Multi-Point Calibration Work Group

Overview
Purpose

• The purpose of the Multi-Point Calibration work group is to review current meter proving methods and industry practices and to propose new H-44 requirements for recommendation to the NCWM S&T Committee if updates are needed.
Definitions

• **What is a Linearization Factor?**
  A number used to electronically correct the calibration curve of a meter at a given flow rate. Common names for linearization factors are:
  – Meter Factor
  – Calibration Factor
  – Correction Factor
  – K-Factor

• **New Proposal to define Multi-Point Calibrated Device** - A device equipped with means to electronically program linearization factors at multiple measurement points. Measurement points on LMDs and VTM are the flow rates for each product.
<table>
<thead>
<tr>
<th>Single-Point</th>
<th>Multi-Point</th>
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<tbody>
<tr>
<td>• Single point calibrations move entire curve up or down, affects where the line intersects zero</td>
<td>• Multi-point calibrations change the shape of the curve, allowing each point to be as close to zero as practicable.</td>
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<tr>
<td>• Wear on the meter can be determined by a change in the shape of the calibration curve, or by repeatability problems.</td>
<td>• Wear on the meter is determined by difference between factors at different flow rates or by repeatability problems.</td>
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Accuracy & Repeatability

A chart comparing the typical single point zeroed, meter characteristic accuracy curve with the same meter calibrated using multi-point calibration as found in many currently available flow computers.

**Multi-point calibration, linearized meter curve**

**Meter Characteristic Curve**

“Single point” calibration “Zeroed” at 600 GPM

C1 through C6 are the multi-point correction factors established during the testing at each of the flow rates. Repeatability must be determined at each flow rate and is represented by the targets.
What Has The Work Group Learned?

• Current H-44 requirements and current technology and practices are not aligned.
  – Many of the current H-44 were designed for PD meters equipped with a nozzle or valve that controlled flow rates. Today, it is more likely that flow rates are controlled through the use of flow computers and electronic valves.

• The use of electronics to calibrate meters and measure product is more prevalent today than when many of the requirements were put in HB44.
  – Often several flow rates are programmed into the flow computer and a linearization factor may be associated with each flow rate and product.
  – Meters are not dedicated to one product, but may measure multiple products. While products may be similar, they may also have differences and NIST H-44 does not provide guidance on selection of flow rates or products for testing.
Learning Continued

• Accuracy can now be optimized for every product through the flow range.

• Slow flow tests become normal tests because these are normal delivery flow rates and the error can be corrected to zero.

• Time needs to be taken to:
  – Verify linearization factors for each product and each flow rate
  – Verify that the meter is repeatable throughout the flow range
Learning Continued

• Conditions other than meter performance can affect the accuracy of the measurement.
  – Product characteristics, flow rate, pressure, and temperature can affect system performance. Also upstream piping from product storage tanks can affect measurement performance even when products are similar.
  – For example, one would assume that a measuring system would see no difference between measuring regular unleaded and premium gasoline since the products are so similar. This may not always be true if the piping between their storage tanks is significantly different.

• Because of the uncertainties associated with the design and installation of measuring systems, the only way to verify the accuracy of the measuring system is to test all products at all flow rates. This should be done on initial verification AND whenever the system has major configuration changes.
Existing Proposals in Both VTM code, and LMD code

• Multipoint Calibrated devices should be tested as configured on initial verification (and after repairs)
  – All products at all configured flow rates
  – Official decides on subsequent inspections which flow rates and which products are to be tested
  – Single-point devices continue to be tested at normal and slow flow rates on initial verification
  – Service Agents need to supply calibration information to W&M officials so they can make informed decisions about subsequent verifications.
Proposed Change to LMD 330-4

N.4.2.5 A wholesale liquid measuring device shall be tested at all flow rates and with all products for which a calibration factor has been electronically programmed prior to placing it into commercial service for the first time or after being repaired or replaced.

A wholesale liquid measuring device not equipped with means to electronically program its flow rates and calibration factors shall be tested at a low and high flow rate with all products delivered prior to placing it into commercial service for the first time or after being repaired or replaced.

The official with statutory authority has the discretion to determine the flow rates and products at which a meter will be tested on subsequent verifications.
Multi-Point Devices Required to be tested as They are Configured

*A wholesale liquid measuring device shall be tested at all flow rates and with all products for which a calibration factor has been electronically programmed prior to placing it into commercial service for the first time or after being repaired or replaced...*

- The only way to know if a measuring system can accurately measure all of the products at all of the flow rates is to test it.
- This will be required when a new measuring system or meter is installed, repaired or replaced.
Single-Point Calibrated Devices Still Tested at Normal and Slow Rates

... A wholesale liquid measuring device not equipped with means to electronically program its flow rates and calibration factors shall be tested at a low and high flow rate with all products delivered prior to placing it into commercial service for the first time or after being repaired or replaced.
Subsequent Verifications

... The official with statutory authority has the discretion to determine the flow rates and products at which a meter will be tested on subsequent verifications.

• This language clarifies that the final say in how meters are tested rests with the weights and measures authority.

• Should not be arbitrary but should be based upon meter performance history.
W&M Officials Need Information About Initial Verification

**UR.2.5.1. Initial Verification Proving Reports**  
Initial verification proving reports for wholesale liquid measuring devices equipped with means to electronically program flow rates shall be attached to and sent with placed-in-service reports when the regulatory agency with statutory authority requires placed-in-service reports.

This language recognizes that weights and measures agencies are sometimes not present during the initial verification. So, if that jurisdiction requires a placed-in-service that the initial proving information be submitted with it.
Vehicle Tank Meters

VTM Proposal 331-1 and its justification is identical to the LMD Proposal
New Proposals (VTM code, and LMD code)

- Multipoint-calibrated devices should have normal tolerances applied at all speeds for which they are configured, down to and including marked minimum
  - Based on the principle that devices should be adjusted as close to zero as possible
  - Single point devices will still have normal and slow flow tolerances
Normal Tests on Wholesale Multi-Point Calibration Devices

3.30 Liquid Measuring Device Code

N.4.1.3 Normal Tests on Wholesale Multi-Point Calibration Devices. – The normal test of a wholesale liquid-measuring device with electronically programmed linearization factors for various flow rates shall be made at the maximum discharge rate developed by the installation. Any additional tests conducted at flow rates down to and including the rated minimum discharge flow rate shall be considered normal tests.

3.31 Vehicle Tank Meter Code

N.4.1.4 Normal Test on Multi-Point Calibration Devices. – The normal test of a vehicle tank meter with electronically programmed linearization factors for various flow rates shall be made at the maximum discharge rate developed by the installation. Any additional tests conducted at flow rates down to and including the rated minimum discharge flow rate shall be considered normal tests.

• Based on G-UR.4.3. Use of Adjustments “...Whenever equipment is adjusted, the adjustments shall be so made as to bring performance errors as close as practicable to zero value.”
New Proposal in Definitions

– Add a definition of multi-point calibrated devices
– Update sections on calibration parameters
New Definition

**Multi-point Calibrated Device** - A device equipped with means to electronically program linearization factors at multiple measurement points.

- Other weighing and measuring devices are now capable of being linearized at multiple measurement points. The conference needs a term to describe these devices.
Update Sections Referring to Calibration Parameters

**calibration parameter.** – Any adjustable parameter that can affect measurement or performance accuracy and, due to its nature, needs to be updated on an ongoing basis to maintain device accuracy, e.g., span adjustments, linearization factors, and coarse zero adjustments. [2.20, 2.21, 2.24, 3.30, 3.31, 3.32, 3.34, 3.35, 3.37, 5.56(a)]
Questions?