LPG Liquid-Measuring Devices Part 3: Pre-Test Determinations

NIST Weights and Measures Division

LPG Short Course

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Pre-Test Determinations

- Test Liquid
- Tolerances
  - Applicable requirements
  - Tolerance values
  - Repeatability
  - Automatic Temperature Compensating System

Test Liquid (N.1.)

- important to test with same liquid as normally dispensed through the device
- calibrate metering system & ATC for product to be used
- even variation in grade can be critical
- commercial LPG is a mixture
  - composition can vary with each shipment
  - coefficient of expansion may be different
    - can be critical
  - especially important because of differences that may exist in the tendency of the product to vaporize

Tolerances--Overview

- devices are not capable of **errorless** performance
- tolerances designed to permit measurement errors small enough not to cause serious economic hardship to the buyer or seller...
  yet...
  not so **small** as to make the cost of manufacturing equipment unreasonably high
- industry often establishes more stringent requirements

Determining Tolerances

- determine applicable tolerances
- need to know:
  - length of time device has been in service
  - type of test being performed
  - size of test draft
- tolerances apply to device under test
  - e.g., applied to meter indication, not prover indication

Types of Tests - Overview

- Normal Test (N.4.1.)
  - Full flow (“fast” test)
  - Also, tests at flow rate = ½ x (max rate + min rate)
- Special Test (N.4.2.)
  - Slow flow (“slow” test)
- Automatic Temperature Compensating System (N.4.1.1.)
  - Normal test with ATC activated
  - Normal test with ATC de-activated
- Repeatability (N.4.1.2.)
  - Multiple tests under same conditions

Tolerances

- Acceptance Tolerances (G-T.1.)
  - Devices just put into commercial use
  - New devices tested within 30 days
  - Reconditioned devices returned to service and tested within 30 days
  - Devices adjusted or repaired after rejection and tested within 30 days
  - Devices undergoing Type Evaluation

Tolerances

- Maintenance Tolerance (G-T.2.)
  - Applies to equipment in use except as defined under Acceptance Tolerance (G-T.1.)
  - Generally, equipment in service for more than 30 days

Tolerances

- Tolerances apply to errors of:
  - Underregistration
    - Meter indicates less product volume than delivered and in the buyer's favor
  - Overregistration
    - Meter indicates more product volume than delivered and in the seller's favor

Tolerances – T.2., Table T.2.

T.2. Tolerance Values. - The maintenance and acceptance tolerances for normal and special tests shall be as shown in Table T.2.

(Amended 2003)

Table T.2. Accuracy Classes and Tolerances for LPG and Anhydrous Ammonia Liquid-Measuring Devices

Accuracy Class	Application	Acceptance Tolerance	Maintenance Tolerance	Special Test Tolerance
1.0	Anhydrous ammonia, LPG (including vehicle tank meters)	0.6 %	1.0 %	1.0 %

Sample Calculation of Tolerances

Example: 50-gallon test draft

Acceptance Tolerance:

Normal Test (0.6%):

(0.006 x 50 gal) = 0.3 gal = +/-69.3 in^3

Special Test (1%):

(0.01 x 50 gal) = +/- 0.5 gal = +/-115.5 in^3

Maintenance Tolerance:

Normal & Special Tests (1%):

(0.01 x 50 gal) = +/-0.5 gal = +/- 115.5 in^3

Repeatability (N.4.1.2., T.3., G-S.5.4.)

- Tests conducted at approximately same rate & draft size
- All other conditions of the test are the same
- Minimum of three consecutive drafts
- The range of tests (spread) shall not exceed 40 percent of the absolute value of the maintenance tolerance.
- Each individual test must be within applicable tolerance

Repeatability Tolerances – Sample Calculation

Example: 100-gallon Test Draft, Acceptance Tolerance

Acceptance Tolerance on 100-gallon Normal Test Draft (0.6%):

0.006 x 100 = 0.6 gal = +/-138.6 in^3

Maintenance Tolerance on 100-gallon Normal Test Draft (1.0%):

0.01 x 100 = +/-1.0 gal or +/- 231 in^3

absolute value =

remove plus & minus signs: 1.0 gal or 231 in^3

Repeatability Tolerances – Sample Calculation (cont.)

Repeatability Tolerance on 100-gal Normal Test Draft:

40% of absolute value of maintenance tolerance =
40% x 1.0 gal = 0.4 x 1.0 gal = 0.4 gal or 92.4 in^3

Sample Results of Two 100-gallon Normal Test Drafts:

Run 1: -100 in^3 Run 2: +40 in^3

Total spread: 140 in^3

Repeatability Tolerances – Sample Calculation #1 (cont.)

Each Run

Meets Acceptance Tolerance ***but***

Exceeds Repeatability Tolerance

Automatic Temperature Compensating Systems (T.4., N.4.1.1.)

- One test run with ATC activated
- One test run with ATC de-activated
- Difference between results of the two tests shall not exceed:
  - 1.0 percent for mechanical automatic temperature compensating systems; and
  - 0.5 percent for electronic automatic temperature compensating systems
- Tests conducted at approximately same rate & draft size
- All other conditions of the test are the same
- Each individual test must be within applicable tolerance

ATC Tolerances -- Sample Calculation

Run a 100-gallon test draft with ATC, fast flow
Run a 100-gallon test draft without ATC, fast flow
Electronic ATC; Maintenance Tolerance

<u>Maintenance Tolerance (1%):</u>

0.01 x 100 =1 gal OR

1 gal x 231 in^3 /gal = 231 in^3

<u>ATC Tolerance (Electronic):</u>

max difference is 0.5%

ATC Tolerances -- Sample Calculation (cont.)

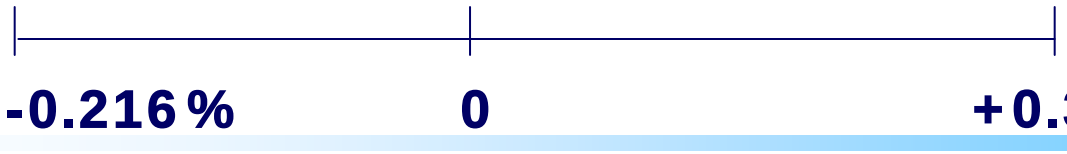
Sample Results:

with ATC activated: -50 in^3
-50/231 = -0.216 gal
-0.216 gal/100 gal =
percent error of -0.216%

without ATC activated: +90in^3
+90/231 = +0.390 gal
+0.390 gal/100 gal =
percent error of +0.346%

Difference: -0.216% to +0.346% = range of 0.562%

Meets Maintenance Tolerance ***but***...
Exceeds Electronic ATC Tolerance



Pre-Test Determinations - Summary

- Test Liquid
  - Same liquid as normally used with device
- Tolerances
  - Set reasonable limits on device performance
  - General Requirements
    - Acceptance/Maintenance
  - Types of Tests
    - Normal Test
    - Special Test
    - Repeatability Test
    - Automatic Temperature Compensating System Test