



MEMORANDUM

TO: Stephen Shedd
U.S. Environmental Protection Agency

FROM: Tracy Johnson ²⁸
Pacific Environmental Services, Inc.

DATE: April 24, 1996

SUBJECT: Average Cargo Tank Leakage
P:\N402

The purpose of this memorandum is to provide a procedure for calculating an average emission factor for vapor leakage from gasoline cargo tanks passing a vapor tightness test at or better than the 1" and 3" pressure decay limit. The various tank truck emission factors for tank trucks subject to various testing conditions are summarized in the attached Table 1.

One-inch Pressure Decay Test

As discussed in Appendix A of the document "Gasoline Distribution Industry (Stage I) - Background Information for Promulgated Standards", EPA-453/R-94-002b (BID, Volume II), the allowable vapor leakage from cargo tanks just passing the 1-inch pressure decay test (change of 1-inch of water from an initial pressure of 18 inches, over 5 minutes) is approximately 0.3 percent (p. A-2). Using the assumptions discussed in Appendix A, the weighted average emission factor for the population of cargo tanks failing the test and just meeting the 1-inch decay limit was estimated to be 8 mg/liter of gasoline loaded (p. A-4).

To calculate the average vapor leakage losses from cargo tanks (based on an average of losses at and better than the enforceable limit), we need to determine the margin with which cargo tanks pass the 1-inch H₂O pressure decay test. In his comments on the proposed standard (docket item no. IV-D-28), Ken Kunaniec discussed a BAAQMD study where 200 cargo tank owners were surveyed to quantify the actual values of the annual certification tests for their tanks. According to Mr. Kunaniec, the results of the survey showed that 86 percent of the cargo tanks had less than 0.25-inch H₂O decay during the 5-minute test, and 91 percent of the cargo tanks had less than 0.5-inch H₂O decay.

Using the results of the BAAQMD study, PES assumed a uniform distribution of the cargo tank test results over each pressure decay range (i.e., 0 to 0.25-inch H₂O, 0.25

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to 0.5-inch H₂O, and 0.5 to 1-inch H₂O), and that the midpoint of each pressure decay range was the average cargo tank leakage for that range. PES also assumed that 3.8 percent of the cargo tanks surveyed in the study failed the 1-inch H₂O decay test (i.e., exceeded the allowable 1-inch pressure drop). This assumption was based on the average failure rates summarized and discussed in Appendix A of BID, Volume II (p. A-3). As a result, the average of losses at or better than the enforceable limit was calculated as follows:

$$0.86 \left(\frac{[0 + 0.25] \text{ inch}}{2} \right) + 0.05 \left(\frac{[0.25 + 0.5] \text{ inch}}{2} \right) + 0.052 \left(\frac{[0.5 + 1.0] \text{ inch}}{2} \right)$$

$$= 0.165 \approx 0.17 \text{ inch H}_2\text{O decay}$$

Therefore, the amount of vapor leakage from a cargo tank which has a pressure decay of 0.17-inch H₂O during the 5-minute test is calculated as follows:

$$V_L = (0.5V) \left(\frac{T}{T_p} \right) \left(1 - \frac{P_F}{P_i} \right) = 0.5 (32,200) \left(\frac{14}{5} \right) \left(1 - \frac{424.83}{425} \right)$$

$$V_L = 18 \text{ liters leakage}$$

$$\frac{18 \text{ liters}}{32,200 \text{ liters}} = 0.00056 \approx 0.06\% \text{ leakage}$$

Using the same methodology discussed in Appendix A of BID, Volume II, the average percentage of vapor leakage from cargo tanks representing a weighted sum of the average losses from failing cargo tanks plus the losses from passing cargo tanks performing better than the enforceable limit (1-inch pressure decay) is calculated as follows:

$$(0.038) (0.121) + (0.962) (0.0006) = 0.0052$$

Therefore the average cargo tank emission factor is calculated by multiplying the percent vapor leakage by the uncontrolled emission factor as follows:

$$0.0052 \times 1,014 \text{ mg/l} = 5.25 \text{ mg/l} \approx 5 \text{ mg/l of gasoline loaded.}$$

Three-inch Pressure Decay Test

As discussed in Appendix A of BID, Volume II, the allowable leakage from cargo tanks just passing the 3-inch pressure decay test (change of 3-inches of water from an initial pressure of 18 inches, over 5 minutes) is approximately 1 percent (p. A-4). Using the assumptions discussed in Appendix A, the weighted average emission factor for the population of cargo tanks failing the test and just meeting the 3-inch decay limit was estimated to be 13 mg/liter of gasoline loaded (p. A-5).

To calculate the average vapor leakage losses from cargo tanks (based on an average of losses at and better than the enforceable limit of 3-inches pressure decay), we can use an average of 0.5% loss from passing cargo tanks. This value was obtained from Table C-4 in the EPA document, "Bulk Gasoline Terminals - Background Information for Proposed Standards", EPA-450/3-80-038a (BID, Volume I).

Using the same methodology discussed in Appendix A, BID Volume II, the average percentage of vapor leakage from cargo tanks representing a weighted sum of the average losses from failing cargo tanks plus the losses from passing cargo tanks performing better than the enforceable limit (3-inches pressure decay) is calculated as follows:

$$(0.031) (0.121) + (0.969) (0.005) = 0.0086$$

Therefore the average cargo tank emission factor is calculated as follows:

$$0.0086 \times 1,014 \text{ mg/l} = 8.7 \text{ mg/l} \approx 9 \text{ mg/l} \text{ of gasoline loaded.}$$

Summary of Emission Factors

Emission factors for vapor leakage from gasoline cargo tanks (i.e., cargo tank trucks and railcars) are summarized in Table 1. As shown in Table 1, cargo tanks in areas without annual vapor tightness testing are estimated to leak 304 mg VOC/liter of gasoline loaded (mg/l). Cargo tanks in areas where a new vapor tightness testing program has been initiated are estimated to leak 101 mg/l. As discussed in Appendix A of BID, Volume II, the emission factor of 13 mg/l represents a weighted sum of the average losses from failed cargo tanks and losses from passed cargo tanks at the 3" test limit. Similarly, the emission factor of 8 mg/l represents a weighted sum of the average losses from failed cargo tanks and losses from passed cargo tanks at the 1" test limit. As discussed in this memorandum, the 9 and 5 mg/l emission factors represent weighted sums of the average losses from failed cargo tanks and average losses from passed cargo tanks at or better than the 3" and 1" test limits, respectively.

Table 1. VOC EMISSION FACTORS FOR VAPOR LEAKAGE FROM GASOLINE CARGO TANKS (Tank Trucks and Railcars)¹

TYPE	Vapor Leakage ²		Discussion
	%	mg/l	
NO TEST PROGRAM	30%	304	Areas without annual vapor pressure/vacuum (P/V) testing program ³ on cargo tanks (CT).
NEW TEST PROGRAM:	10%	101	EPA estimate used at and prior to the 1994 proposal of the MACT Subpart R. <u>May</u> still be appropriate for new vapor-tightness testing programs before the program matures to steady-state.
3" TEST:			
Enforceable Limit:	1.3%	13	Values represent a weighted sum of the average losses from failed CT plus the losses from passed CT at the 3-inch test limit (the <u>enforceable limit</u>).
Average:	0.9%	9	Same as above, except the losses from passed CT are based on an average of losses at and better than the enforceable limit ⁴ .
1" TEST:			
Enforceable Limit:	0.8%	8	Values represent a weighted sum of the average losses from failed CT plus the losses from passed CT at the 1-inch test limit (the <u>enforceable limit</u>).
Average:	0.5%	5	Same as above except, the losses from passed CT are based on an average of losses at and better than the enforceable limit.

¹ Source: Appendix A. "Gasoline Distribution Industry (Stage I) - Background Information for Promulgated Standards," November 1994, EPA-453/R-94-002b. Unless otherwise noted.

² Includes the total organic (essentially all VOC) vapor leakage from cargo tank's vapor collection/containment equipment. Likely areas of leakage are the tank's hatch and manhole seals and P/V vents.

³ Annual P/V testing of cargo tanks using EPA Method 27 at 18-inches of water pressure and 8-inches of vacuum. The CTG and the NSPS allow a 3-inch drop in pressure over 5 minutes. The MACT standard allows a 1-inch drop in pressure over 5 minutes.

⁴ Using an average of 0.5% loss from passed cargo tanks from Table C-4, "Bulk Gasoline Terminals-Background Information for Proposed Standards," December 1980, EPA-450/3-80-038a. Losses from ~~passed~~ cargo tanks at the enforceable limit are 1% and 0.33% for the 3-inch and 1-inch test, respectively.