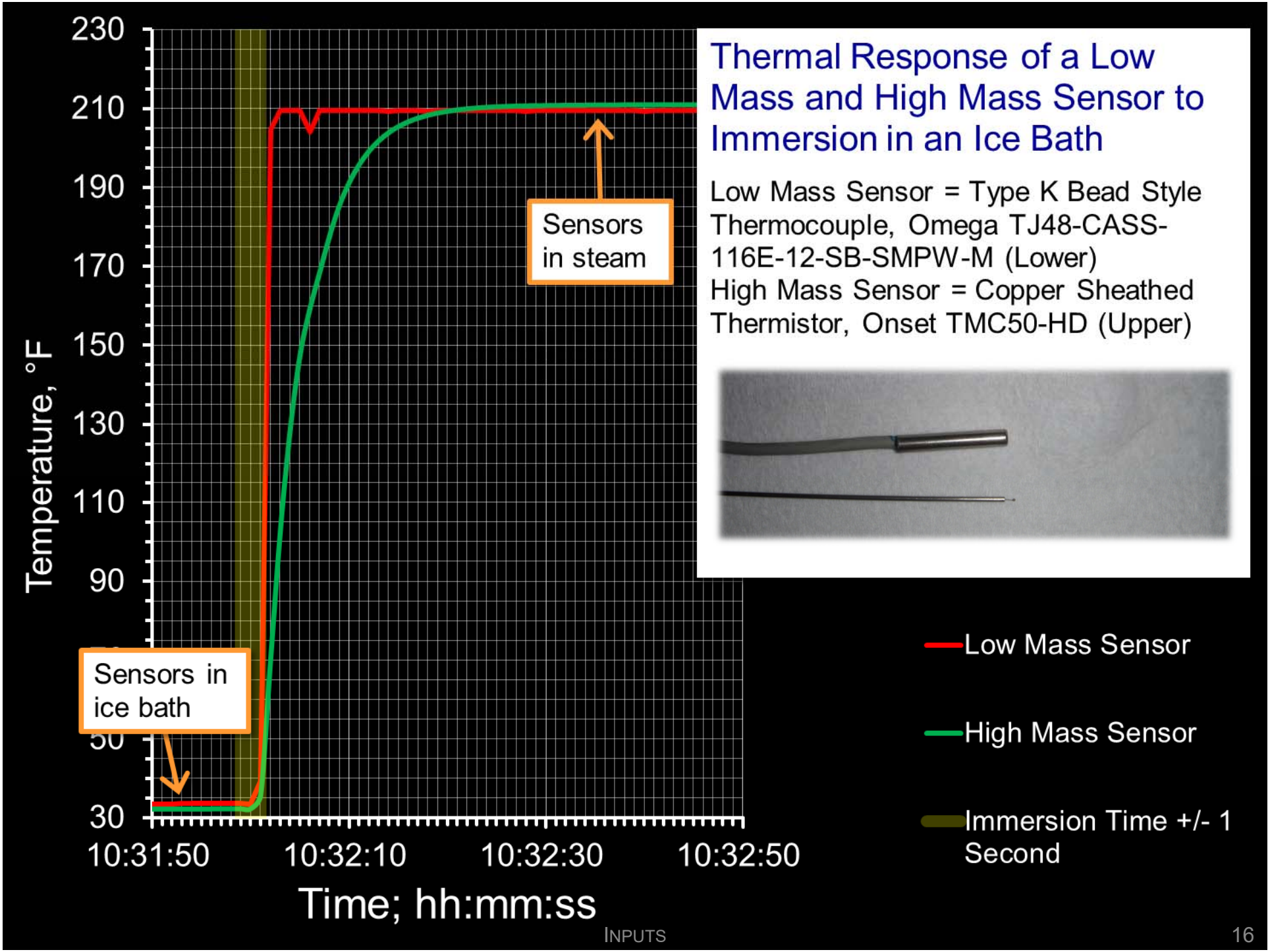
Averaging sensors assume a uniform distribution of flow across the sensing element

- *This is generally not the case due to the "bullet" shape of the fully developed velocity profile for the air and water flowing in our systems.*
- *This s hardly ever the case in mixed air plenums or other locations where two fluid streams are mixing.*

Sensing What is Really Going On

For more about mixing and temperature stratification in a mixed air plenum, see *Economizers–The Physics of a Mixed Air Plenum* and *Retrocommissioning Findings: Economizer Mixed Air Plenum Stratification–Overview*, *both at www.Av8rDAS.Wordpress.com*


Temperature Sensor Response to Approximately 13 Seconds of Heat from a Hair Dryer With and With-out a Themowell
Temperature, °F
95
90
85
80
75
70
65
-30
70
170
270
370
470
Elapsed Seconds from the Time of Application of Heat
Temperature Response Without a Well, °F
Temperature Response With a Well, °F
Heat Applied
Heat Removed



Thermal Response of a Low Mass and High Mass Sensor to Immersion in an Ice Bath

Low Mass Sensor = Type K Bead Style Thermocouple, Omega TJ48-CASS-116E-12-SB-SMPW-M (Lower)
High Mass Sensor = Copper Sheathed Thermistor, Onset TMC50-HD (Upper)


Visit http://av8rdas.wordpress.com/2014/03/28/4-20-ma-current-loop-experiments-thermal-mass-effects/ for video clips and details

More than One Well is a Good Thing

Providing a second well next to a pipe mounted sensor allows you to insert a calibration standard that sees the same conditions

The same is true for other sensors like pressure sensors (provide a second service valve for calibration)

Mounting Position Can Be Important

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Visit http://tinyurl.com/ngwb3zj for video clips and details