What's Behind Your Test Kit Measurements?

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Our Background

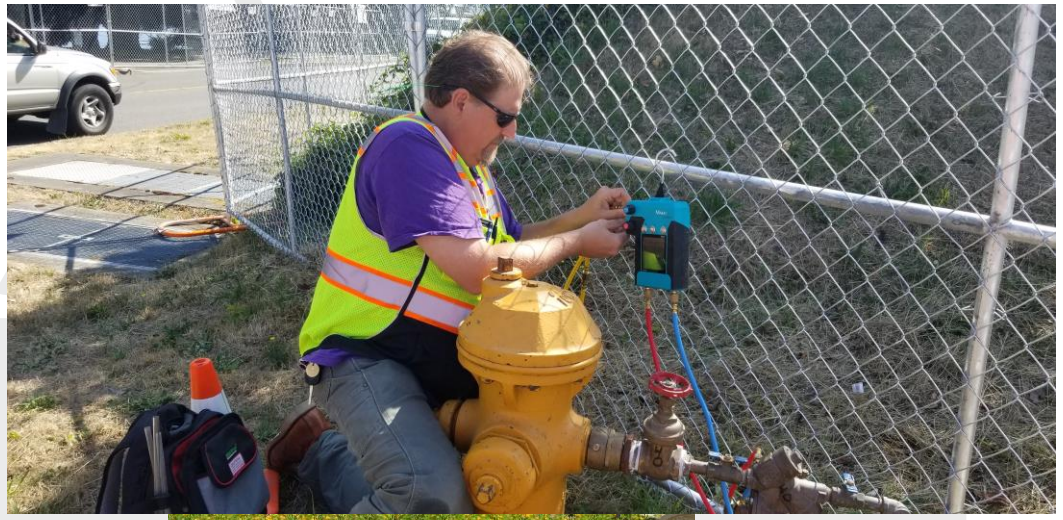
- Developing field instrumentation for over 20 years
  - 20 + patents
  - 100 + products for field technicians
  - HVACR, Marines, NASA, Airforce, Navy, Army, Dollywood and Cross Connection Control testers around the world
- Labor shortage in trades
  - Increased numbers of testers
    - Recruiting and formal training
  - Increased productivity
    - Increased education and understanding
      - Formal training and continuing education
    - Better tools make testers more productive
      - Rock vs hammer vs nail gun

Why You Test

- Why do you test backflow assemblies every year?
  - Expectations and results

What You Bring to a Test

- What you need to bring to each test
  - Experience
    - Training
    - Previous tests
  - Problem solving skills
    - Draw analogies
    - Deduce
- Test Equipment and Tools



From Physical Principles to Field Measurements

- Physical Standards in direct comparison labs (NIST, ISO, ANSI)
- Accredited calibration laboratories
- Field calibration laboratories
- General Measurement System

Terminology

- Certification
  - Meets applicable standard
    - 3rd party standard (UL, FCC, etc.)
      - USC Manual 10
    - Meets manufacturer's standard
- Calibration
  - Comparison to a standard
- Adjustment
  - Changing a device under test to meet calibration

General Measuring System

- General Measurement System
  - Sensor/Transducer Stage
    - In contact with thing being measured
  - Signal Conditioning Stage
    - Filtering, amplification/ dampening, etc.
  - Readout – Recording Stage
    - How the reading is perceived

Transducer Stage in Your Test Kit

- Senses Desired Input
  - Excludes others
  - Temperature compensation example

Signal Conditioning Stage in Your Test Kit

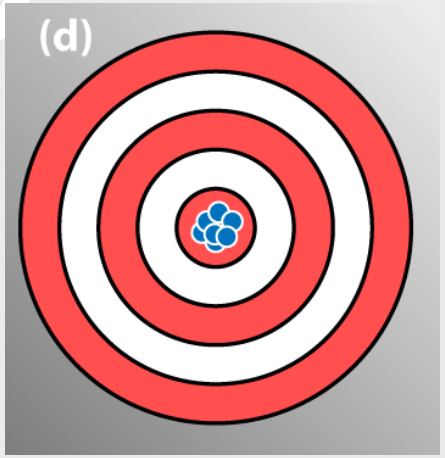
- Modifies sensor/ transducer signal into form usable for final stage
  - Analog test kit (from diaphragm displacement to dial on scale position)
    - Amplification in analog - Diaphragm displacement is tiny, but dial sweep is large
  - Digital test kit (from analog to digital signal)
    - With our sensor, this displacement is not visible to the naked eye
    - Our sensor development story

Readout-Recording Stage

- Analog
  - Dial on a gauge
  - Follower needle
  - Chart recorder
  - Typically recorded with a notepad or other external device
- Digital
  - Digital readout of value
  - Capture button
  - Rate of change graph
  - Output via Bluetooth for report creation

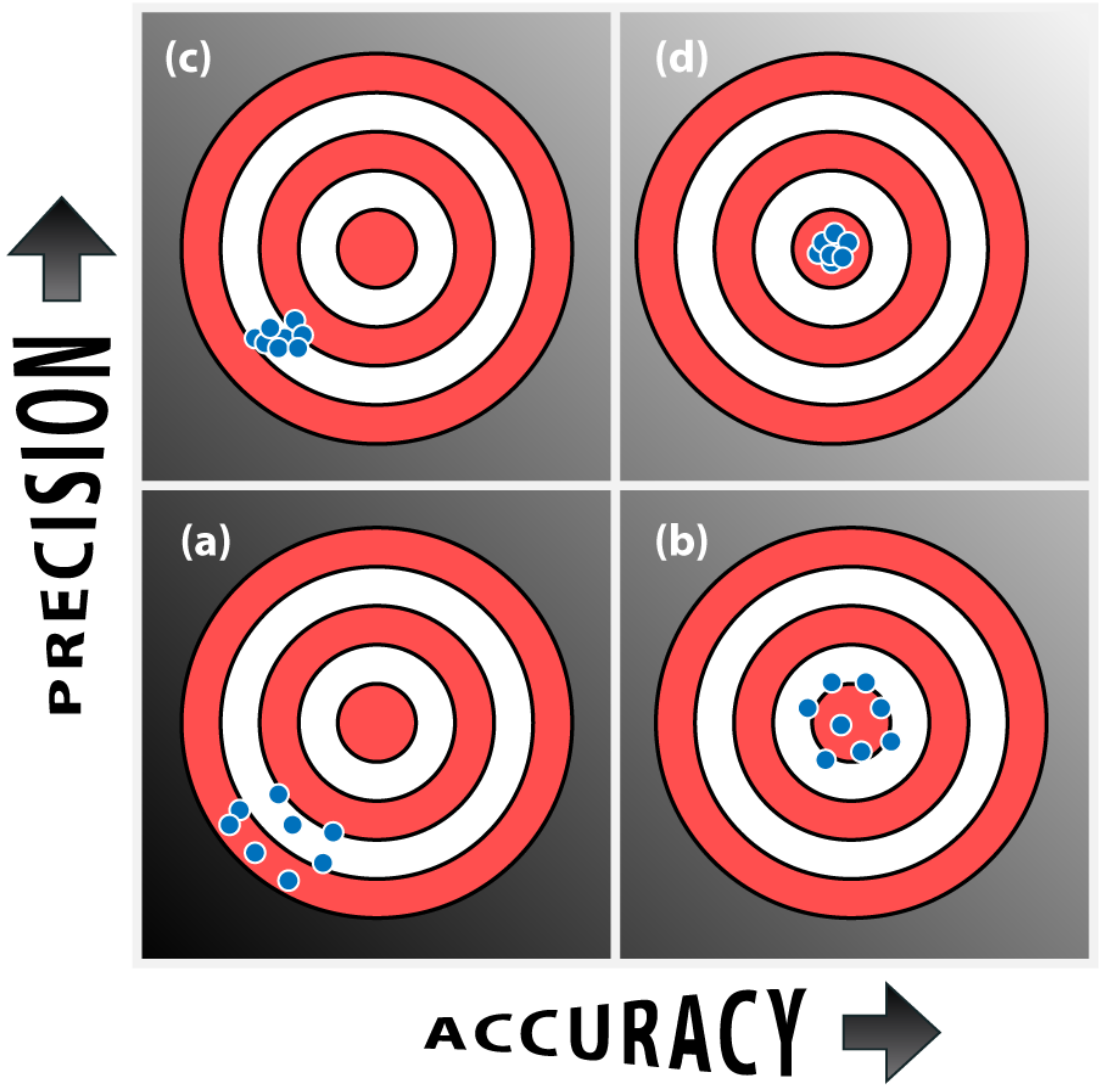
Significance of Measurements

- To be useful, measurements must be accurate and precise
  - Measurements used for diagnosis and trouble shooting
    - Pass/ Fail
    - Diagnosis upon failure
  - Allows you to learn and build up experience and knowledge
  - Incorrect information can be more harmful than no information



Precision and Accuracy

- Accuracy vs Precision
  - Accuracy = Centered around real quantity
  - Precision = more repeatable
- Calibration Adjustment
  - Usually helps with accuracy but not precision
  - Unless reworked or majorly repaired, your test kit is the most precise the day it's made



A Few Good Measurements

- We want the truth!
- Error - The difference between the measured/ recorded result and the true value of the quantity being measured

Types of Errors Outside Test Kit in CCC

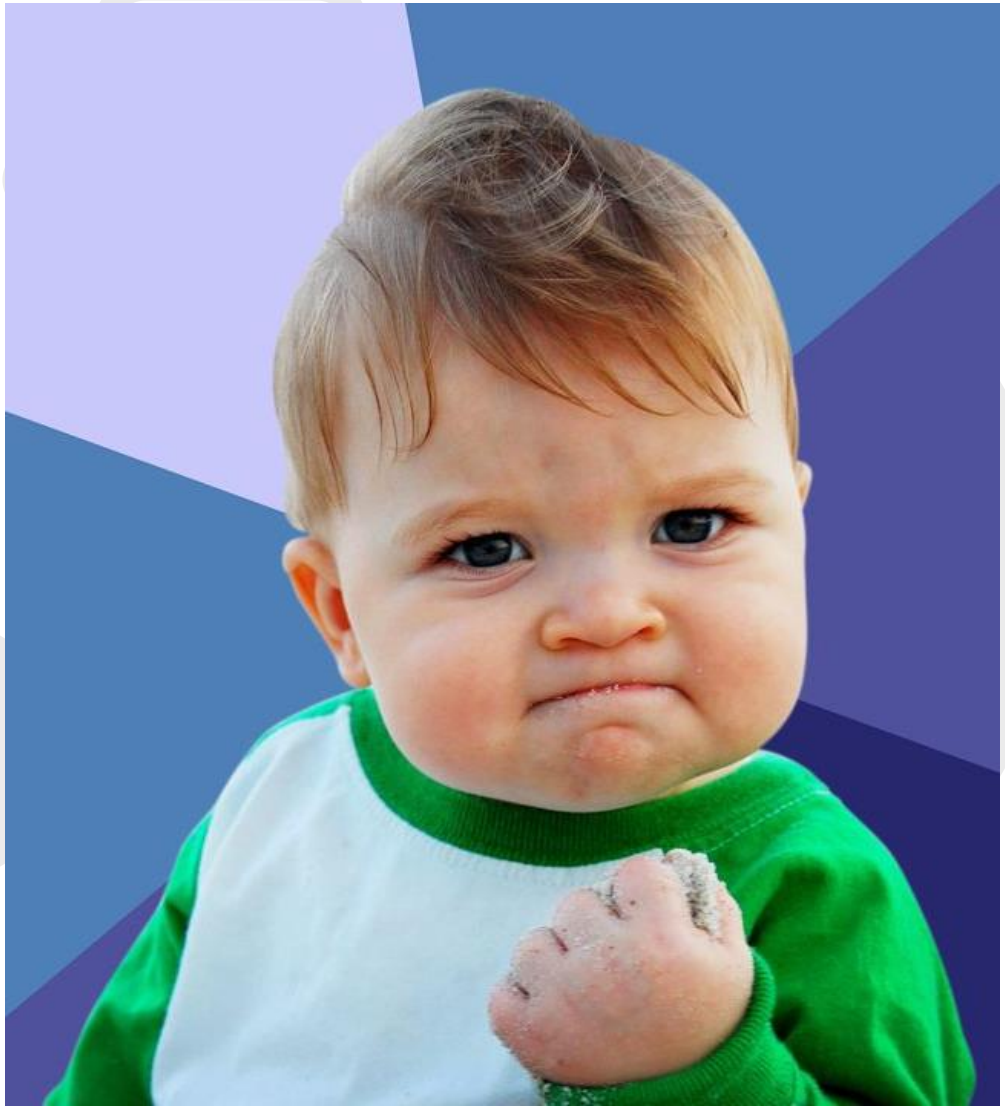
- Testing error
  - Incorrect/ incomplete test method used
    - Test method or fault of tester
    - Example, not raising test kit to proper elevation or orientation of test kit
  - Improper testing conditions for the method
    - NYC example
- Perception error (at interface of test kit and observer)
  - Incorrectly reading display (eyesight, darkness, etc.)
  - Parallax
    - Position of needle in analog kits; mirrors
- Transcription error
  - Incorrect initial recoding
  - Incorrect transmission

Types of Errors Inside Test Kit in CCC

- Drift
  - Deviation from expected calibration over time due to temp, vibration etc
    - USC Accuracy after other tests
    - Gets worse with test kit age
- Mechanical friction - Corrosion and foreign object build up
- Hysteresis – Responds accurately to increasing AND decreasing pressure
  - Water pressure changes in line go up and down important that it’s accurate in both ascending and descending
  - Why there’s a dissipation test in USC Manual 10
  - Why you can’t calibrate some analog test kits in both ascending and descending
- Loading error
  - Measuring device influences measurement

How You Can Reduce Error in Your Testing pt. 1

- Send in your test kit to a qualified lab for calibration, certification and adjustment for that kit
  - Ask them for their current certificate for their standard
  - At least 4x as accurate
  - Make sure they’re on the manufacturer’s current list or website



How You Can Reduce Error in Your Testing pt. 2

- Protect your test equipment
  - Drain it from water and keep it out of freezing environments
    - Undrained water is a water column which acts on the sensor(s)
  - Clean and replace filters to keep foreign objects out
  - Connect the hoses in the same orientation every time
  - Extreme temperatures tend to cause faster drift
    - Off the dash of vehicle in heat
    - Inside the house at night
  - Vibration and impact protection (particularly for analog test kits)
  - Open valves “slowly” 3-4 seconds for opening a test cock.

How You Can Reduce Error in Your Testing pt. 3

- Follow current and approved test procedures
  - Learn about the “why” behind the test procedures
  - If you’re thinking about a variation from procedure, ask the makers of the test procedures
- Use the best measurement equipment for the job
  - Is it designed for the application?
  - Is it accurate, precise, rugged enough?
  - Is the performance verified by a 3rd party?
- Keep improving your judgement
  - More experience testing
  - Continue education
  - Ask and share, we all drink the same water

Thank You For Your Time

- Have any questions about measurement science or the content of this presentation: support@arbiterbackflow.com
- To download copies of test procedures, watch videos of test procedures and more visit:

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