Vapor Leak Frequency & Emissions DRAFT analysis

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Overview

- MOVES2010b: vapor leaks not explicitly defined
- MOVES2013 proposal: vapor leaks & non-leaks separate
  - Based on PSHED data
  - Leaks defined as greater than 0.3g/15min
- Emissions calculated:

  Non-leak rate * (1 – Leak Prevalence) +
  Vapor leak rate * (Leak Prevalence)

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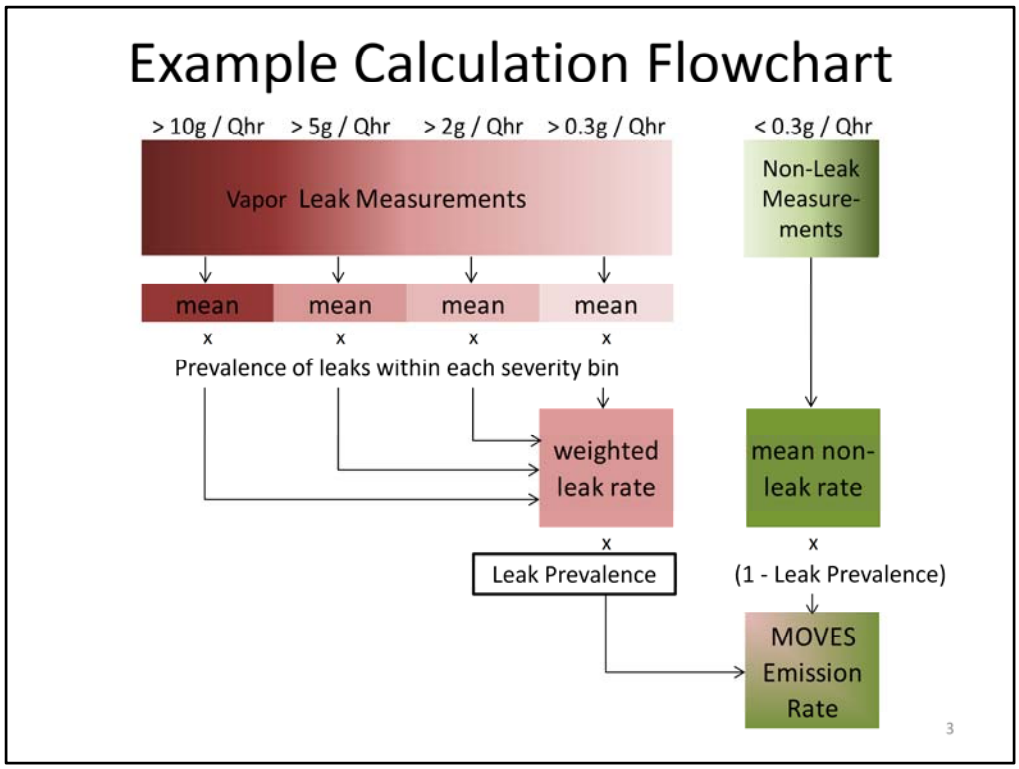
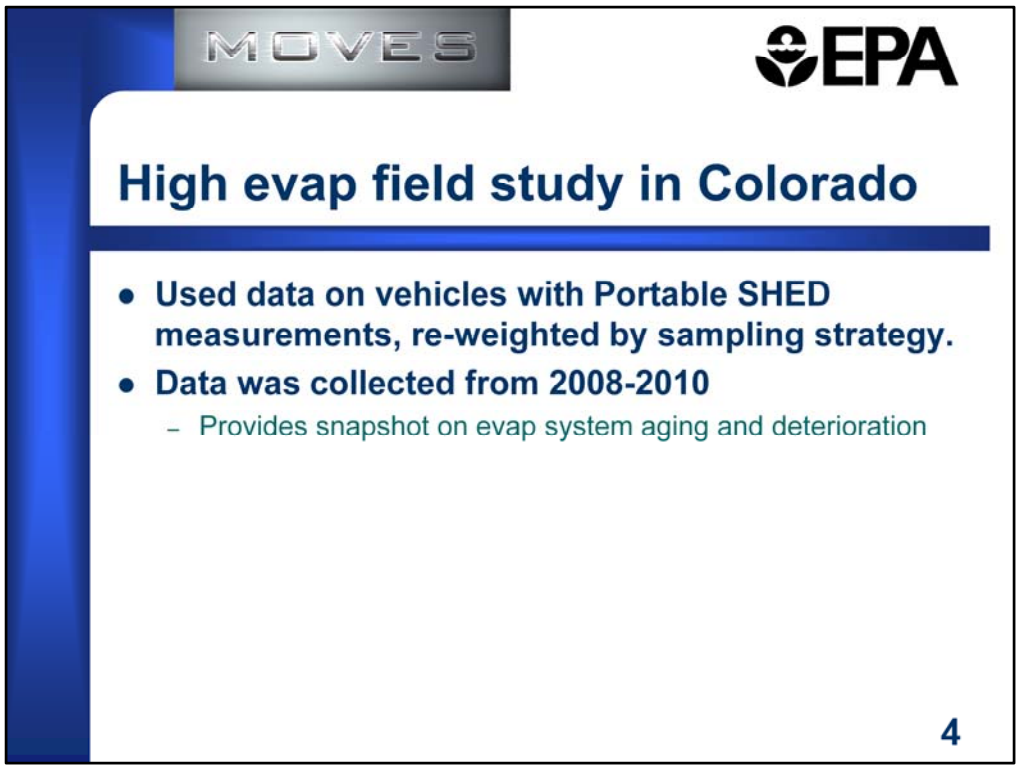


Calculating a final vapor emission rate must include both vehicles with and without vapor leaks. Vapor leak measurements are very diverse so they are binned by severity, then weighted by the occurrence of leaks in each severity bin. This weighted leak rate is then multiplied by the overall frequency of leaks and combined with the non-leak rate.



The High Evap study in Colorado sampled vehicles from an I/M lane and tested their evaporative emissions in a Portable SHED (portable garage tent) The PSHED was sealed and had 99% retention from calibration tests over 15 minute period. The vehicles were sampled using remote sensing technology and recruited via a stratified sampling method targeting higher emitters. After results were obtained, back-calculating via the sampling strategy provides an estimate of the frequency of leaks.

Leak Frequency by Model Year Group and Leak Size

High-PSHED Definition (g/Qhr)	Model Year Group					All Model Years
	1961-1970	1971-1980	1981-1995	1996-2003	2004-2010	
>100	0	0	0.001	0	0	
>50	0	0	0.003	0	0	
>20	0.53	0	0.03	0	0	
>10	0.53	0.30	0.05	0.03	0	
>5	0.68	0.85	0.09	0.03	0	
>2	0.68	1	0.22	0.04	0	
>1	1	1	0.26	0.04	0	
Total Vehicles	4	7	75	76	13	

76 measurements required to reach conclusion that 4% (1 in 25) leak.

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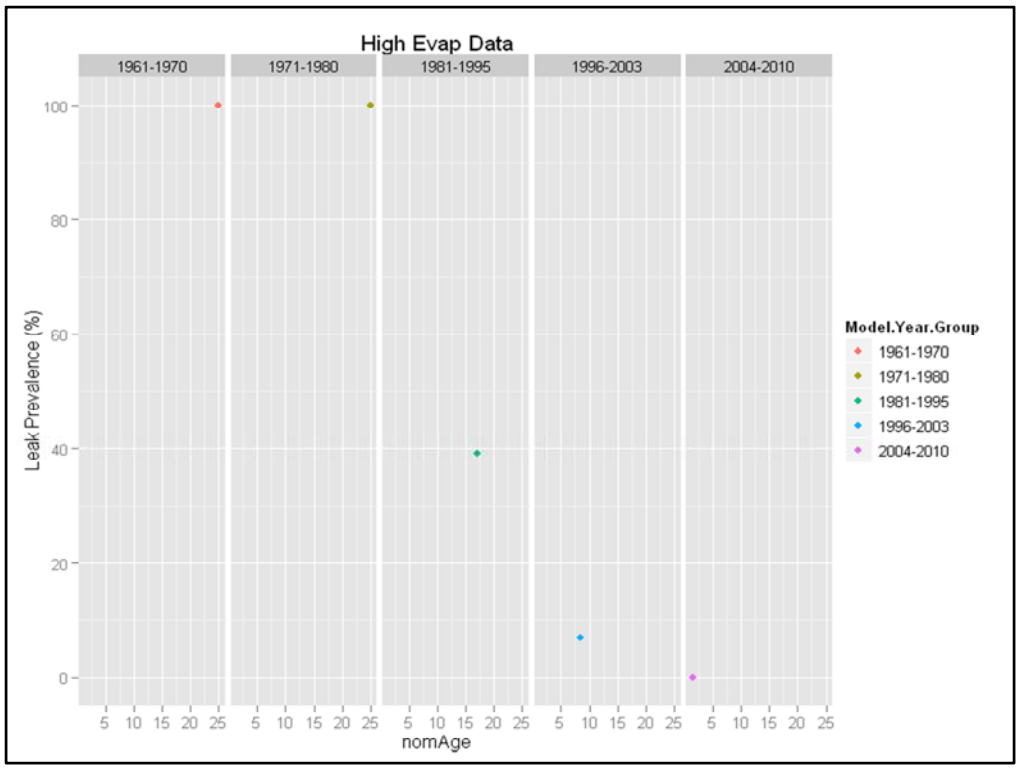
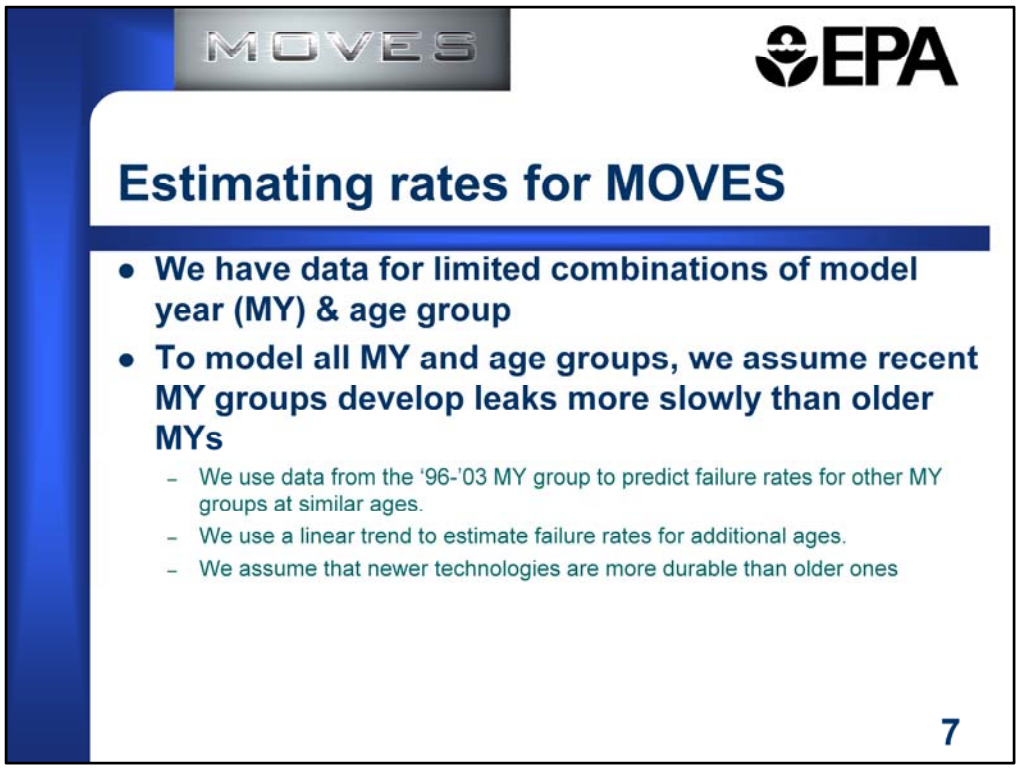
This table includes the prevalence of vehicles having different size leaks. It highlights that for vehicles 1996-2003, 76 vehicles were tested, and 1 in 25 had leaks greater than 1g/15min. Only 13 vehicles were tested in the 2004-2010 model year range.

For model years > 2003, we do not believe our sample size was sufficient to conclude there are 0.00% leaks. Other studies have found leaks in these vehicles.


High Evap Data
1961-1970
1971-1980
1981-1995
1996-2003
2004-2010
Leak Prevalence (%)
100
80
60
40
20
0
5 10 15 20 25
nomAge
Model.Year.Group
1961-1970
1971-1980
1981-1995
1996-2003
2004-2010



Why? Due to the nature of point-in-time testing, we only have one age group for each model year group. We do not believe a sample of 20+ year old vehicles represent those same vehicle's performance when they were new, so we have proposed this alternative.

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Leaks are found in all MY groups, including 2004+

- **RSD monitors selected Tier 2 vehicles; owners chose not to participate**
- **Leaks unrelated to durability exist**
  - After market installations/repairs
- **CRC E-77 laboratory testing programs**
  - 8 out of 15 randomly recruited vehicles showed a leak on the Static test procedure
  - Size of leaks grew over course of program
- **Evap OBD analysis**
  - Analysis of 5-States OBD data show > 1% of 4-5 year old vehicles are leakers; > 2% of 7-10 year old vehicles
  - Not all vehicles with high portable SHED results have evap OBD codes set

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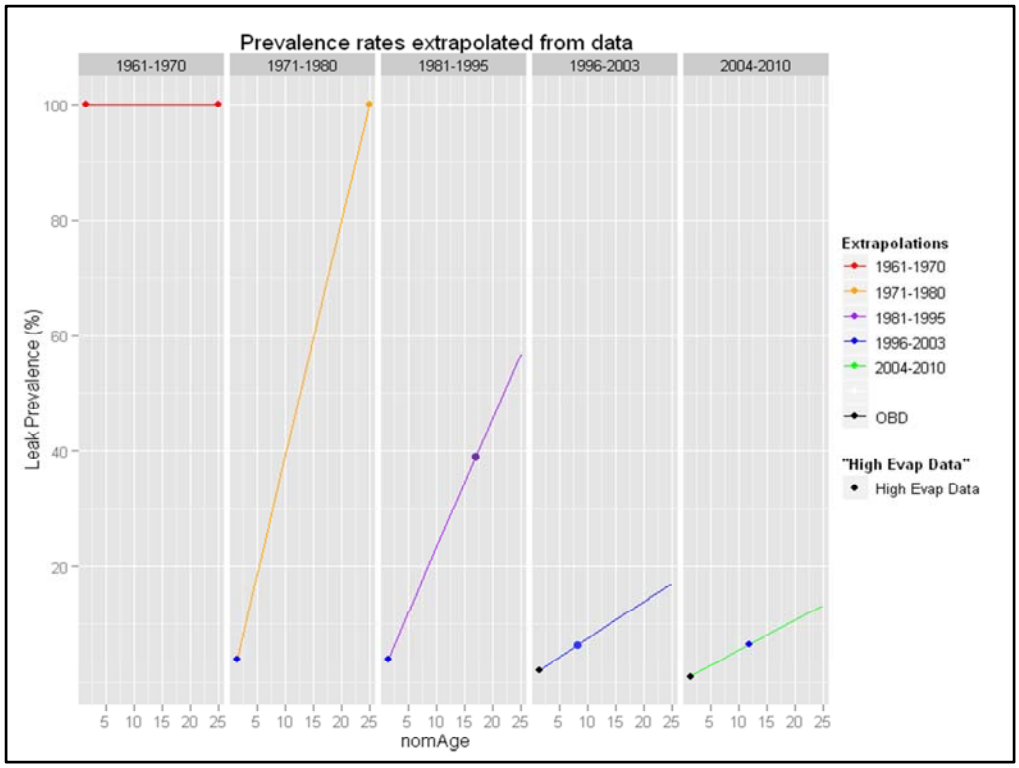
Prevalence rates extrapolated from data
1961-1970
1971-1980
1981-1995
1996-2003
2004-2010
Leak Prevalence (%)
100
80
60
40
20
5 10 15 20 25
nomAge
Extrapolations
1961-1970
1971-1980
1981-1995
1996-2003
2004-2010
OBD
"High Evap Data"
High Evap Data

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Calculating Vapor Leak Emission Rates

- **Diurnal modal data:**
  - Vapor Emissions
    - High Evap Field Study
    - E-77 Program Diurnal tests
  - Tank Temperature
    - Direct SHED readings
- **Calculate:**
  - Tank Vapor Generation
    - Wade – Reddy Equation
    - $TVG = Ae^{(B*RVP)}\left(e^{(C*T1)} - e^{(C*T0)}\right)$

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Vapor Leak Emission Rates

- Vapor leaks vary by orders of magnitude
- Vapor leaks of similar size binned & averaged
- Apply prevalence rates to these averages

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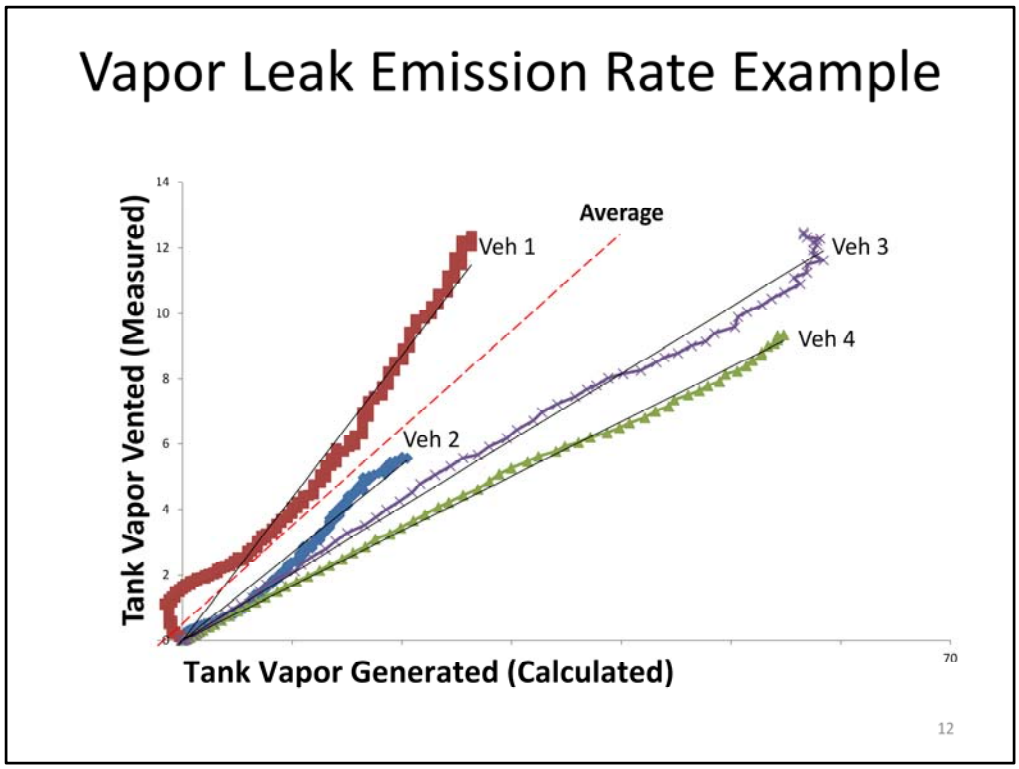
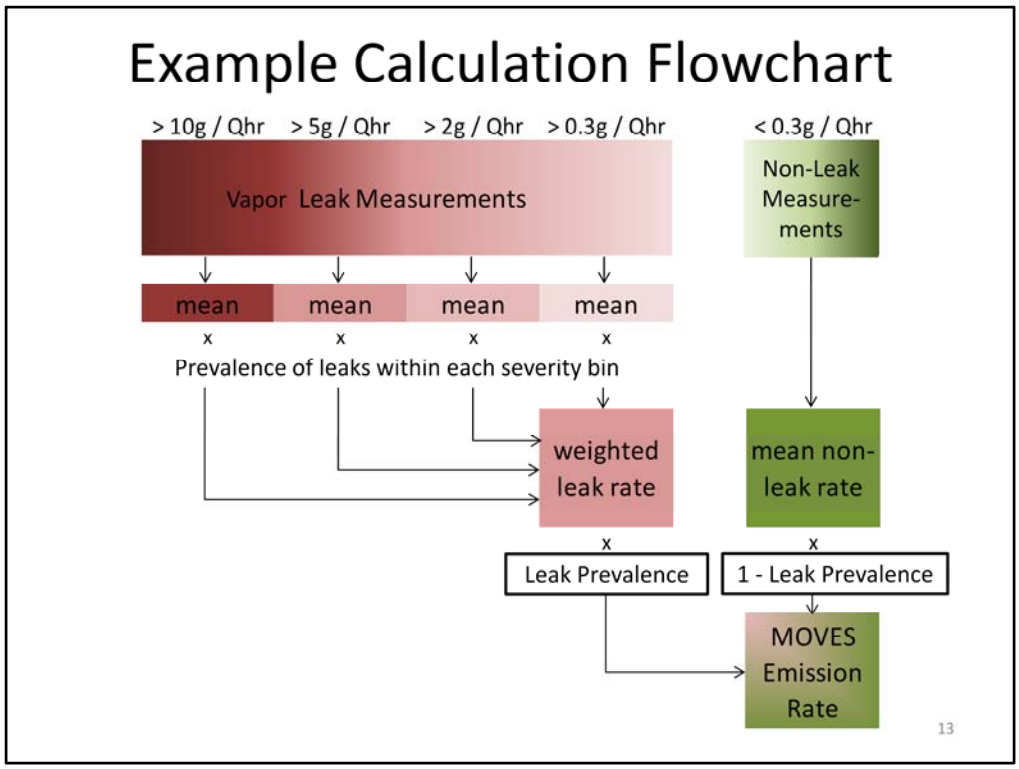


SHED diurnal measurements are binned by the severity of the leak. This graphic is an example of the tests from one such bin. Minute by minute data is plotted. The Y-axis is the measured vapor vented during the test; the corresponding X-axis point is the calculated vapor generated using the proper inputs (Temperature, RVP, Ethanol, Tank Size) The slopes of all linear regressions are averaged to get the representative rate.



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SUMMARY

- First discrete implementation of vapor leaks within MOVES
- Vapor leaks exist within the fleet
- Vapor leak emissions are diverse in cause and behavior; over several orders of magnitude

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Questions?
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