

Vapor Recovery Test Procedure

Determination of Proposed Test Method Acceptance of Air to Liquid Ratio Measuring Devices In Comparison with TP 201.5.

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1 APPLICABILITY

This test procedure can be used to determine the acceptability of an alternate air to liquid ratio (A/L) test method and equipment to TP 201.5 for vacuum assist vapor recovery system. This test procedure will determine if the proposed test method and equipment is equivalent to TP 201.5.

2 PRINCIPLE AND SUMMARY OF TEST PROCEDURES

the determination of acceptability is based upon EPA Test Method 301 Section 6.2 with a Validated Method (June 1996 revision). This procedure tests nine paired samples to determine if a proposed test method and equipment is acceptable to the 95% confidence level, and can be used as an equivalent A/L measuring device. Test method comparisons will be made at or beyond the extremes of the known situations which exist under test conditions. The results of the extreme testing, if acceptable, will be averaged. A proposed test method and equipment must be tested on each vapor recovery system on which equivalency is desired.

2.1 Definitions

Validated Method: TP 201.5

Proposed Method: Any test method and equipment seeking equivalency to be used as an alternate A/L measuring device.

3 BIASES AND INTERFERENCES

Validated Method (TP 201.5): There are no known biases or interferences to the method and equipment if used in accordance with the approved test procedure.

Proposed Method: Analysis of the proposed method in comparison with TP 201.5 by EPA 301 will show any biases, and it will determine if the bias is acceptable.

Due to vapor recovery system behavior, this comparison test must be performed specifically for the vapor recovery system behavior to achieve test data consistency and repeatability. It is necessary to control the number of simultaneous dispensing episodes during the test data collection. Tests must be performed with a limit on the number of simultaneous dispensing episodes served by a common assist vapor pump and a common liquid fuel delivery pump. For example, on vapor recovery systems with dispenser based vacuum assist pumps, no other dispensing can occur at the refueling facility on the same fuel grade or served by the same vapor recovery pump during the data collection; on vapor recovery systems with centralized vacuums, tests must be performed with no other dispensing at the entire refueling facility during the data collection.

To ensure repeatability, paired sample comparisons must be run under as similar conditions as possible.

Due to variations in the refueling facility front end equipment (i.e. nozzle, hoses, breakaways, etc.) test comparisons must be made to encompass the extremes of pressure drop for these components. This will ensure that the Proposed Test Method is equivalent for all front end component combinations. Results at both extremes must pass the criteria. The final results will be the average of the two extreme test results.

4 SENSITIVITY, RANGE, AND PRECISION

Validated Method: 201.5 specifications are well within the limits of sensitivity, range, and precision for the specified equipment.

Proposed Method: Equipment must be used within its designed sensitivity, range and precision.

5 EQUIPMENT

Validated Method: Equipment for the Validated Method is described in TP 201.5.

Proposed Method: Equipment will vary.

6 TEST PROCEDURE

The refueling facility and vapor recovery system shall be prepared to operate within the limits stated in the Vapor Recovery Certification Executive Order.

Validated Method: Shall be performed as stated in TP 201.5.

Proposed Method: Shall be performed as per manufacturers instructions.

Paired sampling shall be conducted under as similar conditions as possible. If deemed acceptable, multiple Proposed Method tests can be paired with a single Validated Method test.

2.1 General Test Instructions

- 1) Ensure that vapor recovery system is operating within the requirements of vapor recovery system's Executive Order.
- 2) Install low vapor restriction front end assembly and verify the vapor recovery system is still operating within the specifications of the Executive Order. If not adjust the vapor recovery system or receive permission from CARB for test acceptance.
- 3) Run nine sets of paired samples for each test with no interruptions. Each test set shall include one test of TP 201.5 and one or more proposed methods tests. The number of proposed tests per validated test shall be limited by CARB decision based upon test circumstance, consistency, and repeatability.
- 4) Record data.
- 5) Remove low vapor restriction front end assembly.
- 6) Install high vapor restriction front end assembly and verify the vapor recovery system is still operating within the specifications of the Executive Order. If not adjust the vapor recovery system or receive permission from CARB for test acceptance.
- 7) Run nine sets of paired samples with no interruptions.

- 8) Record data
- 9) Return system to original front end configuration and ensure that the vapor recovery system is operating within the specifications of the Executive Order.

7 CALCULATING RESULTS

Results are to be calculated as instructed in EPA Test Method 301 Section 6.2 Comparison with a Validated Method (June 1996 Revision).

- 1) Determine the standard deviation, SD_d , of the differences, d_i 's, of the paired sample differences using Equation 301-6.

$$SD_d = \sqrt{\frac{\sum_i^n (d_i - d_m)^2}{n-1}} \quad \text{Eq. 301-6}$$

d_i = The difference between the I-th pair of samples, $v_i - p_i$ (validated - proposed).

d_m = The mean of the paired sample differences.

n = The number of samples ($n = 9$).

- 2) Test the bias for statistical significance by calculating the t-statistic. Determine if the mean of the differences between the proposed method and the validated method is significant at the 80% confidence level.

$$t = \frac{|d_m|}{\frac{SD_d}{\sqrt{n}}} \quad \text{Eq. 301.7}$$

If $t > 1.397$ then the bias is statistically significant, and a correction factor is needed.

If $t \leq 1.397$ then the bias is not statistically significant, and a correction factor is not needed.

- 3) Calculation of a Correction Factor (if necessary, see t-statistic test, Eq 301-7).

$$CF = \frac{1}{1 - \frac{d_m}{V_m}} \quad \text{Eq. 301-8}$$

V_m = The mean of the validated method's data.

Multiply all analytical results by CF to obtain the final values (for Eq. 301.10 [new d_i 's]).

The data and the proposed method are unacceptable if the correction factor is outside the range of 0.90 to 1.10.

- 4) Calculate, SD_v , the standard deviation of the validated method.

$$SD_v = \sqrt{\frac{\sum_i^n (v_i - V_m)^2}{n-1}}$$

V_i = The I-th validated sample.

- 5) Calculate S_v^2 , the variance of the validated method.

$$(S_v)^2 = (SD_v)^2 \quad \text{Eq. 301.9}$$

- 6) Calculate, S^2_{pooled} , the pooled variance.

$$S^2_{\text{pooled}} = \frac{\sum_i^n d_i^2}{2(n-1)} \quad \text{Eq. 10}$$

If the proposed method has a bias (see t-statistic test Eq. 301-7), all proposed method data points must be multiplied by CF before calculating the d_i 's for this calculation.

- 7) Calculate, S_p^2 , the proposed method variance.

$$S_p^2 = 2S_{\text{pooled}}^2 - S_v^2 \quad \text{Eq. 301-11}$$

** If $S_v^2 > S_{\text{pooled}}^2$, let $S_p^2 = S_{\text{pooled}}^2/2$.

- 8) Calculate the F-Test. This determines if the variance of the proposed method is significantly different from that of the validated method.

$$F = \frac{S_p^2}{S_v^2} \quad \text{Eq. 301.12}$$

The critical F value at a 95% confidence level is 3.44.

If $F > 3.44$, the difference in precision is significant and the proposed method is unacceptable.

Summary of Criteria for Acceptability

- 1) $0.90 \leq CF \leq 1.10$
- 2) $F < 3.44$

EPA Method 301 Comparison of ST-39 with TP-201.5

A/L	(A-V)/L	di	dm	SDd	t	SDv	Sv2	di2	S2pool	Sp2	F
1.16	1.15	0.01	-0.0024	0.0155	0.7057	0.0558	0.0031	0.0001	0.0001	0.0001	0.0197
1.17	1.14	0.03						0.0009			
1.12	1.12	0.00						0.0000			
1.14	1.14	0.00						0.0000			
1.13	1.11	0.02						0.0004			
1.17	1.18	-0.01						0.0001			
1.12	1.13	-0.01						0.0001			
1.15	1.14	0.01						0.0001			
1.16	1.16	0.00						0.0000			
1.11	1.13	-0.02						0.0004			
1.17	1.19	-0.02						0.0004			
1.10	1.12	-0.02						0.0004			
1.12	1.12	0.00						0.0000			
1.12	1.12	0.00						0.0000			
1.10	1.09	0.01						0.0001			
1.00	1.00	0.00						0.0000			
1.04	1.06	-0.02						0.0004			
1.02	1.01	0.01						0.0001			
1.01	1.00	0.01						0.0001			
1.16	1.18	-0.02						0.0004			
1.19	1.22	-0.03						0.0009			