

Facility Dynamics

ENGINEERING

Inputs and Outputs – The Field Perspective

Factory Calibration, Single vs. Multi-point Calibration, Relative Accuracy, WISIWIG (or not)

Presented By:

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Senior Engineer

NAVFAC, San Diego

Verify Input/Output Details Calibration



Factory Calibration

- A good start
 - Addresses the factory provided components
 - Does not address the potential field impacts
 - Position effect
 - Lags
 - Lead resistance
 - A to D conversion
 - D to A conversion
 - COV limits
 - Bifocals

5 September, 2015

Emerson Process Management
Rosemount Inc.
8200 Market Blvd
Chanhassen, MN U.S. 55317-9766

Calibration Data Sheet Consistent with ISO 10474 3.1 or EN 10204 3.1

Customer Information Name: ILLUMINATE CONTRACTING LLC PO: 150415	Manufacturer Information Sales Order: 4342794 Line: 1
Device Information Device Type: Temperature Transmitter Tag No: Serial No: 0868371 Model No: 3144PD1A1NAP8B5M5C2Q4XA Output: Linear	Calibration Information Factory: CHANHASSEN, MN, USA Station Name: FinalSIN3 Operator ID: 8860 Calibration Date: 9/4/2015 3:15:43PM Internal Ref #: 11960097

Calibration Data

Sensor 1		Pt100 00385C2	4 Wire	0.00 TO 100.00 DEG C	
% of Range	Measured Input	Digital Output	Analog Output	% Span Error	Pass/Fail
100.087	100.987 DEG C	100.979 DEG C	20.0113 mA	-0.0164	PASS
50.084	50.084 DEG C	50.071 DEG C	12.0113 mA	-0.0134	PASS
0.034	0.034 DEG C	0.032 DEG C	4.0046 mA	-0.0052	PASS

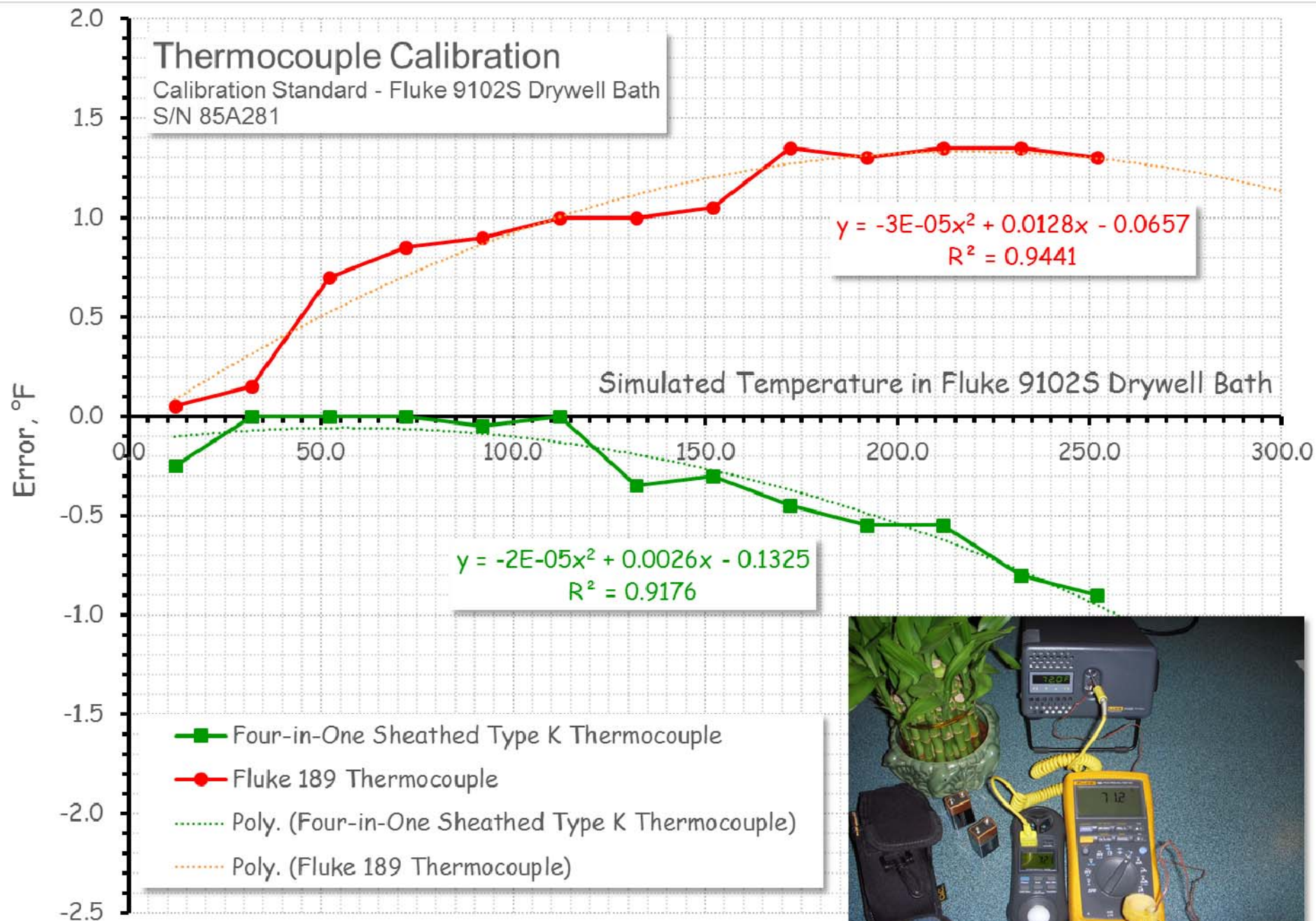
This is to certify that the listed product meets the applicable Rosemount Specifications. Measuring and test equipment used in the manufacture and inspection of the listed product are traceable to the National Institute of Standards and Technology. The calibration system was designed to meet the intent of ANSI Z540-1-1994.

Kelly Klein
Kelly Klein
Vice President of Global Quality, Approvals & EHS

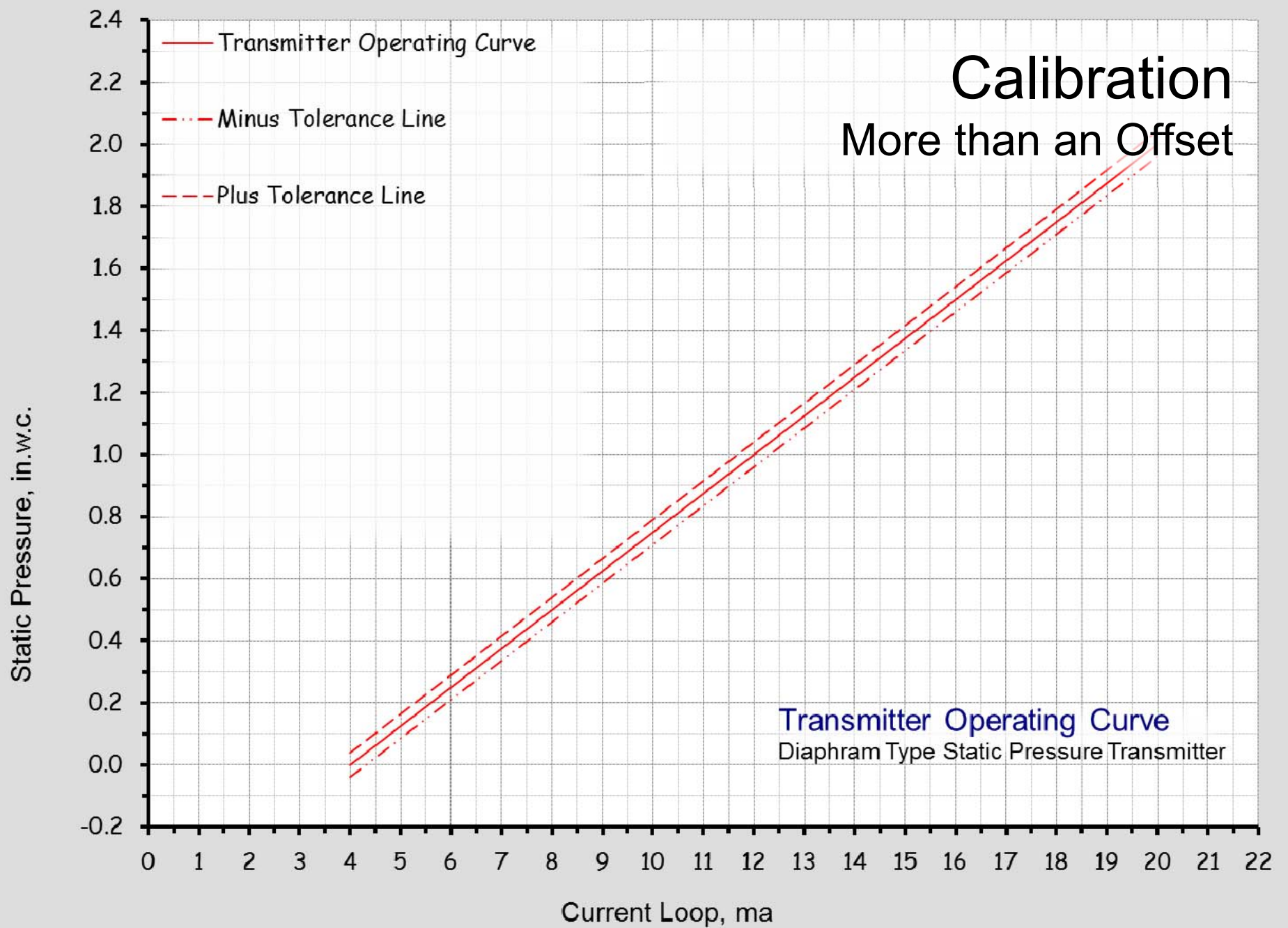
ROSEMOUNT

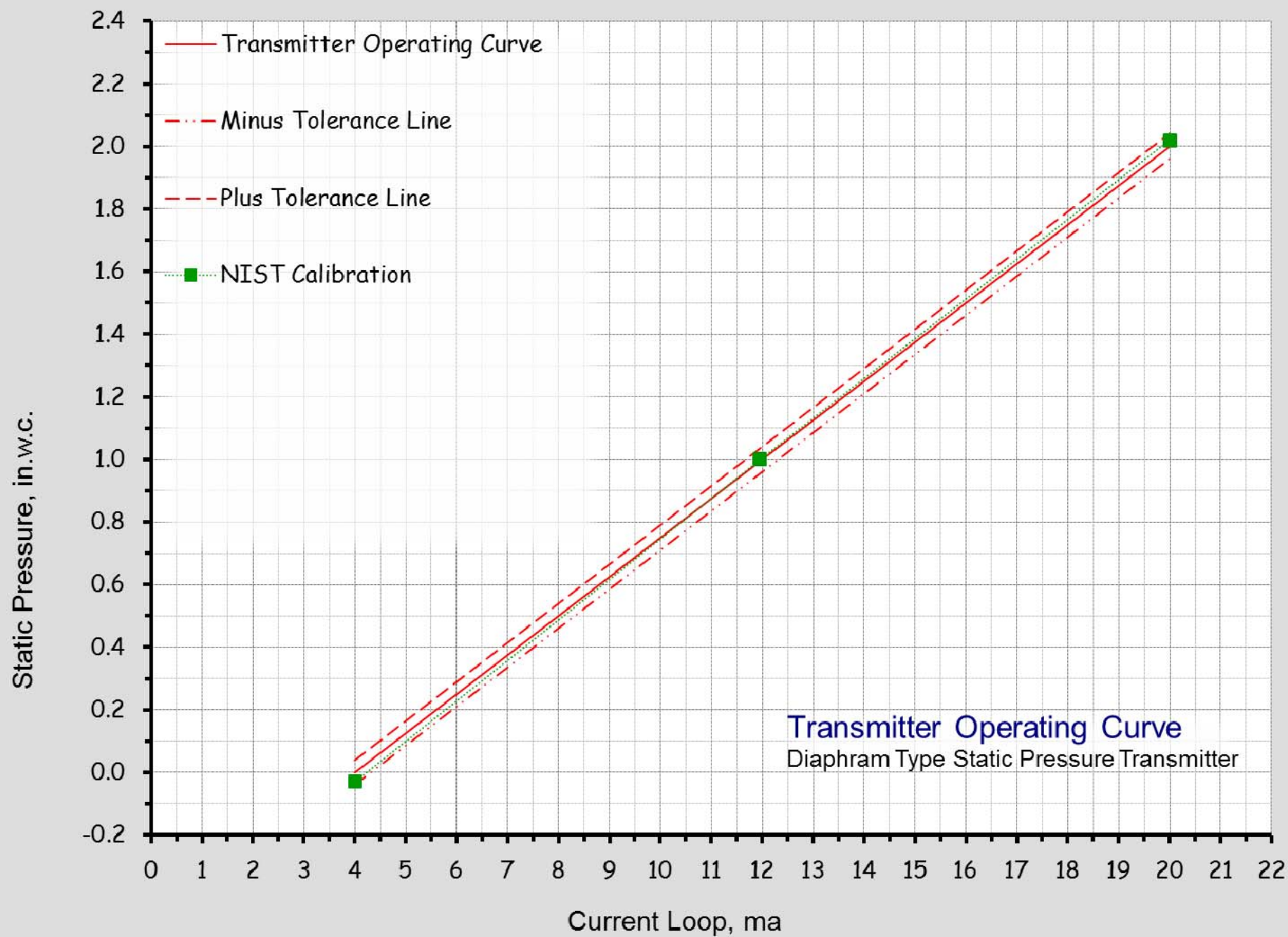
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JTC0868371_Q4-TEMP_RTC_1



TAB 4-4 - SINGLE VS. MULTIPOINT CALIBRATION



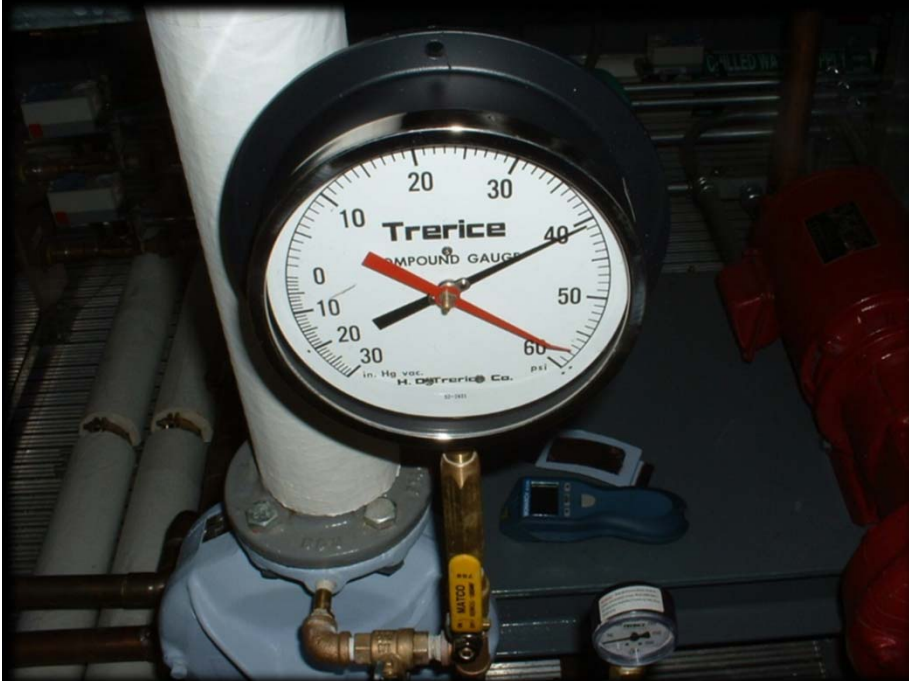


Un-Calibration

Use an Un-calibrated Standard



Un-Calibration Misread Your Instrument

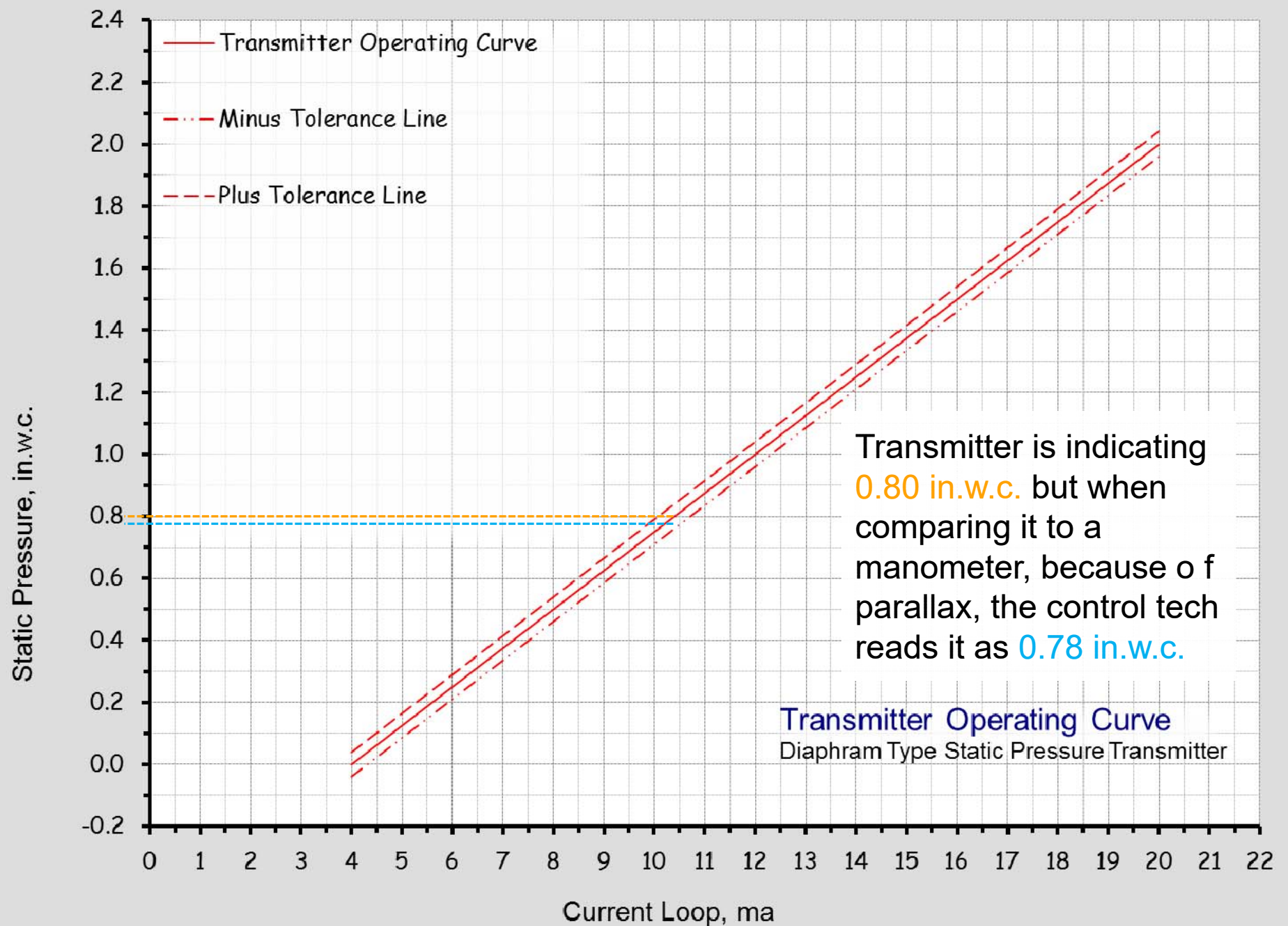


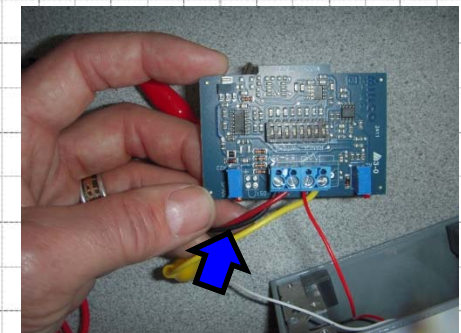
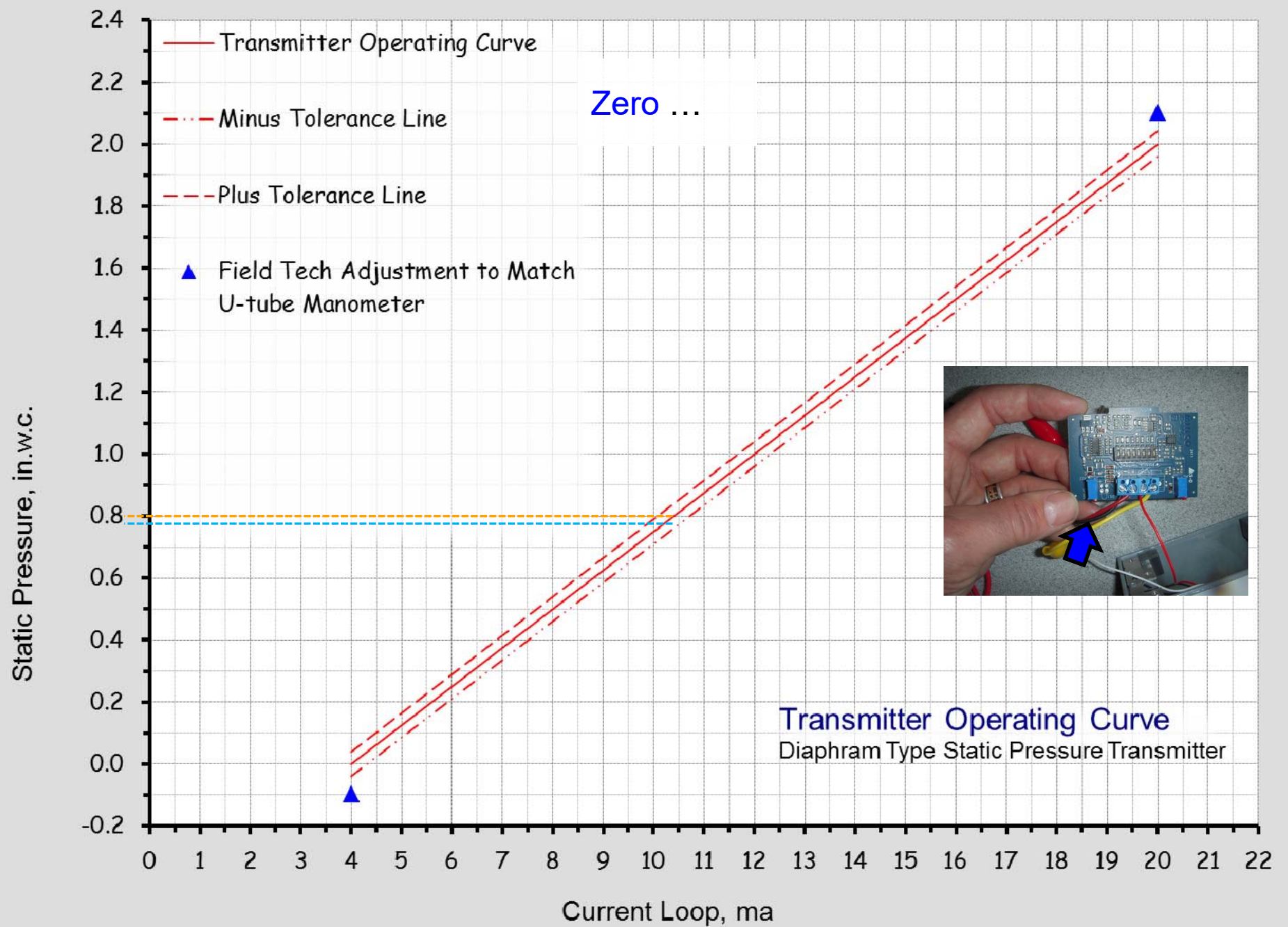
TAB 4-4 - SINGLE VS. MULTIPOINT CALIBRATION

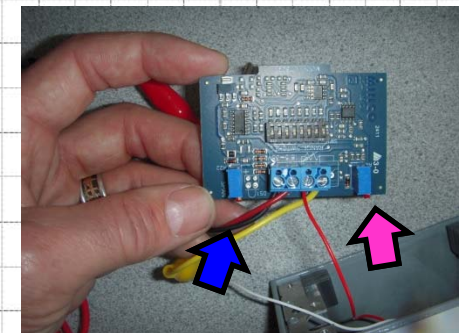
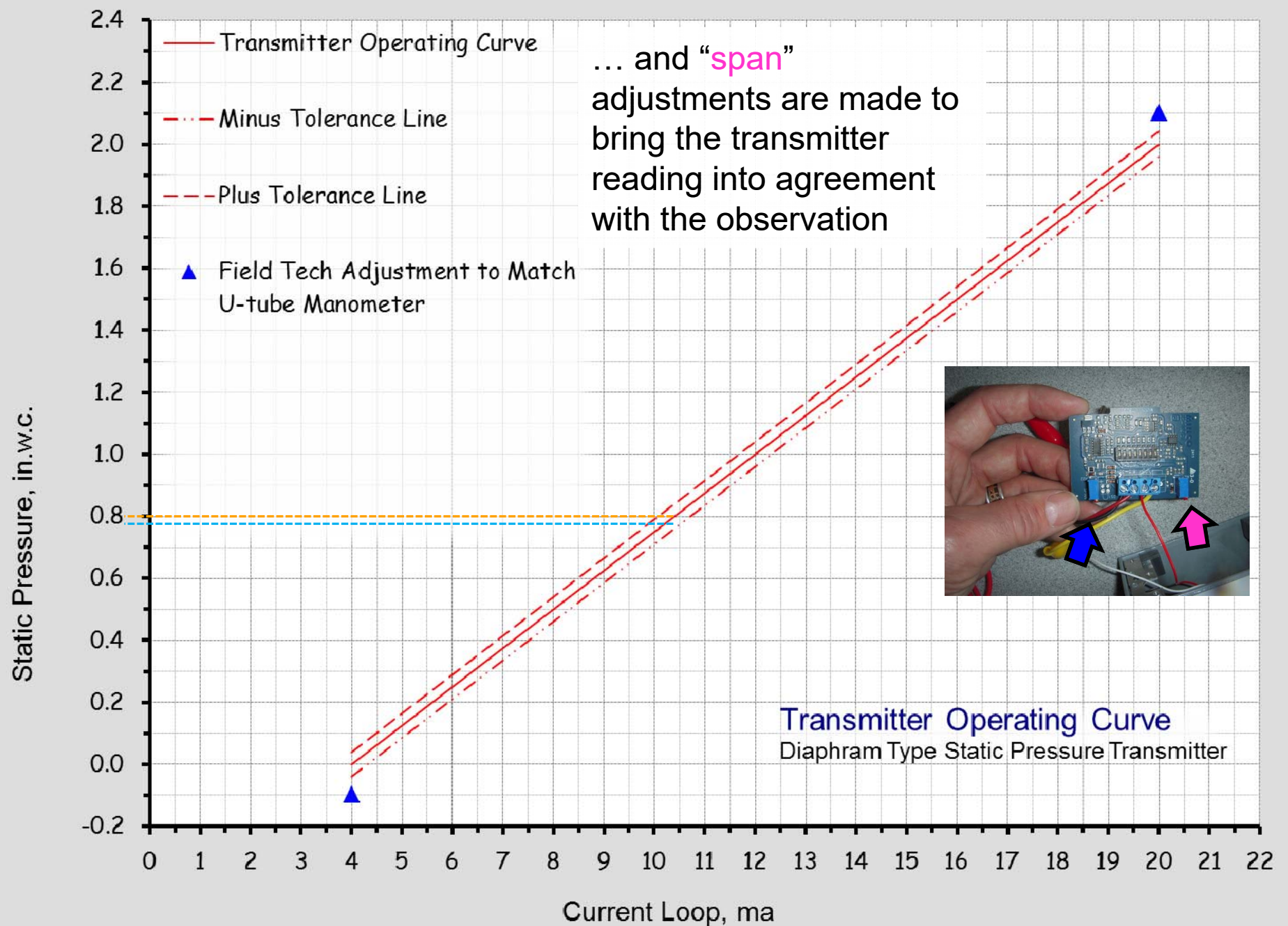
Un-Calibration Misread Your Instrument

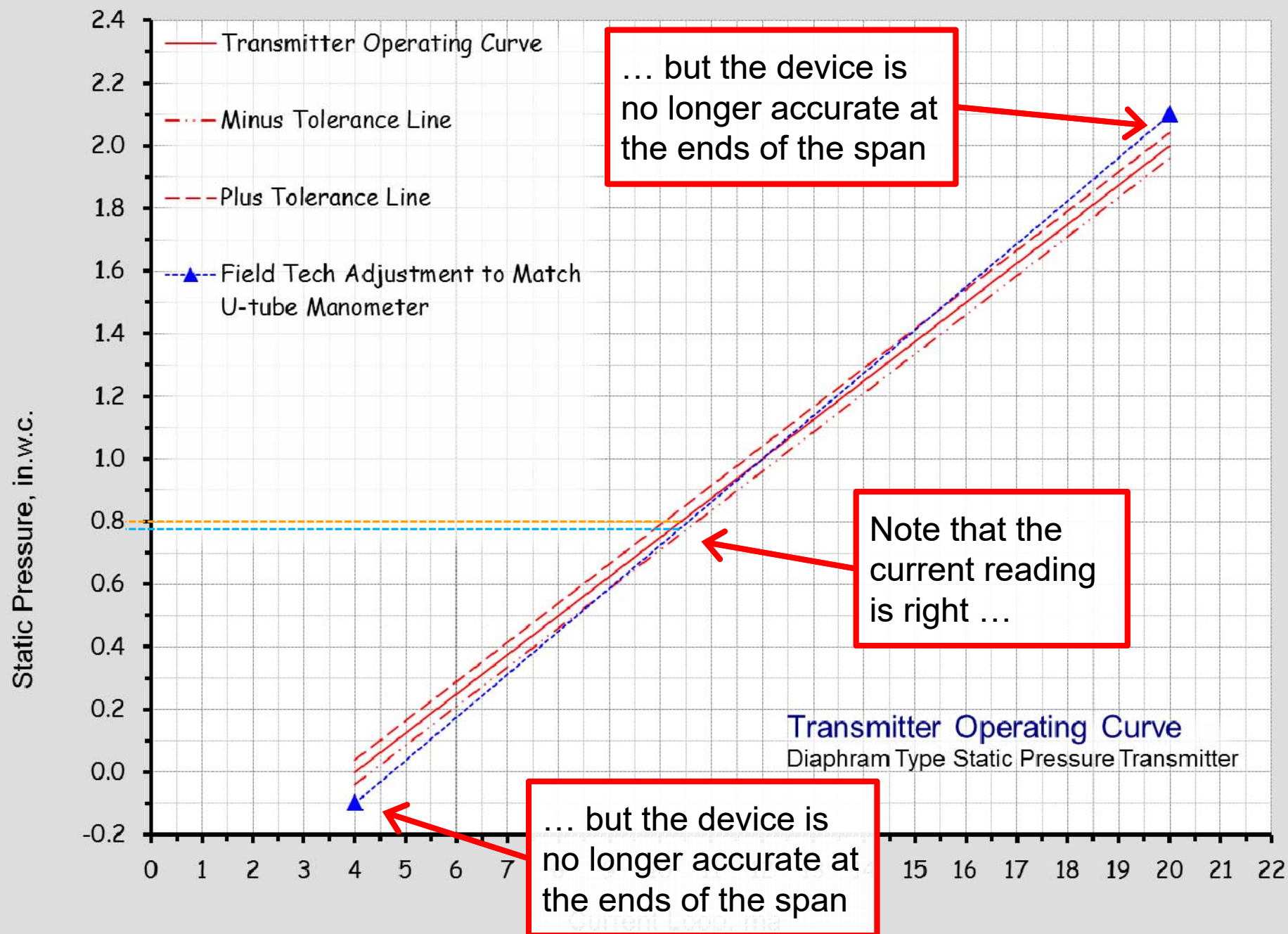
Reflection of Meniscus

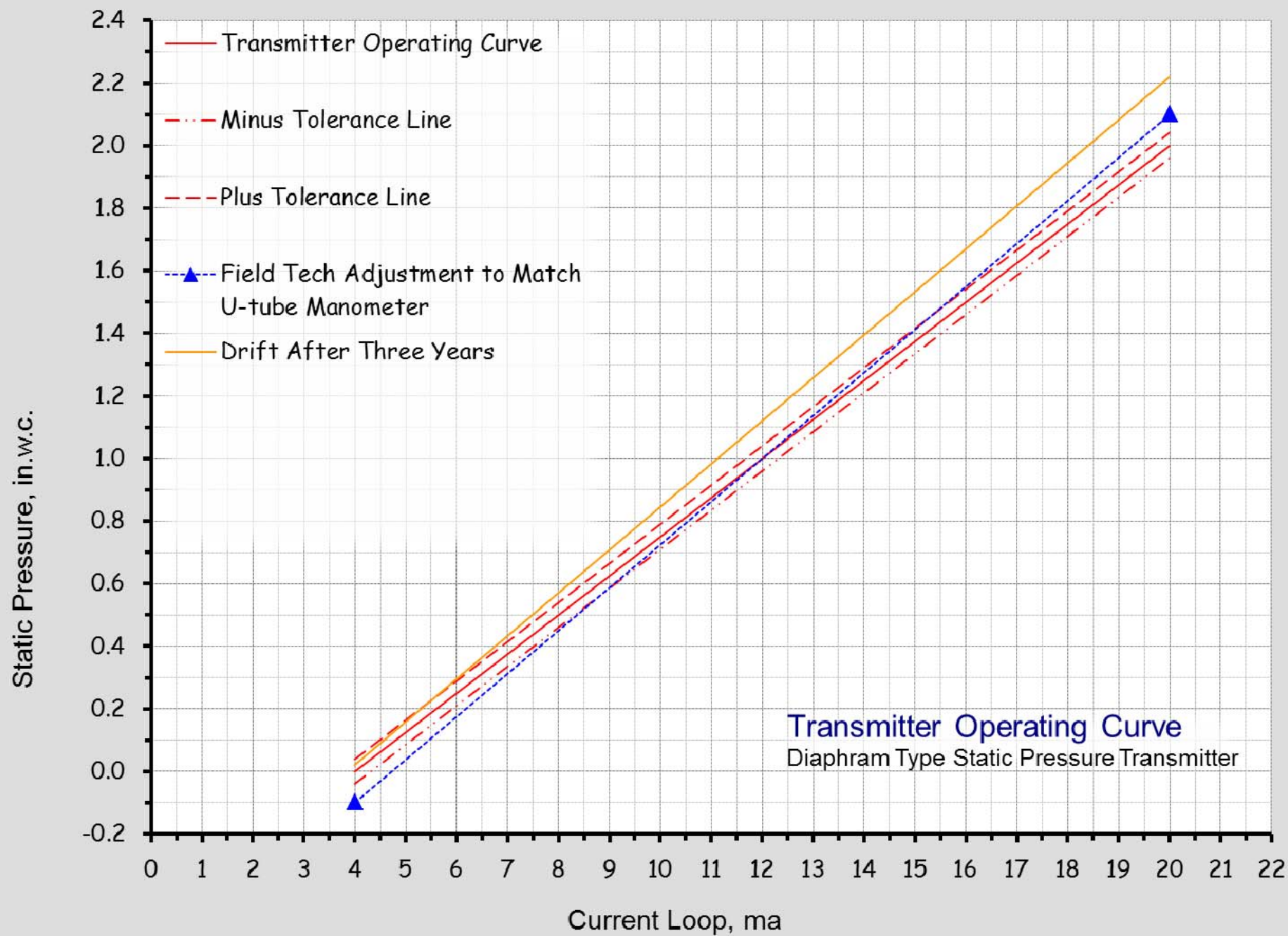
Meniscus

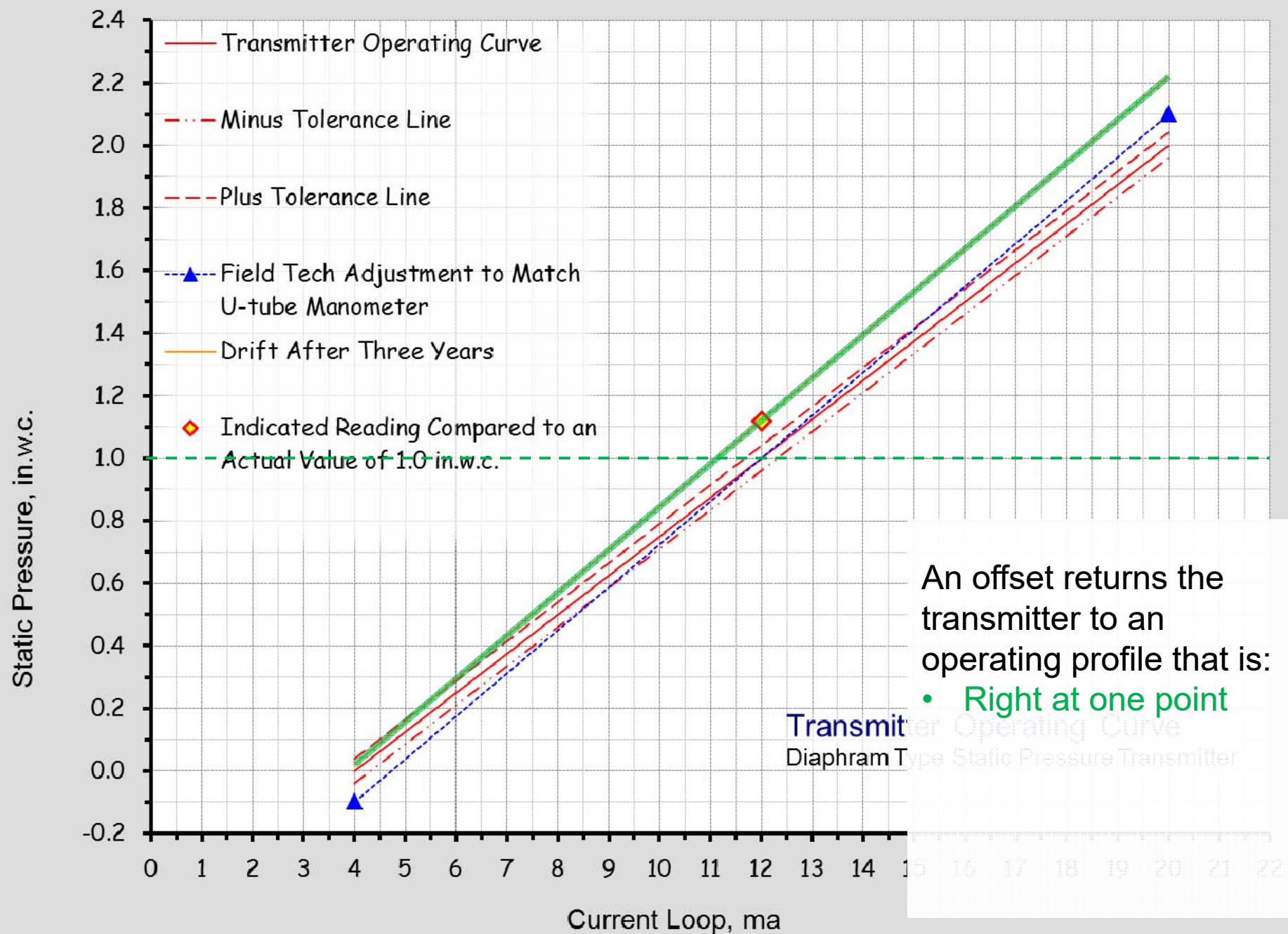


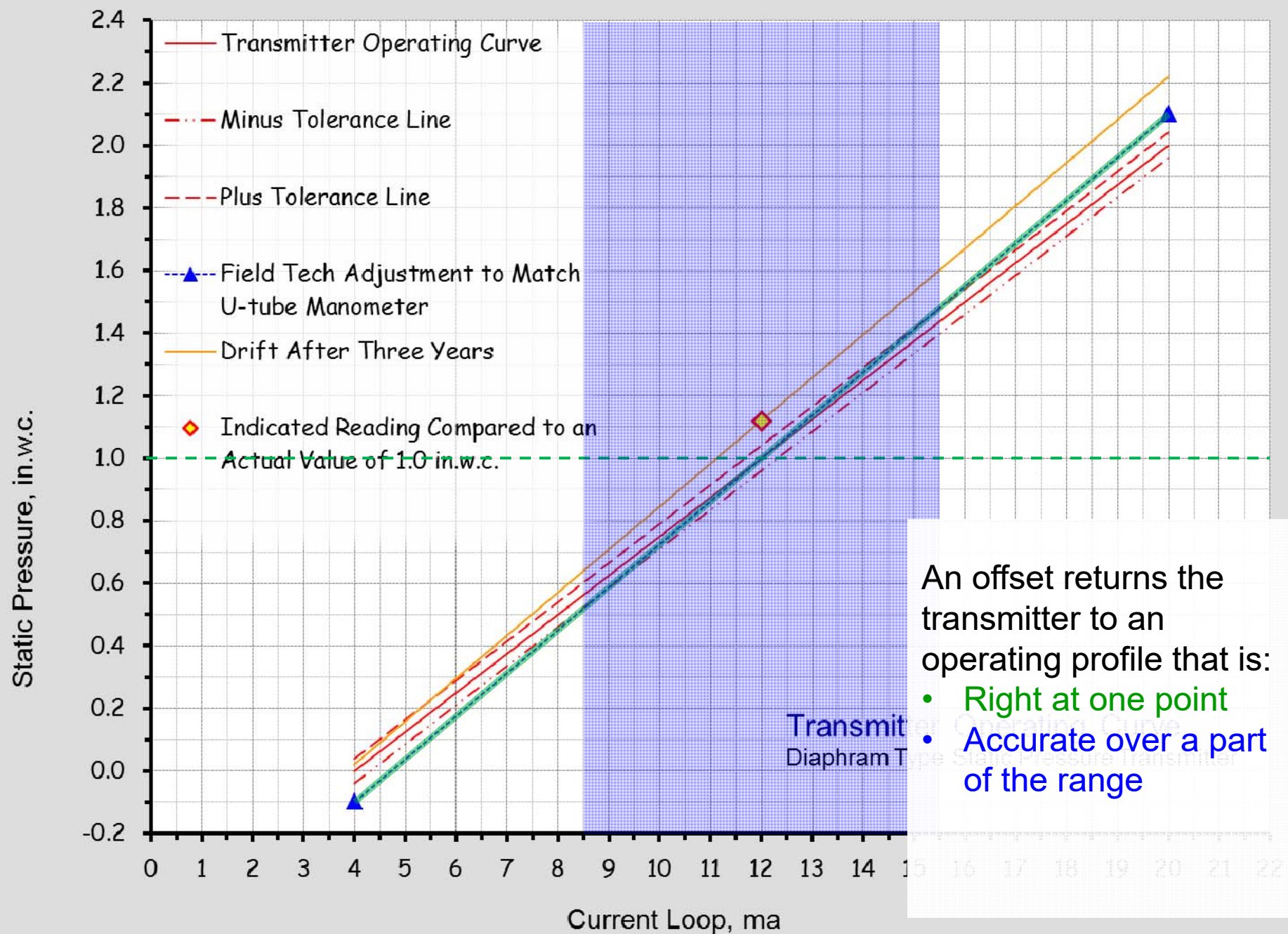






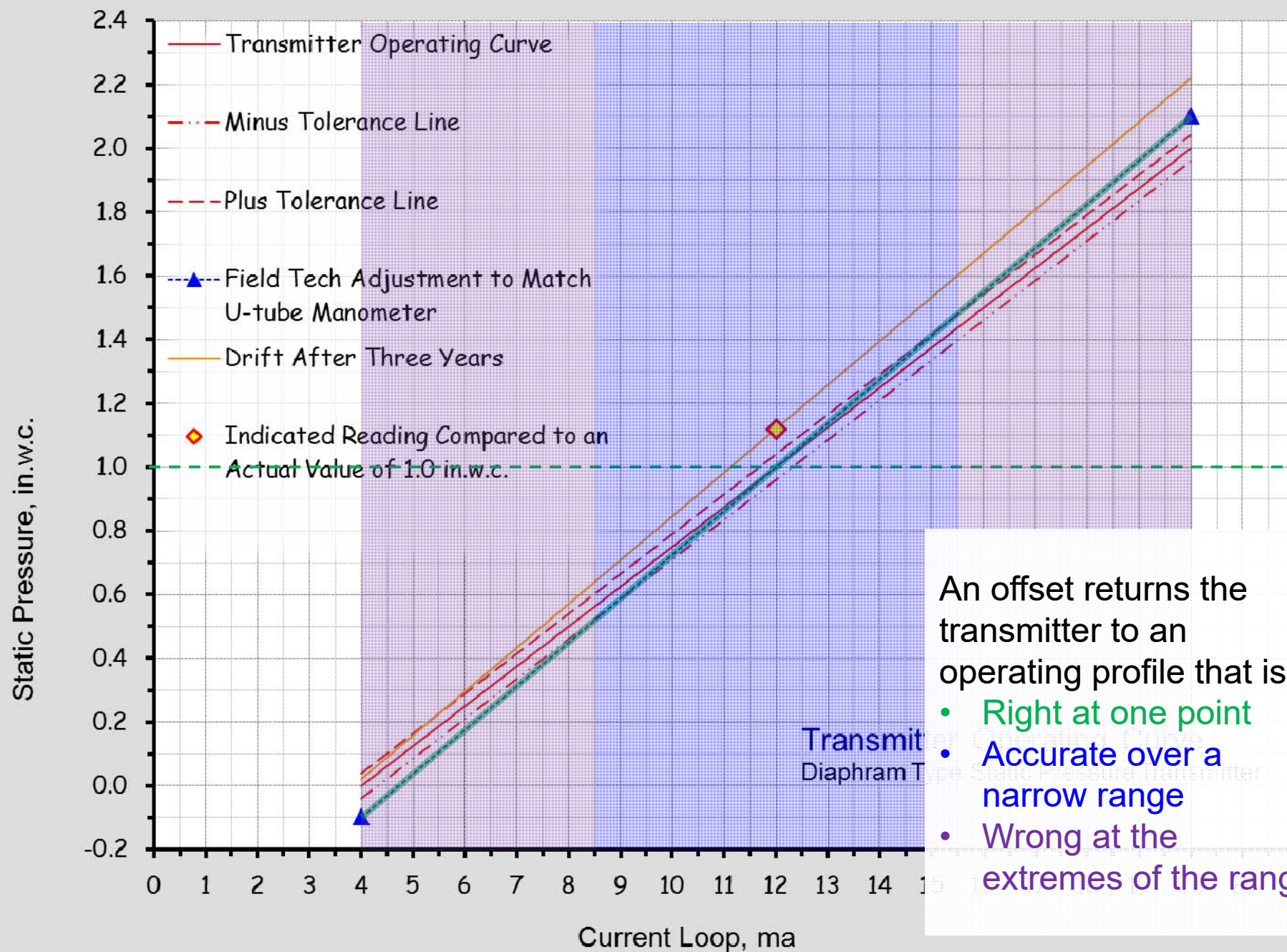






An offset returns the transmitter to an operating profile that is:

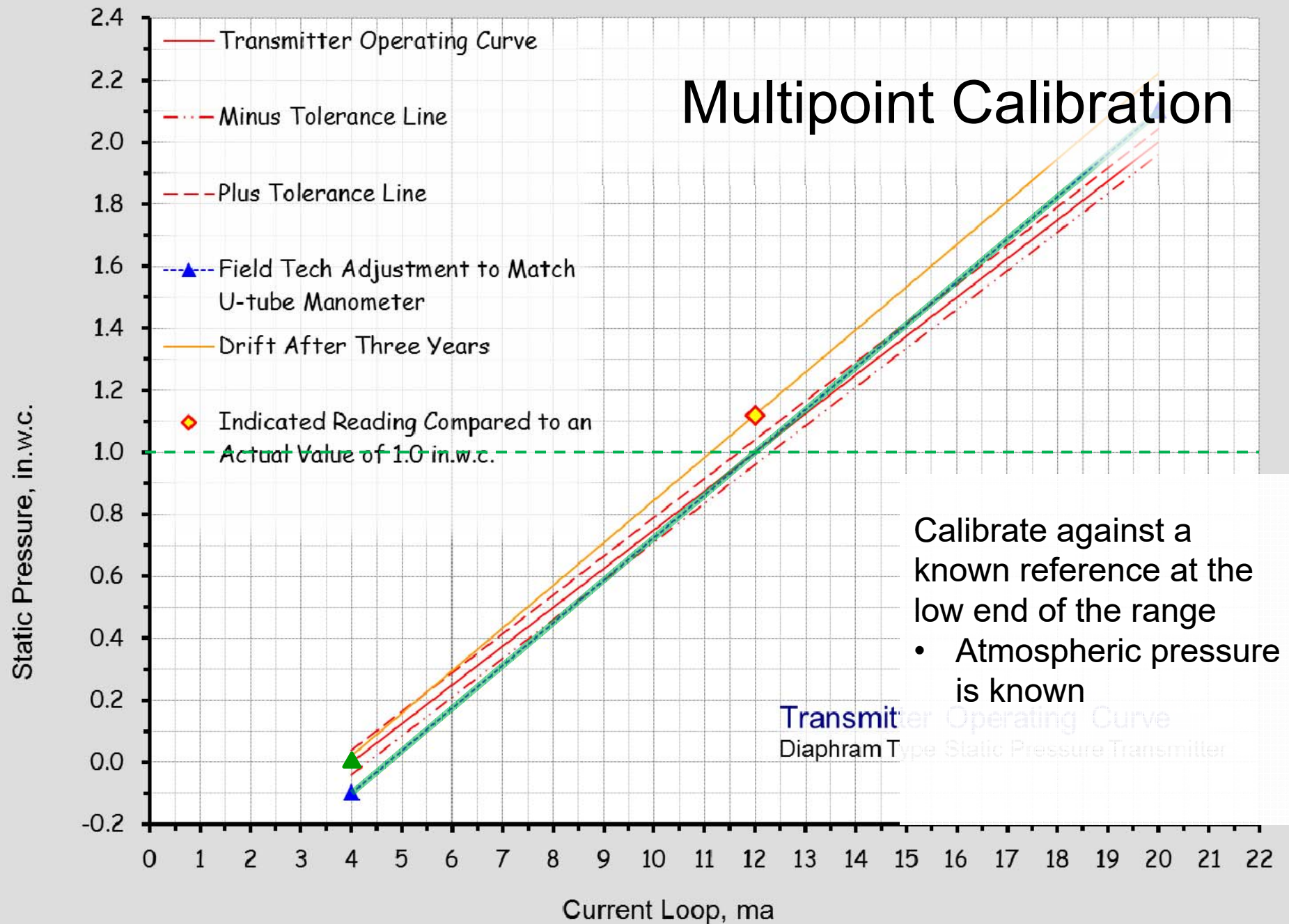
- Right at one point
- Accurate over a part of the range

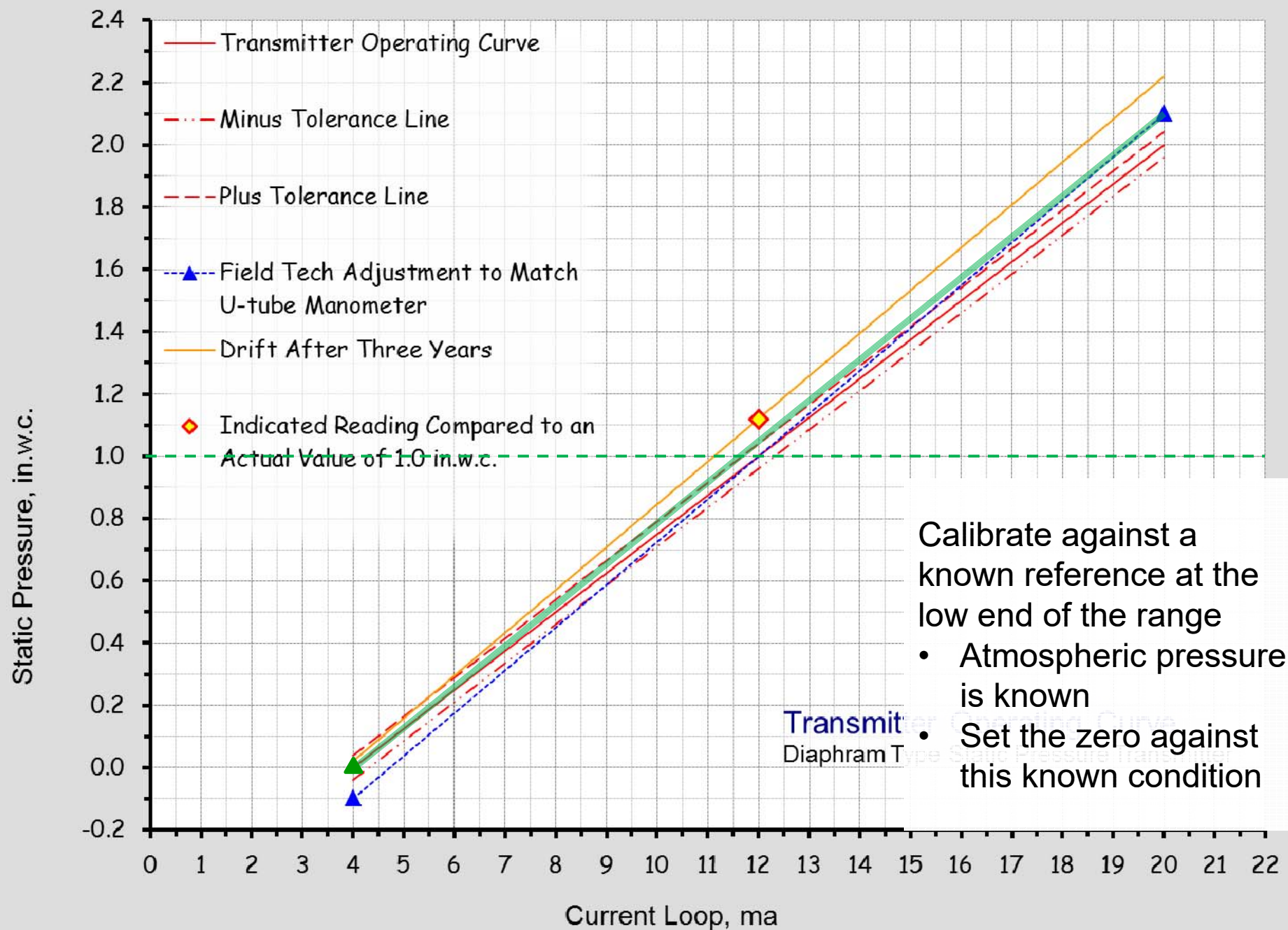


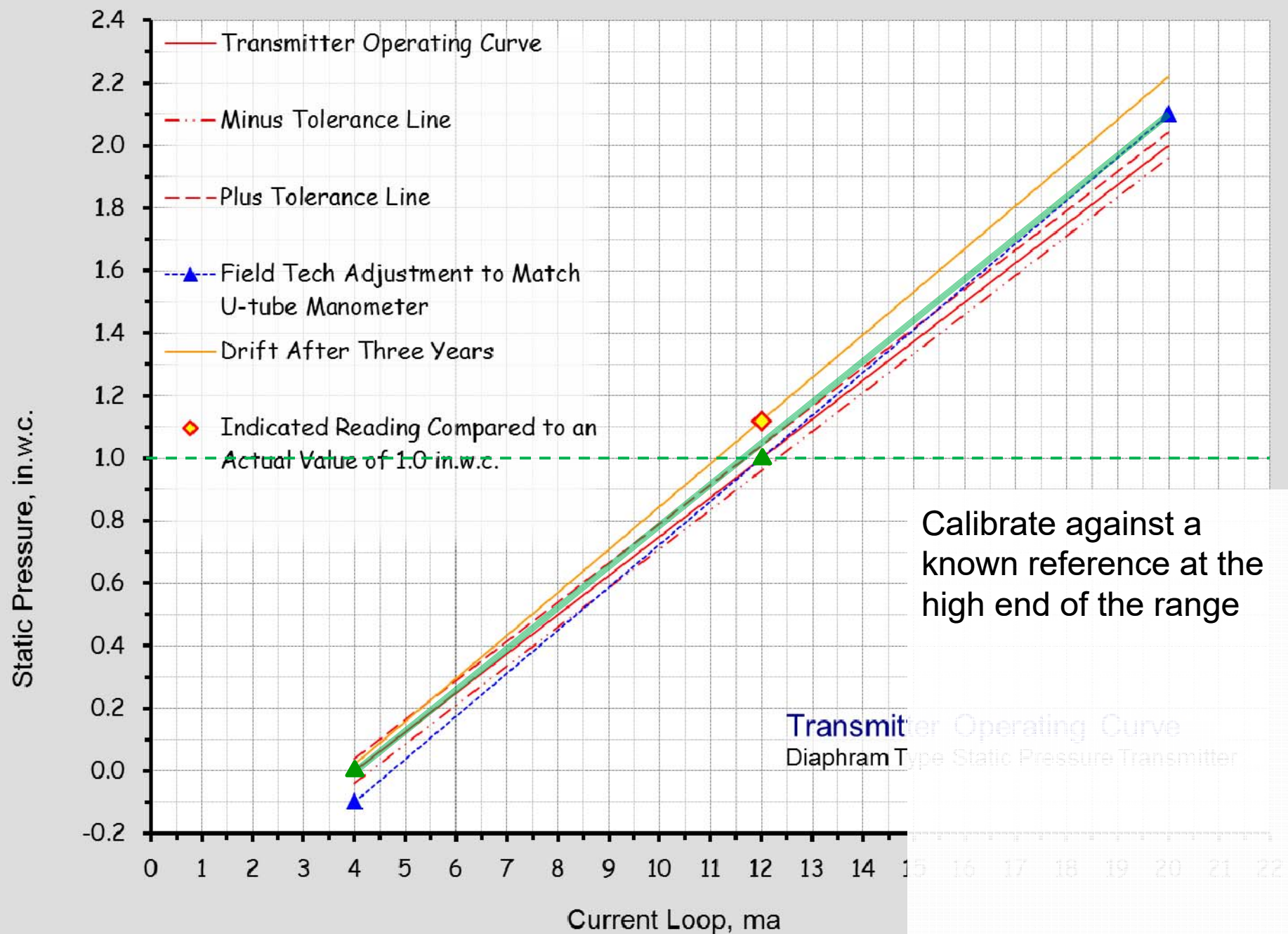
An offset returns the transmitter to an operating profile that is:

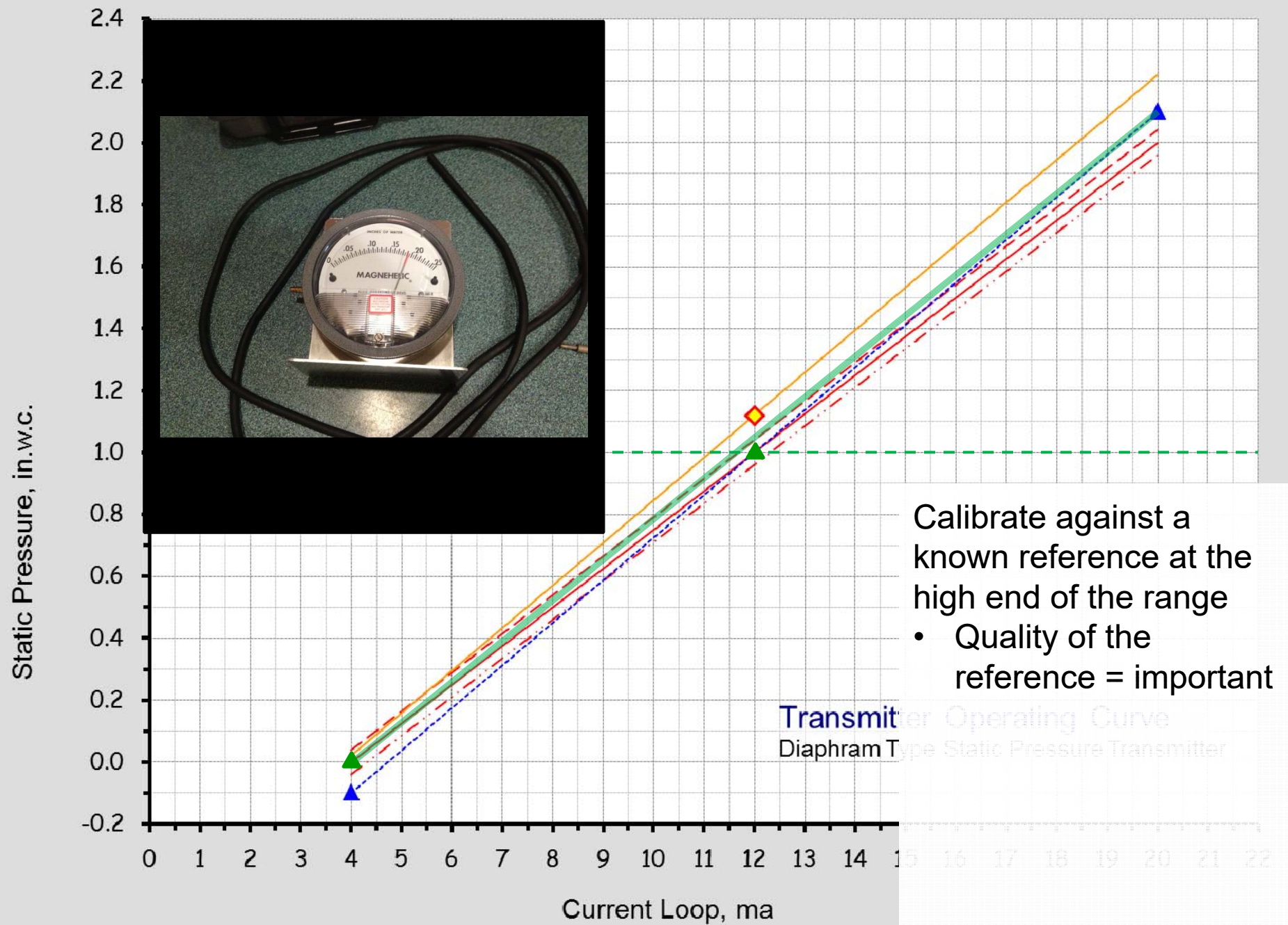
- Right at one point
- Accurate over a narrow range
- Wrong at the extremes of the range

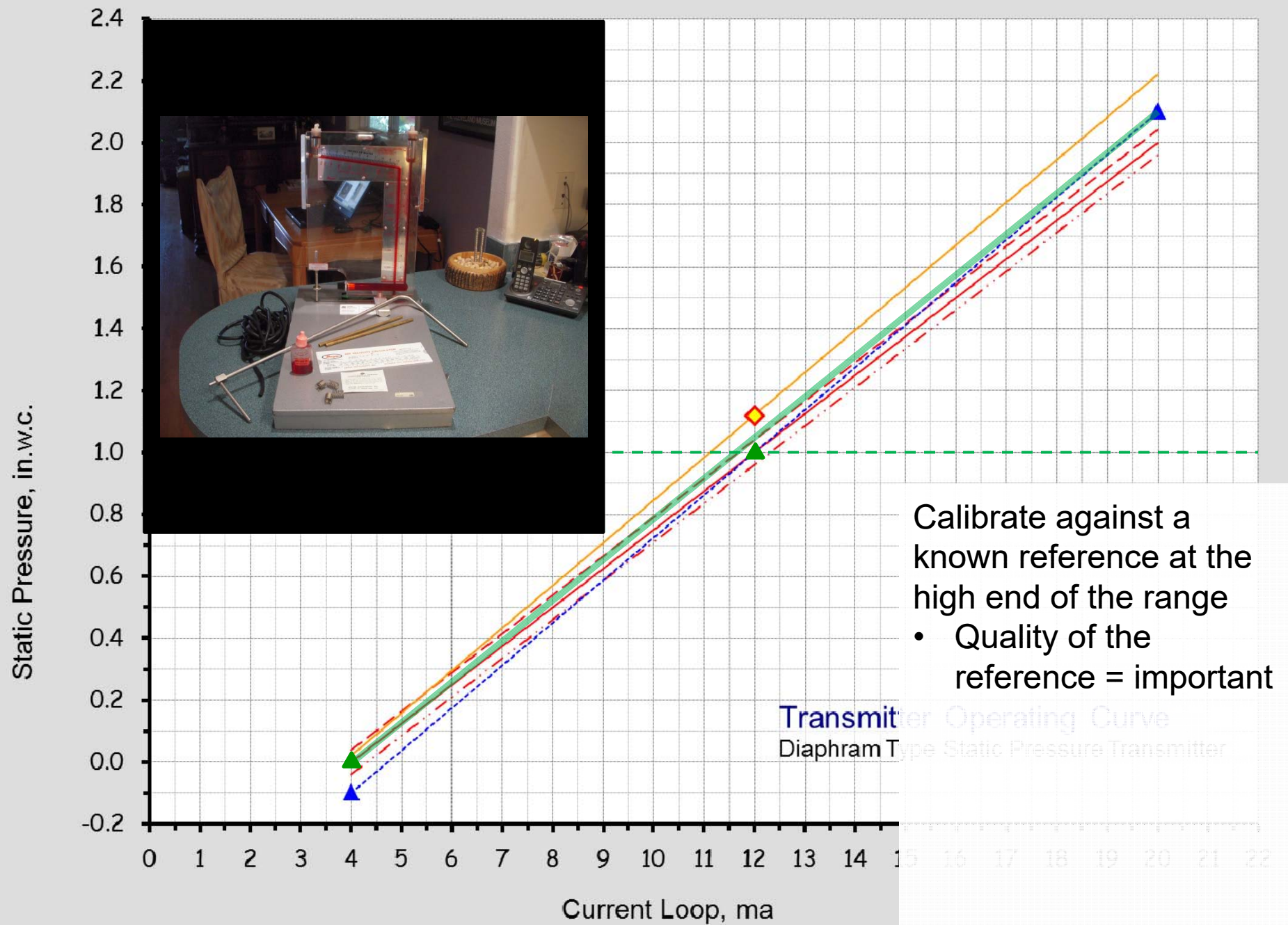
Multipoint Calibration





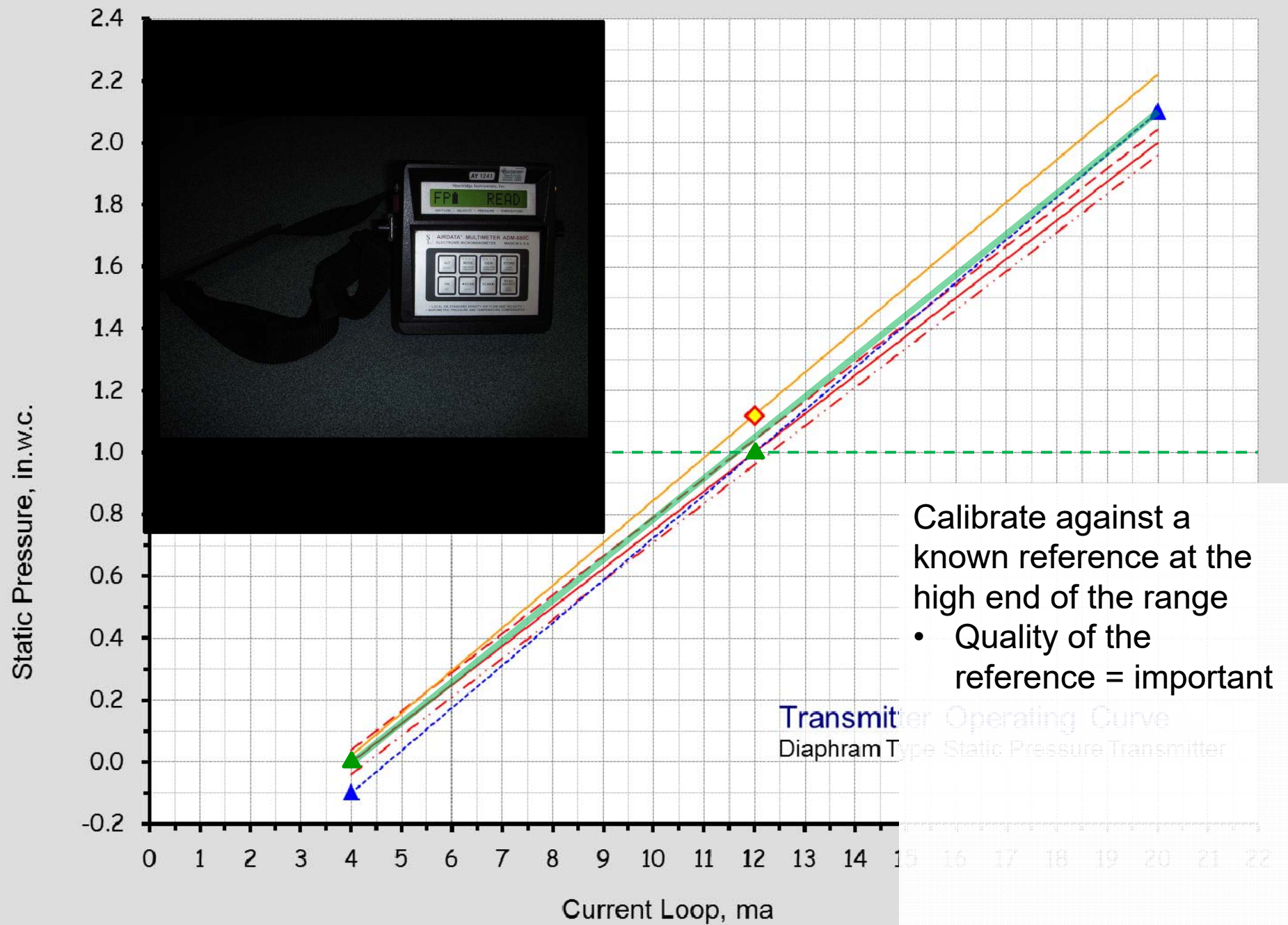


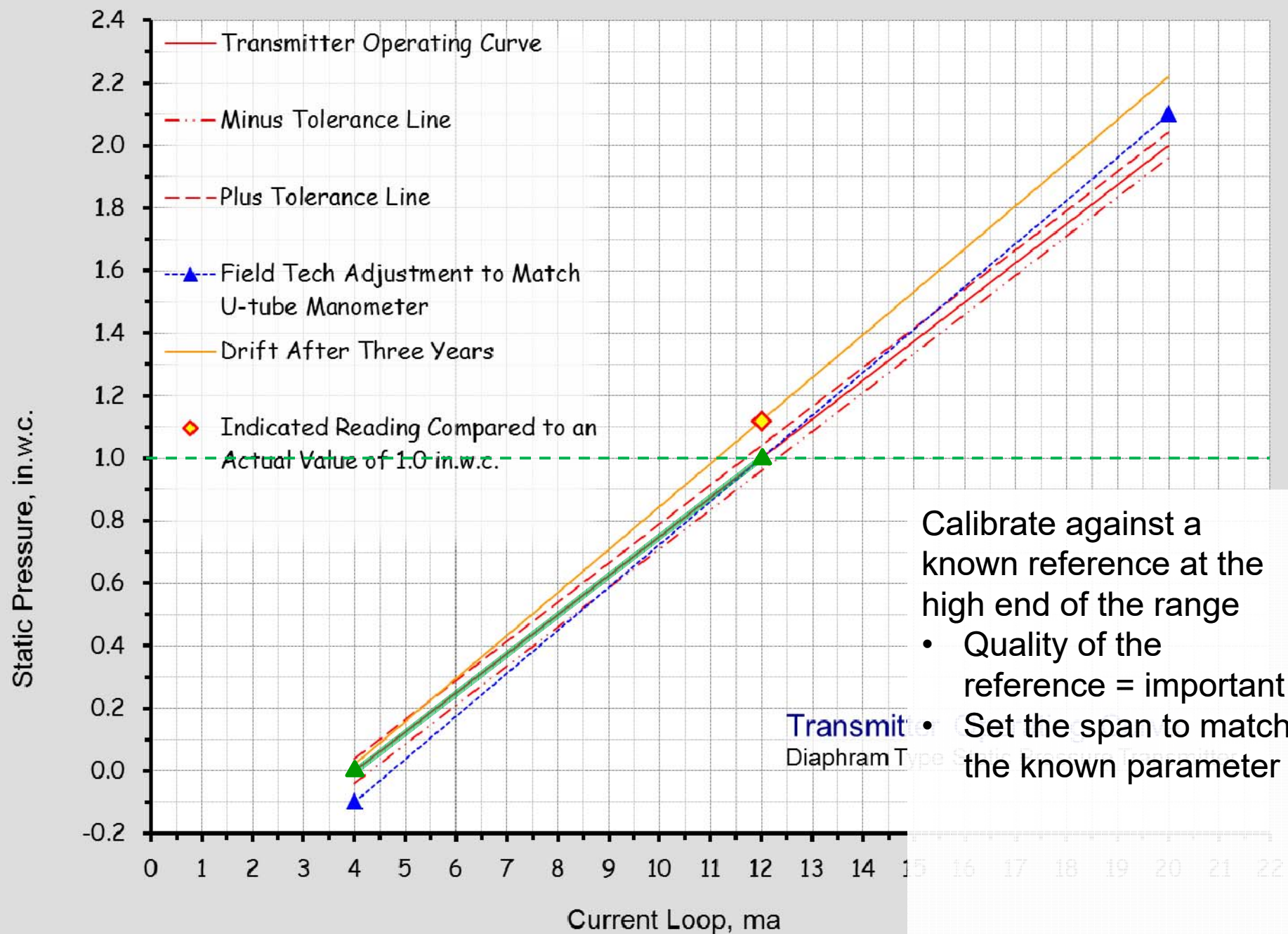




Calibrate against a known reference at the high end of the range

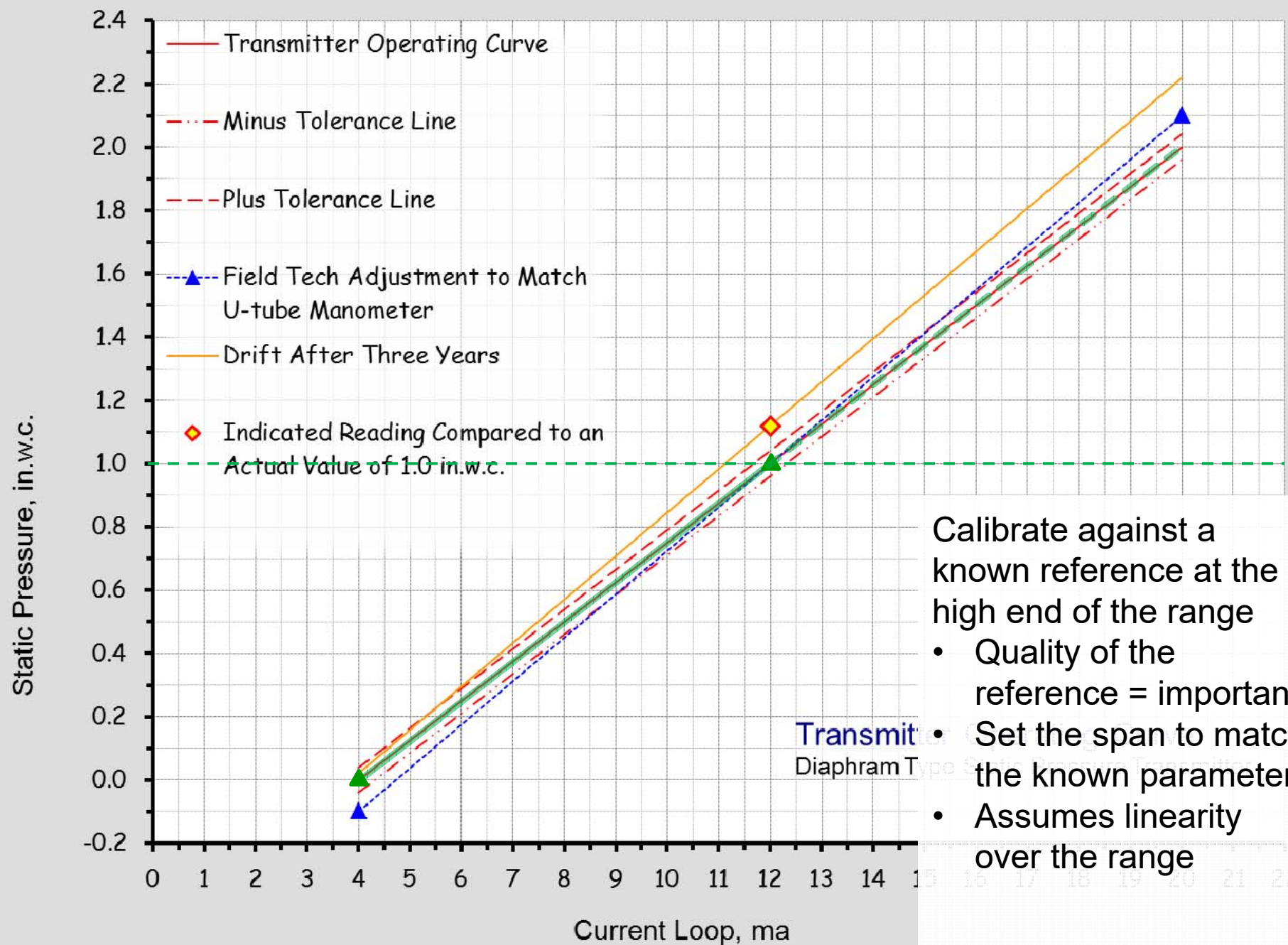
- Quality of the reference = important





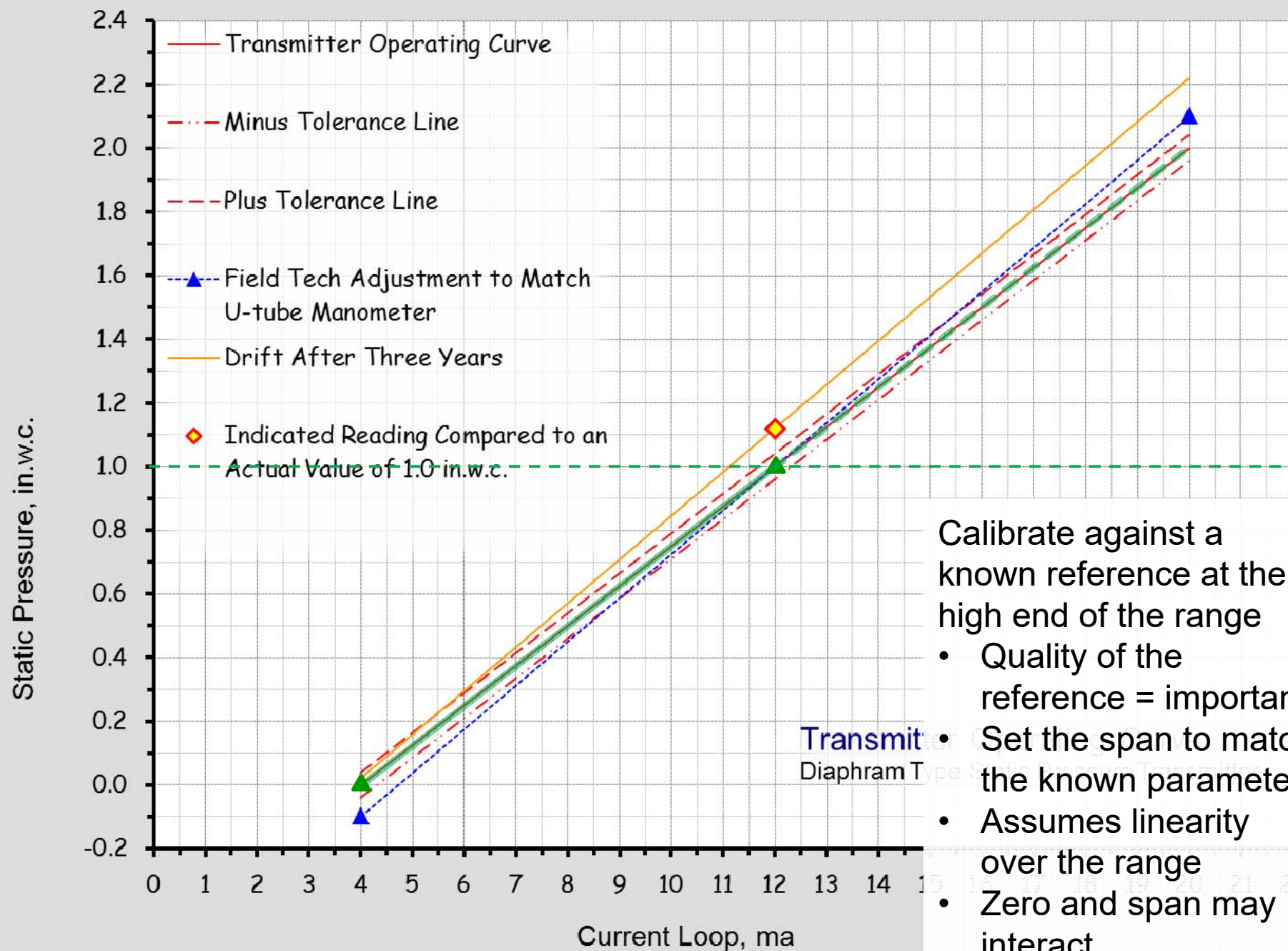
Calibrate against a known reference at the high end of the range

- Quality of the reference = important
- Set the span to match the known parameter



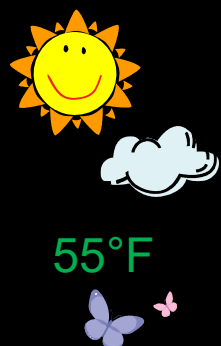
Calibrate against a known reference at the high end of the range

- Quality of the reference = important
- Set the span to match the known parameter
- Assumes linearity over the range



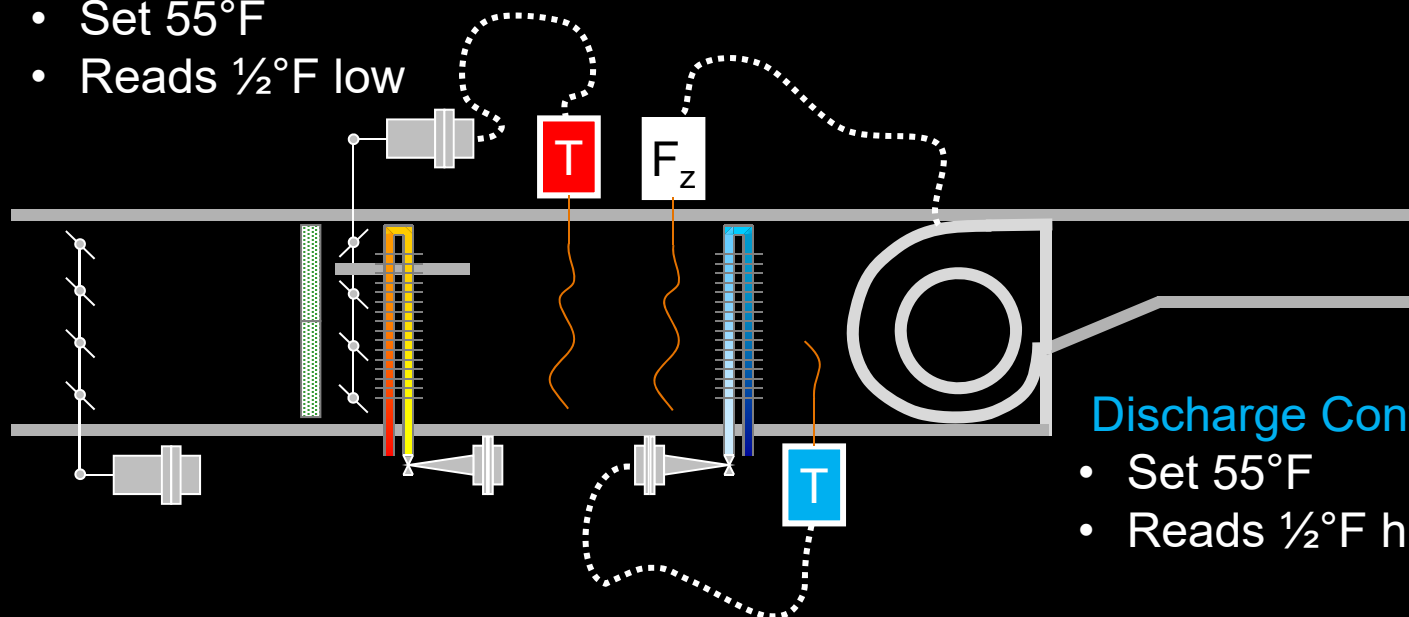
Calibrate against a known reference at the high end of the range

- Quality of the reference = important
- Set the span to match the known parameter
- Assumes linearity over the range
- Zero and span may interact



Preheat Controller

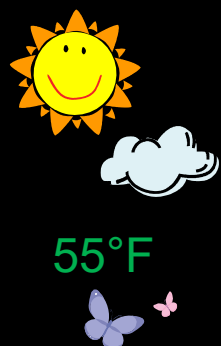
- Set 55°F
- Reads $\frac{1}{2}^{\circ}\text{F}$ low



Discharge Controller

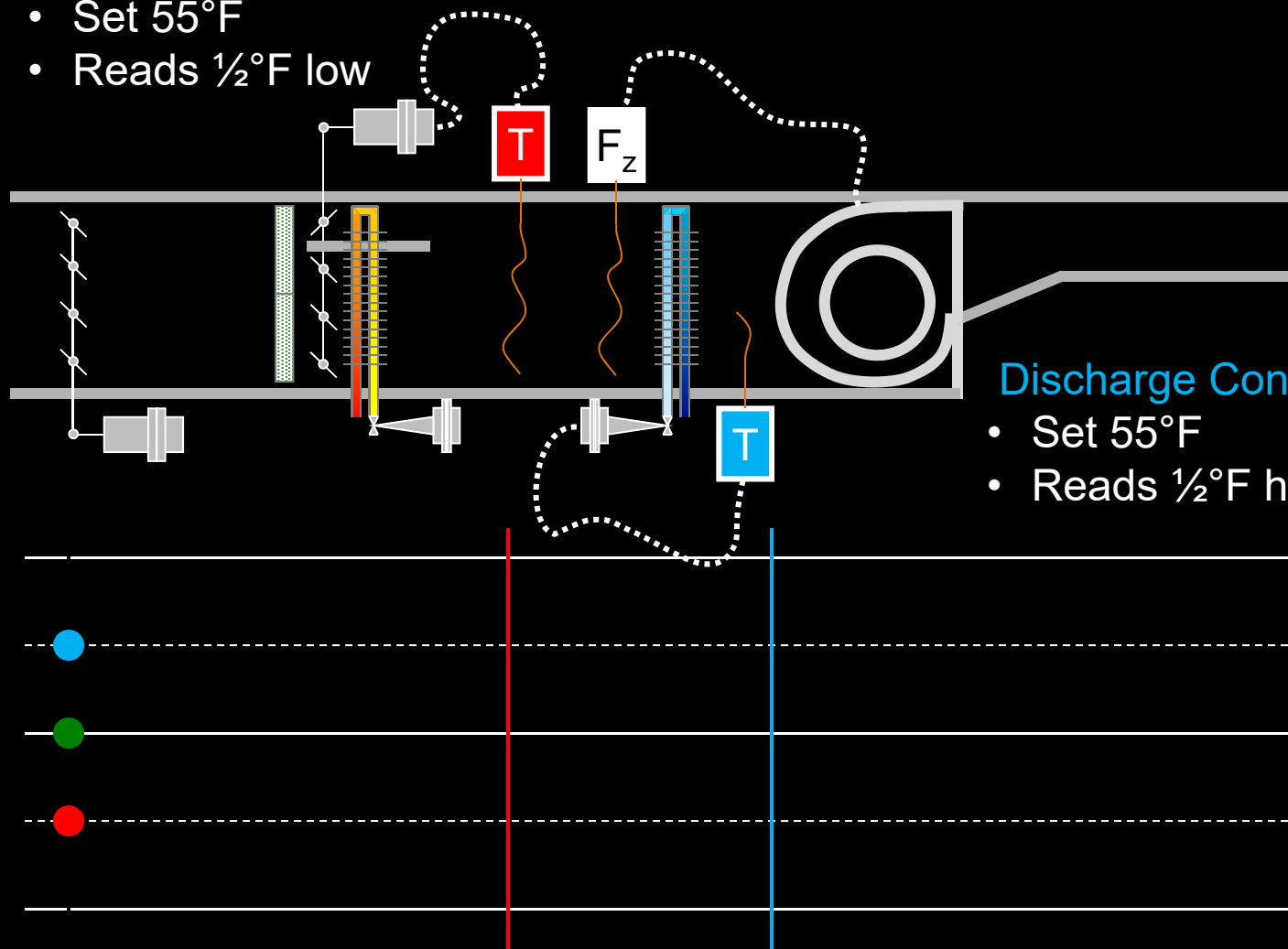
- Set 55°F
- Reads $\frac{1}{2}^{\circ}\text{F}$ high

Relative Calibration/Accuracy



Preheat Controller

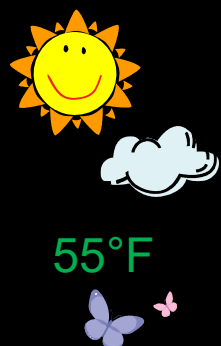
- Set 55°F
- Reads ½°F low



Discharge Controller

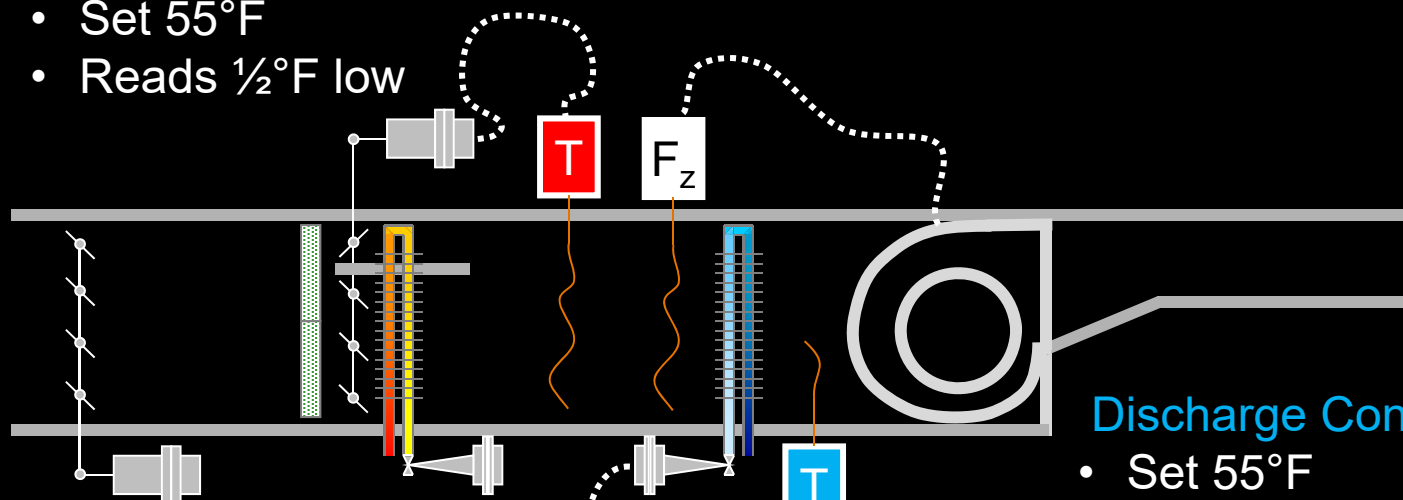
- Set 55°F
- Reads ½°F high

Relative Calibration/Accuracy



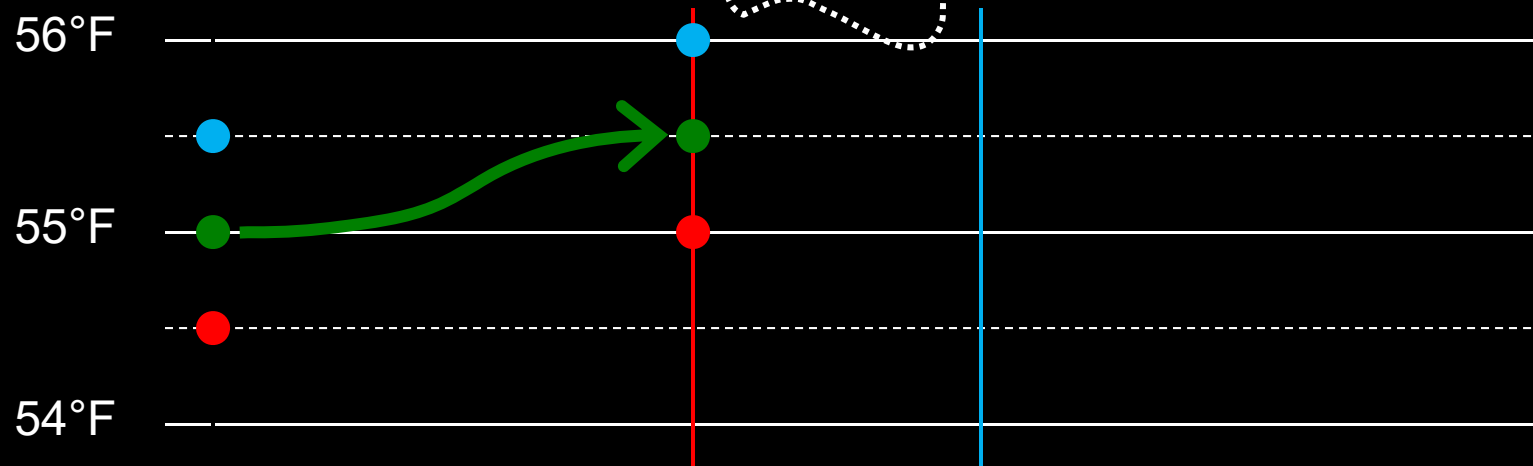
Preheat Controller

- Set 55°F
- Reads ½°F low

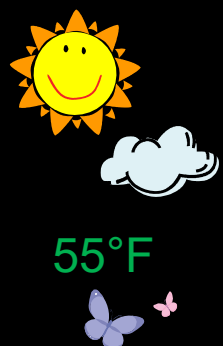


Discharge Controller

- Set 55°F
- Reads ½°F high

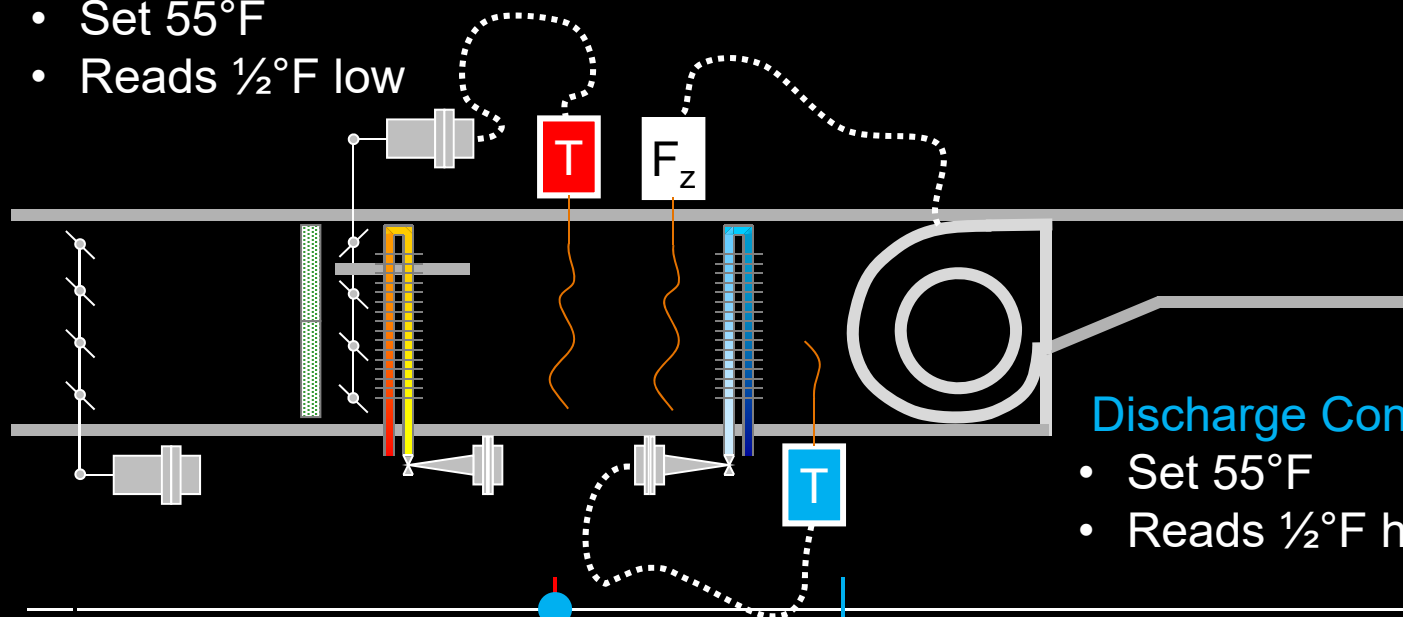


Relative Calibration/Accuracy



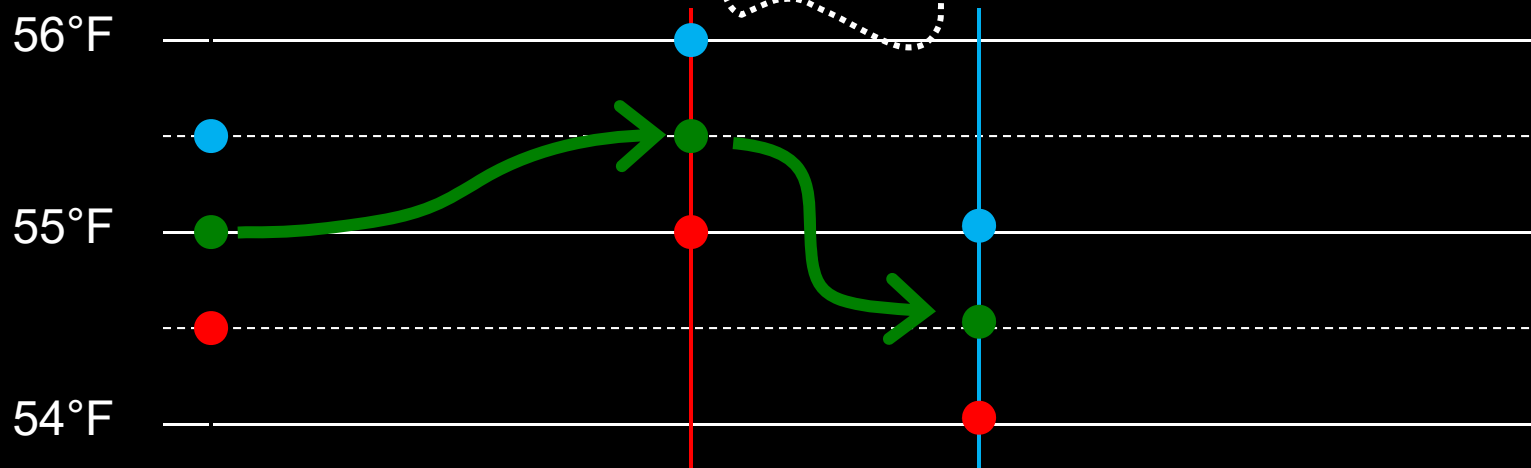
Preheat Controller

- Set 55°F
- Reads ½°F low



Discharge Controller

- Set 55°F
- Reads ½°F high



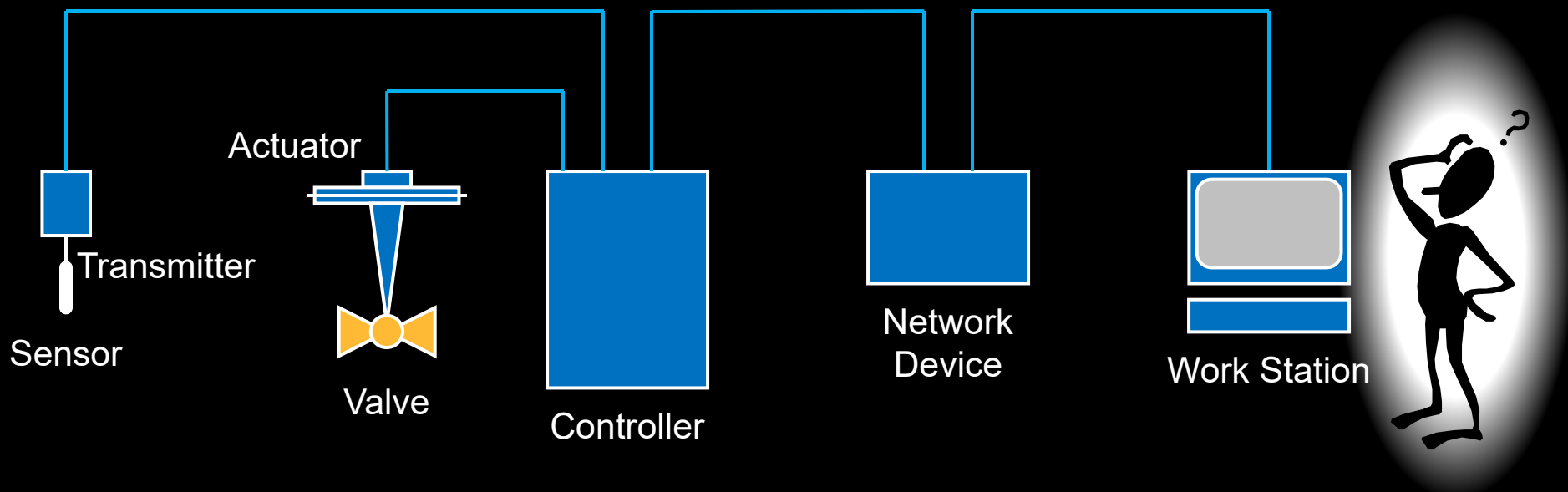
Relative Calibration/Accuracy

What You See is What You Get;

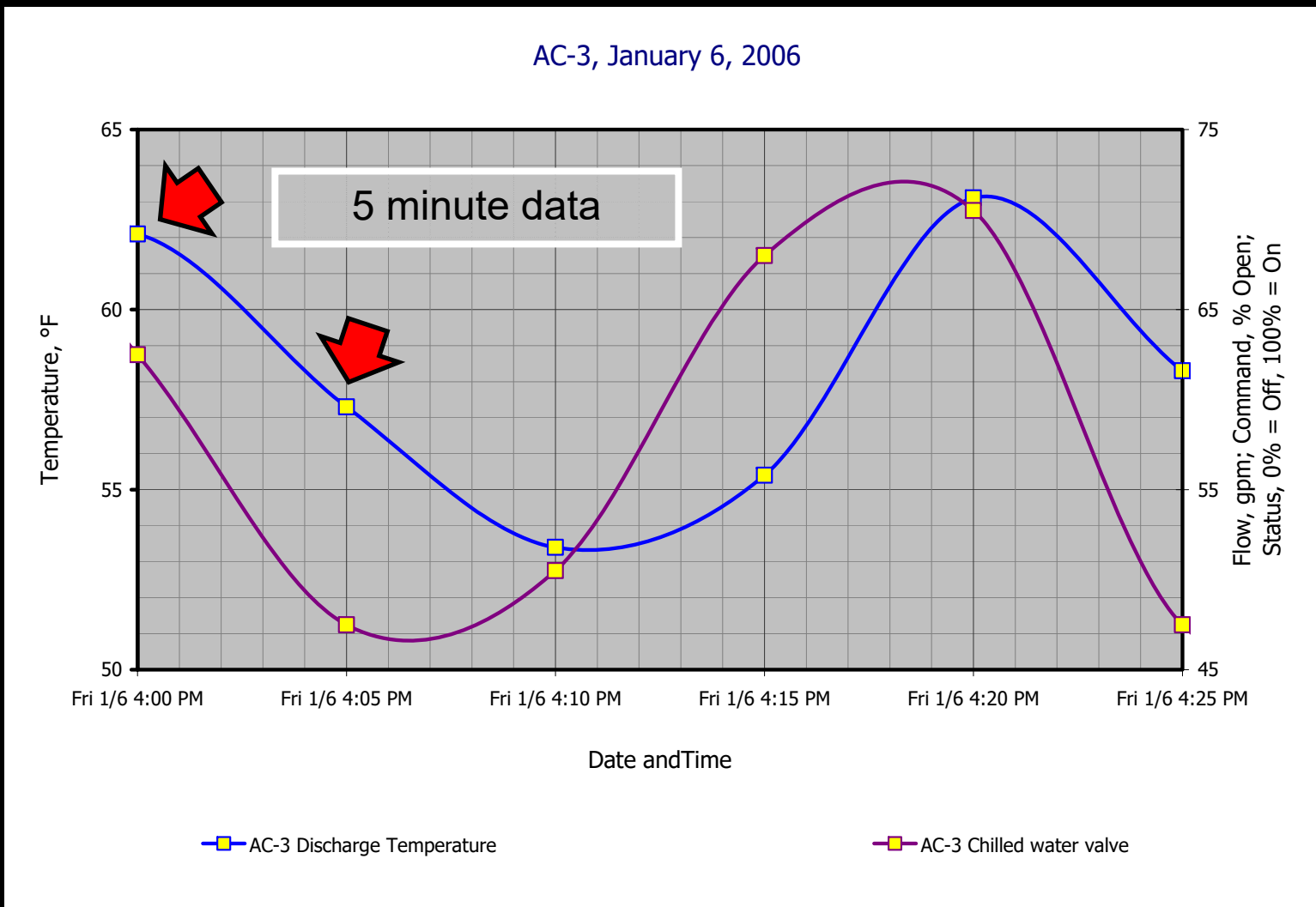
Maybe ...

... or maybe not

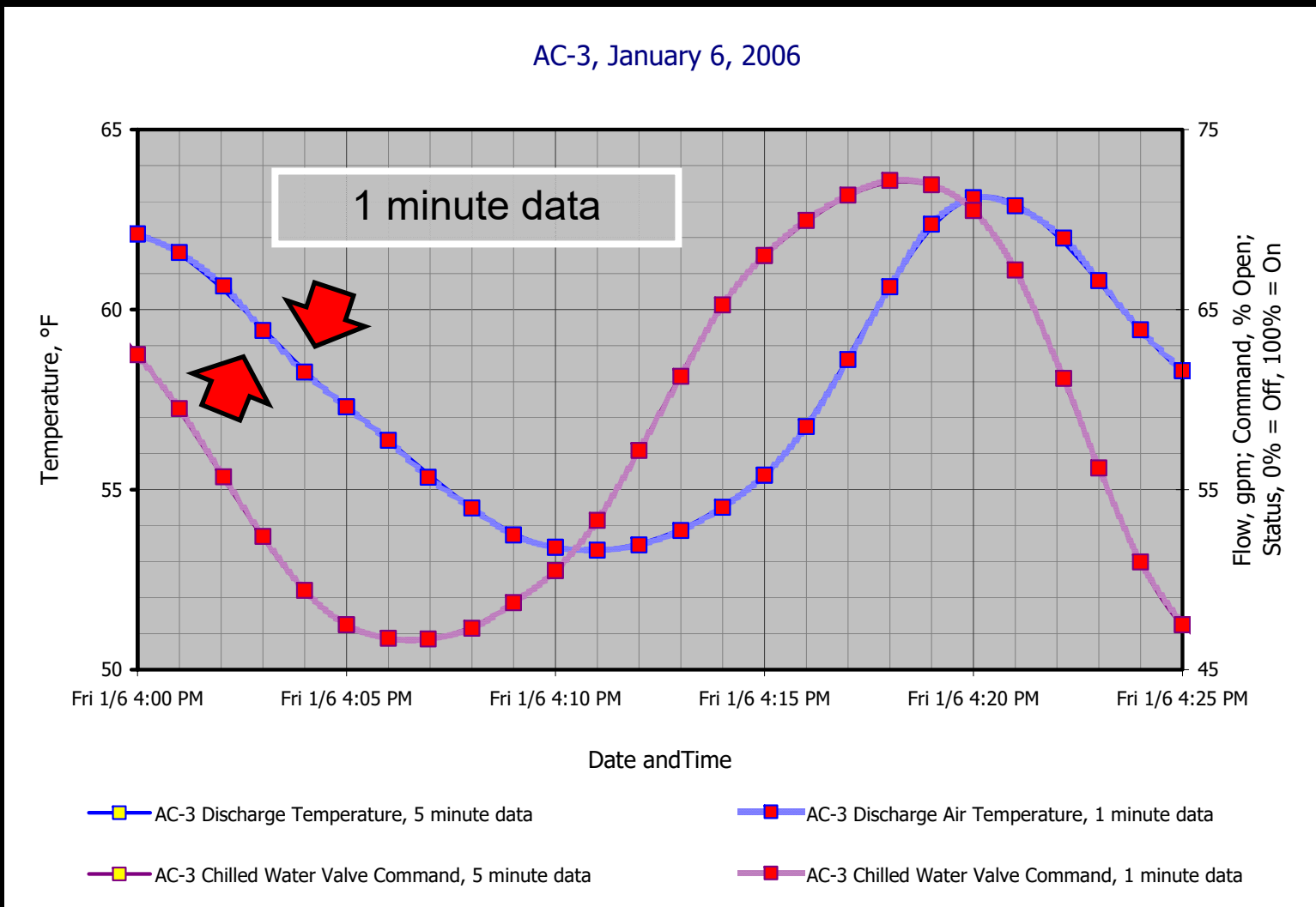
- There are many elements between the sensor and the observer and the observer and the actuator
- All of them can impact accuracy, precision, and performance



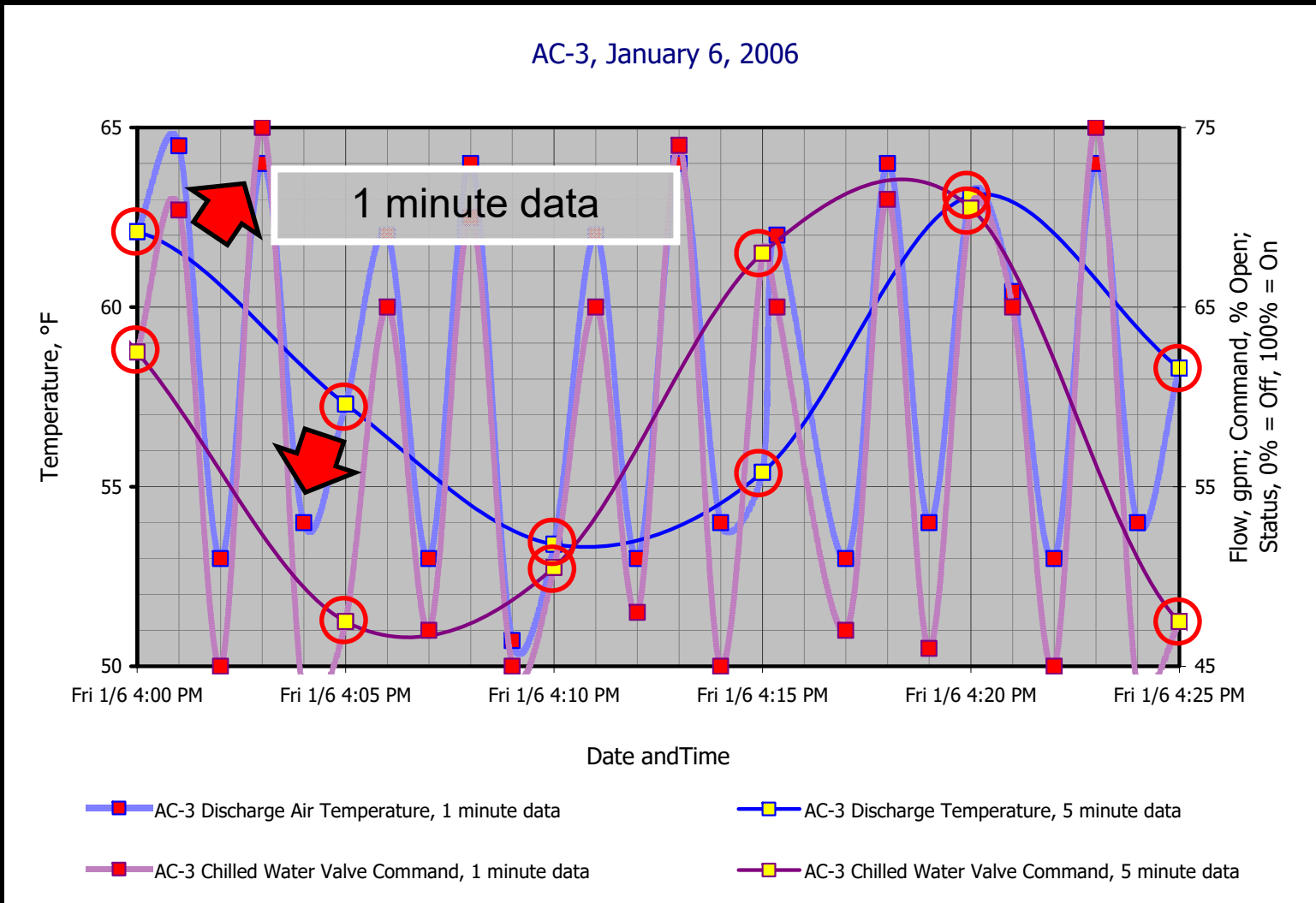
What You Sense is What You Get;



What You Sense is What You Get; *Maybe ...*



What You Sense is What You Get; *Or Maybe Not!*



TAB 4-5 - RELATIVE ACCURACY AND WISIWIG

The Nyquist Theorem a.k.a the Sampling Theorem

How Fast is Fast Enough

$$f_s \geq 2 \times f_c$$

Where:

f_s = The sampling frequency

f_c = The highest frequency contained in the signal

In words:

The sampling frequency should be at least twice the highest frequency contained in the signal.

The Nyquist Theorem a.k.a the Sampling Theorem

The Theory Behind the Generalization

The slides that follow use a spreadsheet model to compare the number of pump cycles and total operating time predicted by data from a logger with the real time data stream

- The logger only knows what it sees at the time it takes its sample
- The logger is not averaging data between samples
- The logger sampling time starts out at twice the feed water pump run cycle time and is reduced to one third of the feed water pump run cycle time

