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Subject: Final Fitting Loss Factors for Internal and External Floating Roof Tanks
EPA Contract No. 68-D2-0159; Work Assignment No. 2-02
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I. Introduction

On April 27, 1995, a conference call was held with representatives from EPA, Midwest Research Institute (MRI), the American Petroleum Institute, and TGB Partnership to discuss the discrepancies between the fitting factors recommended by MRI and those recommended by API for use in estimating emissions from floating roof storage tanks. The MRI recommended factors were documented in a memorandum entitled "Loss Factors for Fittings on Internal and External Floating Roof Tanks - Recommendations for Incorporation in AP-42 Section 7.1."[1] The API recommended factors were documented in the draft publication entitled "Evaporative Loss from Floating Roof Tanks."[2] The purpose of this memorandum is to document how the discrepancies were resolved during the conference call and present the final fitting factors for floating roof tanks that will be incorporated into AP-42 section 7.1.

II. Issue Resolution

The major discrepancy in the data analyses was in the development of fitting factors for slotted guide-pole configurations. The discrepancy in the fitting factors was a result of the inclusion of addition data by MRI (Tests 4BNF and 8AWG) in the fitting factor analysis for the slotted guide pole configuration (Fitting No. 4) that consisted of a float (located 1 inch above the cover), gasket, and pole wiper at the sliding cover elevation, and differences in the grouping of guide pole configurations between the two analyses. Different guide pole configurations were grouped together in order to develop a single fitting factor for fitting configurations that could not be

distinguished statistically (i.e., represented the same level of control).

During the conference call, it was determined that the additional test runs (Tests 4BNF and 8AWG) should not have been included in the data analyses for the guide pole configuration that consisted of a float, gasket, and pole wiper. During Test 4BNF, the float was accidently left off the configuration, and in Test 8AWG a different hardware setup was used. Therefore, the data from Tests 4BNF and 8AWG were properly excluded from the data set for this fitting configuration.

In regard to the grouping of guide pole configurations, it was agreed that the groupings shown in Table 1 will be used in the analysis of the guide pole data. The results of both the MRI and API statistical evaluations showed that the addition of a gasket does not result in any appreciable reduction in emissions and that while the presence of a float in the guide pole tends to reduce emissions, the position of the float in the guide pole is not a critical factor. As indicated on Table 1, the data for Fitting No. 30 will not be included in the published guide pole fitting factors because this fitting configuration is not typically applied to external floating roof tanks. However, MRI will present the results of the analyses of this fitting in the background document for AP-42, Section 7.1.

Other issues resolved during the conference call were the level of precision (number of significant figures) that the results would be reported, and the elimination of the fitting factors for the 2 1/2 in. diameter roof legs. The fitting factors for the 2 1/2 in. diameter roof legs were eliminated because: (1) the use of this leg size is atypical; and (2) no new test work was conducted on this leg size.

III. Final Fitting Factors for External and Internal Floating Roof Tanks

The final fitting factors for external and internal floating roof tanks are presented in Tables 2 and 3, respectively. However, it should be noted that the application of the wind speed correction factor proposed by API for external floating roof tanks still results in a significant discrepancy between the MRI and API fitting estimates. An evaluation of the wind speed correction factor will be conducted in June 1995. Table 4 presents a comparison of the emission estimates generated using the old AP-42 factors, the new proposed fitting factors, and the proposed fitting factors after incorporation of the wind speed correction factor. Depending upon the guide pole configuration assumed for the tank, the application of the wind speed correction factor can vary from predicting higher emissions than those generated using the old AP-42 factors (unslotted guide poles) to predicting significantly lower emission estimates than those generated using the old AP-42 factors (slotted guide poles).

IV. References

1. Memo from Jones, R., Parker, A., and Wallace, D., MRI, to Beauregard, D., EPA/EFIG. Loss Factors for Fittings on Internal and External Floating Roof Tanks - Recommendation for Incorporation in AP-42 Section 7.1. March 15, 1995.

2. "Manual of Petroleum Measurement Standards: Chapter 19: Evaporative Loss Measurement, Section 2 Evaporative Loss from Floating-Roof Tanks." Preliminary Draft. American Petroleum Institute. Washington, D.C. December 1994.

TABLE 1. Guide Pole Fitting Configurations.

Fitting No.	Control Measure				Control Level
	Gasket[a]	Float[b]	Pole sleeve[a]	Pole wiper[c]	
1	0	0	0	0	Presence of gasket had no effect on emissions from configuration
25	1	0	0	0	
3	0	1	0	0	Presence of gasket had no effect on emissions from configuration
26	1	1	0	0	
20	1	0	0	1	
2	1	0	1	0	
30	1	3	0	1	Configuration not included in analyses because configuration was atypical.
23	1	2	0	1	Position of float does not significantly effect emissions
4	1	1	0	1	
24	1	2	1	1	
29	1	1	1	2	

[a] 0 = control measure not implemented
1 = control measure implemented

[b] 0 = no float used
1 = float with 0.25 inch gap and wiper 1 inch above cover
2 = float with 0.25 inch gap and wiper at cover elevation
3 = float with 0.125 inch gap and no wiper

[c] 0 = no pole wiper
1 = pole wiper at sliding cover elevation
2 = pole wiper 6 inches above sliding cover

Table 2. EXTERNAL FLOATING ROOF-FITTING LOSS FACTORS, K_a, K_b, AND m

Fitting type and construction details	Loss factors K_a (lb-mole/yr)	K_b (lb-mole/(mph)^m-yr)	m (dimensionless)
Access hatch (24-inch diameter well)			
Bolted cover, gasketed	1.6	0	0[a]
Unbolted cover, ungasketed	36	5.9	1.2
Unbolted cover, gasketed	31	5.2	1.3
Unslotted guide-pole well (8-inch diameter unslotted pole, 21-inch diameter well)			
Ungasketed sliding cover	31	150	1.4[a]
Gasketed sliding cover	25	13	2.2
Ungasketed sliding cover w/pole sleeve	25	2.2	2.1
Gasketed sliding cover w/pole wiper	14	3.7	0.78
Gasketed sliding cover w/pole sleeve	8.6	12	0.81
Slotted guide-pole/sample well (8 inch diameter slotted pole, 21-inch diameter well)			
Ungasketed or gasketed sliding cover	43	270	1.4[c]
Ungasketed or gasketed sliding cover, with float	31	36	2.0
Ungasketed or gasketed sliding cover, with pole wiper	41	48	1.4
Ungasketed or gasketed sliding cover, with pole sleeve	16	21	1.8
Ungasketed or gasketed sliding cover, with float and pole wiper	21	8.8	1.7
Ungasketed or gasketed sliding cover, with float, pole sleeve, and pole wiper at sliding cover elevation	19	7.0	1.2
Ungasketed or gasketed sliding cover, with float pole sleeve, and pole wiper located 6 in. above sliding cover	9.1	16	0.43
Gauge-float well (20-inch diameter)			
Unbolted cover, ungasketed	14	5.4	1.1[a]
Unbolted cover, gasketed	4.3	17	0.38
Bolted cover, gasketed	2.8	0	0
Gauge-hatch/sample well (8-inch diameter)			
Weighted mechanical actuation, gasketed	0.47	0.02	0.97[a]
Weighted mechanical actuation, ungasketed	2.3	0.00	0.00

Table 2. (continued)

Fitting type and construction details	Loss factors K_a (lb-mole/yr)	K_b (lb-mole/(mph)^m-yr)	m (dimensionless)
Vacuum breaker			
Weighted mechanical actuation, ungasketed	7.8	0.01	4.0
Weighted mechanical actuation, gasketed	6.2	1.2	0.94[a]
Roof drain (3-inch diameter)[c]			
Open	1.5	0.21	1.7
90% closed	1.8	0.14	1.1[a]
Roof leg (3-inch diameter)[d]			
Adjustable, pontoon area	2.0	0.37	0.91[a]
Adjustable, pontoon area - gasketed	1.3	0.08	0.65
Adjustable, pontoon area - sock	1.2	0.14	0.65
Adjustable, center area	0.82	0.53	0.14[a]
Adjustable, double-deck roofs	0.82	0.53	0.14
Fixed	0	0	0
Rim vent (6-inch diameter)[e]			
Weighted mechanical actuation, gasketed	0.71	0.10	1.0[a]
Weighted mechanical actuation, ungasketed	0.68	1.8	1.0

Note: The roof-fitting loss factors, K_{Fa}, K_{Fb}, and m, may only be used for wind speeds from 2 to 15 miles per hour.

[a]If no specific information is available, this value can be assumed to represent the most common or typical roof fitting currently in use.
[b]A slotted guide-pole/sample well is an optional fitting and is not typically used.
[c]Roof drains that drain excess rainwater into the product are not used on pontoon floating roofs. They are, however, used on double-deck floating roofs and are typically left open.
[d]The most common roof leg diameter is 3 inches.
[e]Rim vents are used only with mechanical-shoe primary seals.

Table 3. SUMMARY OF INTERNAL FLOATING DECK FITTING LOSS FACTORS (K_F)

Deck fitting type	Deck fitting loss factor, K_F (lb-mole/yr)
Access hatch (24-inch diameter)	
Bolted cover, gasketed	1.6
Unbolted cover, gasketed	31
Unbolted cover, ungasketed	36[a]
Automatic gauge float well	
Bolted cover, gasketed	2.8
Unbolted cover, gasketed	4.3
Unbolted cover, ungasketed	14[a]
Column well (24-inch diameter)[b]	
Builtup column-sliding cover, gasketed	33
Builtup column-sliding cover, ungasketed	47[a]
Pipe column-flexible fabric sleeve seal	10
Pipe column-sliding cover, gasketed	25
Pipe column-sliding cover, ungasketed	31
Ladder well (36-inch diameter)[b]	
Sliding cover, gasketed	56
Sliding cover, ungasketed	76[a]
Roof leg or hanger well	
Adjustable	7.9[a]
Fixed	0
Sample pipe or well (24-inch diameter)	
Slotted pipe-sliding cover, gasketed	43
Slotted pipe-sliding cover, ungasketed	43
Sample well-slit fabric seal 10% open area	12[a]
Stub drain (1-inch diameter)[c]	1.2
Vacuum breaker (10-inch diameter)	
Weighted mechanical actuation, gasketed	6.2[a]
Weighted mechanical actuation, ungasketed	7.8

[a]If no specific information is available, this value can be assumed to represent the most common/typical deck fittings currently used.
[b]Column wells and ladder wells are not typically used with self-supported roofs.
[c]Not used on welded contact internal floating decks.

TABLE 4. Comparison of Loss Rates for External Floating Roof Fittings

Diameter, ft[a]	Basis of fitting factors	Loss rates, lb-mole/yr
100	Current AP-42[b]	823
100	New fitting factors[b]	4141
100	New fitting factors with wind speed correction factor applied[b]	1617
100	Current AP-42[c]	3294
100	New fitting factors[c]	4053
100	New fitting factors with wind speed correction factor applied[c]	1082

[a] The tank was assumed to have a double-deck roof with mechanical shoe seals. The wind speed at the location was assumed to be 10.4 mph.

[b] The tank was assumed to be equipped with a typical set of fittings. The guide pole configuration was an unslotted guide pole with an ungasketed sliding cover.

[c] Typical fittings were assumed with the exception of the guide pole configuration. In this example, the guide pole configuration used was a slotted guide pole with an ungasketed sliding cover and float.