Category: 25 – Gasoline Tank Trucks

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
Office of Air Quality Planning and Standards
Research Triangle Park, North Carolina 27711

DATE: September 15, 1981

SUBJECT: State of Virginia Tank Truck Certification Regulation

FROM: G. T. Helms, Chief
Control Programs Operations Branch (MD-15)

TO: Jim Sydnor
Air Programs Branch, Region III

As requested, the State of Virginia equivalency calculations for a proposed tank truck certification regulation have been reviewed and our comments are as follows.

1. The State of Virginia has two areas (Richmond and Norfolk) that are projected to meet the ozone standard by 1982. Because tank trucks are less than 100 tons/year sources, the State only has to have a program that will ensure that the tank trucks are essentially leak tight. However, there is one area (Washington) that requires an extension until 1987 to meet the ozone standard and, in that case, a tank truck certification program is required.

2. In an interstate area such as Washington, tank trucks may travel, load, and unload in areas (Washington, D.C.; Maryland, etc.) that require an 18 inches of water pressure test. The 10-inch pressure drop test suggested by the State of Virginia would not be acceptable to those States requiring the more stringent 18-inch pressure test. To our knowledge, no other State requiring tank truck certification regulations has adopted a regulation with a pressure test less than 18 inches of water as cited in the tank truck CTG.

3. Test equipment and procedures required to test a tank truck at 10 inches of water pressure is identical to that required to test a tank truck at 18 inches of water.

4. Tank trucks are periodically tested at pressures up to 27 inches of water to ensure proper operation of pressure relief valves.

5. EPA test data indicate that back pressure from vapor control equipment and/or associated piping exceeds ten inches of water pressure in many instances. Trucks loading gasoline in Virginia may be subject to actual pressures greater than ten inches of water pressure.

6. The formula cited by the State of Virginia to show that emissions would not vary greater than five percent is used for rough estimates when applying a bag test to the domes of tank trucks. The bag test is only

applicable to bottom loaded trucks. Top loaded trucks or vapor collection equipment on tank trucks cannot be tested by this method.

An exaggerated example of the inappropriateness of the use of the formula would be where a tank truck lost a hatch cover and all vapors were vented to the atmosphere through that point during loading operation. Assuming the initial and final pressure in the tank truck would be essentially the same and the formula would give erroneous results, using data provided by the State of Virginia:

$$VL = (0.5 \times 33.588) \times \left(\frac{14.83}{5}\right) \times \left(1 - \frac{407}{407.1}\right)$$

$$VL = 12.27 \text{ liters}$$

7. Calculations using Bernoulli's Theorem indicate that, with a given orifice size, emissions from a tank truck with an internal pressure of 18 inches of water would exceed emissions from a tank truck with an internal pressure of 10 inches of water by approximately 26 percent (see attached calculations).

Conclusions

Based upon the comments noted above, it would be our recommendation that the State of Virginia adopt a pressure/vacuum test that would be consistent with other States and the control technique guideline (CTG) document.

Attachment

cc: Ray Cunningham
Neil Swanson

Attachment

Vapor Leaks - Loading

Assumptions:

1. Equivalent leak size = 1/8 inch orifice.
2. Constant tank pressure = 18 inches water gauge and 10 inches water gauge.
3. Average loading - leak time = 5 minutes.
4. Vapor is incompressible fluid.
5. Molecular weight of gasoline/air vapor = 43 lbs/lb-mol

$$\rho_{vapor} = \left(\frac{43 \text{ lbs}}{379 \text{ ft}^3}\right) = 0.113\frac{\text{lb}}{\text{ft}^3} = 0.0035\frac{\text{slugs}}{\text{ft}^3}$$

6. Gasoline constitutes 62.4% by weight of vapor.[1]

Applying Bernoulli's Theorem between the inside of tank trucks and the atmosphere:

$$P_{truck} + \left[\frac{1}{2}\left(\rho_{vapor}\, v_{vapor}^2\right) + \rho_{vapor}\, g h\right]_{in\ truck} + \left[\frac{1}{2}\left(\rho_{vapor}\, v_{vapor}^2\right) + \rho_{vapor}\, g h\right]_{to\ atm.} = P_{atm.}$$

where

$$\left[\frac{1}{2}\left(\rho_{vapor}\, v_{vapor}^2\right) + \rho_{vapor}\, g h\right]_{in\ truck} \rightarrow 0 \quad \text{and}$$

$$\left[\rho_{vapor}\, g h\right]_{to\ atm.} \rightarrow 0$$

$$P_{truck} - P_{atm.} = \left[\frac{1}{2}\left(\rho_{vapor}\, v_{vapor}^2\right)\right]_{to\ atm.}$$

$$\Delta P = \left[\frac{1}{2}\left(\rho_{vapor}\, v_{vapor}^2\right)\right]_{to\ atm.}$$

vapor leak velocity, v_{vapor} =

$$v_{vapor} = \sqrt{\frac{2\,\Delta P}{\rho_{vapor}}}$$

Where: Delta P = 18 inches water and 10 inches water, respectively,

$$\rho_{vapor} = 0.0035\frac{\text{slugs}}{\text{ft}^3}$$

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[1] From: Air Pollution Engineering Manual, AP-40, Second Edition, Table 171, Page 655.

Then: vapor leak flow rate, Q = area x V

and

vapor leak mass rate. M = Q x ρ_{vapor} x (weight percent of gasoline)

Calculation:

Vapor Leaks - Loading - 18 Inches of Water Gauge

$$v_{vapor} = \sqrt{\frac{2\,\Delta P}{\rho_{vapor}}} = \sqrt{\frac{2(18\ \text{in})(62.4\ \text{lb H}_2\text{O/ft}^3)}{(12\ \text{in/ft})(0.0035\ \text{slugs/ft}^3)}}$$

$$v_{vapor} = 231.3\ \text{ft/sec}$$

$$Q = A_{leak} \times v_{vapor} = \tfrac{1}{4}\pi\left(\frac{0.125\ \text{in}}{12\ \text{in/ft}}\right)^2 \times 231.3\ \text{ft/sec}$$

$$= (8.522\times10^{-5}\ \text{ft}^2)\times(231.3\ \text{ft/sec})$$

$$= 0.0197\ \text{ft}^3/\text{sec}$$

$$M = Q\times\rho_{vapor}\times(\%\text{wt.gasoline})$$

$$= (0.0197\ \text{ft}^3/\text{sec})\times(0.113\ \text{lb vapor/ft}^3)\times(0.624\ \text{lb gasoline/lb vapor})$$

$$= 0.00139\ \text{lb/sec/leak}$$

Emission per leak = (0.00139 lb/sec) (60 sec/min) (5 min)

= 0.42 lb/leak

Vapor Leaks - Loading - 10 Inches of Water Gauge

$$v_{vapor} = \sqrt{\frac{2\,\Delta P}{\rho_{vapor}}} = \sqrt{\frac{2(10\text{ in})(62.4\text{ lb }H_2O/ft^3)}{(12\text{ in/ft})(0.0035\text{ slugs/ft}^3)}}$$

$$v_{vapor} = 172.4\text{ ft/sec}$$

$$Q = A_{leak} \times v_{vapor} = \tfrac{1}{4}\pi\left(\frac{0.125\text{ in}}{12\text{ in/ft}}\right)^2 \times 231.3\text{ ft/sec}$$

$$= (8.522\times10^{-5}\text{ ft}^2)\times(172.4\text{ ft/sec})$$

$$= 0.0147\text{ ft}^3/\text{sec}$$

$$M = Q \times \rho_{vapor} \times (\%\text{wt.gasoline})$$

$$= (0.0147\text{ ft}^3/\text{sec})\times(0.113\text{ lb vapor/ft}^3)\times(0.624\text{ lb gasoline/lb vapor})$$

$$= 0.00104\text{ lb/sec/leak}$$

Emission per leak = (0.00104 lb/sec)(60 sec/min)(5 min)

= 0.31 #/leak

The difference in emissions between 18" water gauge and 10" water gauge is

0.42 lb - 0.31 lb = 0.11 lb

or

$$\left(\frac{0.11}{0.42}\right) = 26\%$$