Stage II Vapor Recovery Systems — Options Paper

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Disclaimer

This document contains opinions and recommendations expressed by the Emissions Factors and Policy Application Group to the Ozone Policy and Strategies Group within EPA. These recommendations are tentative in nature and do not necessarily represent current Agency policy. These recommendations may or may not be adopted based upon further study.

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List of Acronyms

A/L – air to liquid ratio
API – American Petroleum Institute
CARB – California Air Resources Board
CE – Control efficiency
DIPE – di-isopropyl ether
DTC – diagnostic trouble code
EF – emission factor
EFPAG – Emission Factors Policy Application Group
EVR – enhanced vapor recovery
FPMA – Florida Petroleum Marketers Association
GDF – gasoline dispensing facility
GVR – Gilbarco Veeder Root
HDGV – heavy duty gasoline vehicle
IEE – incompatibility excess emissions
ISD – in station diagnostics
IUVP –In use verification program
MTBE – methyl tertiary butyl ether
NACS – National Association of Convenience Stores
NESCAUM – Northeastern States for Coordinated Air Use management
OBD – onboard diagnostics
ORVR – onboard refueling vapor recovery
P/V – pressure/vacuum
RSA –Remote Sensing Air, Inc
RVP – Reid vapor pressure
SIGMA – Society of Independent Gasoline Marketers of America
SII – Stage II
TAEE – tert-amyl ethyl ether
TAME – tertiary amyl methyl ether
TCEQ – Texas Commission on Environmental Quality
UST – underground storage tank
VA – vacuum assist
V/L – vapor returned to liquid dispensed ratio
VMT – vehicle miles traveled
VRS – vapor recovery system
VST – Vapor Systems Technology, Inc.
WSPA – Western States Petroleum Association

I. Executive Summary

In order to determine how better emissions monitoring at gasoline dispensing facilities (GDFs) could provide emissions reductions or state implementation plan (SIP) credits, the Emissions Factors Policy Applications Group (EFPAG) within the Emissions, Monitoring, and Analysis Division of the U.S. Environmental Protection Agency's (EPA's) Office of Air Quality Planning and Standards (OAQPS) reviewed a number of interrelated emissions quantification and policy issues. These issues include:

1. How to determine when "widespread use" of on-board refueling vapor recovery (ORVR) canisters occurs,
2. How to phase out Stage II vapor recovery systems (VRS) once widespread use occurs,
3. Whether other emissions points, such as the underground storage tank (UST) vents need to be controlled,
4. Whether there are opportunities to provide State Implementation Plan (SIP) credits to states for certain volatile organic compound (VOC)-reduction activities at GDF,
5. Whether potential UST pressure-related emissions exist,
6. What are actual emissions reductions achieved by Stage II VRS,
7. What actual emissions reductions are achieved by ORVR, and the control efficiency of ORVR throughout the vehicle's life span,
8. How to quantify excess emissions from ORVR and vacuum assist Stage II VRS incompatibility,
9. Whether equity issues for existing GDF should be considered when new GDF are built near the widespread use date,
10. Whether nationwide, as opposed to only nonattainment area-wide, controls are needed,
11. Whether a maximum achievable control technology (MACT) or generally available control technology (GACT) is needed to control hazardous air pollutant (HAP) emissions at GDF,
12. Whether in-station diagnostics and/or enhanced vapor recovery are needed, and
13. Whether the emissions factors used to estimate GDF emissions are accurate.

This paper discusses these issues and identifies options for the Ozone Policy and Strategies Group in OAQPS's Air Quality Standards and Strategies Division, as well as for the Waste and Chemical Processes Group in OAQPS's Emissions Standards Division, to consider in addressing these issues.

II. Introduction

Emissions from GDF are a nationwide problem, and gasoline use in vehicles and trucks is increasing annually. Volatile organic compounds (VOC) and HAP are emitted from the re-fueling of light-duty gasoline vehicles and trucks at GDF and fugitive sources at GDF. VOC emissions from Stage II refueling processes were estimated to be more than 470,000 tons per year (ton/yr) in the 1999 version 2.0 National Emissions Inventory (1999v2 NEI).[1, 2] From the 1999v2 NEI, the HAP emissions (pollutants listed in the Clean Air Act Amendments of 1990) from Stage II refueling could be in the range of 22,000 to 83,000 ton/yr, based on use of emissions factors for baseline, reformulated, and oxygenated gasoline.[3]

The emissions points from controlled Stage II process operations include vehicle refueling emissions at the nozzle/fillpipe interface, spillage, UST vent breathing and emptying, and pressure-related fugitives. A VRS captures the vehicle refueling vapors normally emitted at the vehicle fill pipe and returns them to the UST.[4] A VRS also has an impact on the UST vent emptying emissions as the UST is emptied during refueling.[5]

When an ORVR-equipped vehicle refuels at GDF with Stage II VRS, the amount and composition of the vapor returned to the UST by the Stage II control system can be impacted. As ORVR equipment is being phased in for new vehicles, there is some concern regarding the compatibility of ORVR controls and Stage II controls. An increase in the amount of air (in lieu of gasoline vapor) returned to the vapor space of the UST will lead to gasoline evaporation, or vapor growth, in the UST and lead to excess emissions from the UST vent. A larger amount of air is returned to the UST vapor space for some Stage II vacuum assist VRS when fueling vehicles with ORVR controls, and therefore, the excess emissions are greater for some vacuum assist systems. These excess emissions are referred to "incompatibility excess emissions."

Currently, UST vent emissions are estimated to be relatively small compared to the uncontrolled refueling emissions level based on current emissions factors (ranges from 7.6 pounds of VOC per 1000 gallons of fuel dispensed [lb VOC/1,000 gal] to 11.1 lb VOC/1,000 gal for an uncontrolled refueling emissions factor to 1.0 lb VOC/1000 gal for UST vent and fugitive emissions).[6, 7] Several Stage II equipment vendors maintain that a larger

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1 *Draft 1999 National VOC Inventory for Gasoline Distribution*. April 2003. See: http://www.epa.gov/ttn/chief/eiip/techreport/volume03/index.html.

2 The NEI emissions estimates include vehicle refueling losses, spillage losses, UST vent breathing and emptying losses, and fugitive losses.

3 A table of HAP species percentages of VOC emissions can be found at http://www.epa.gov/ttn/chief/eiip/techreport/volume03/iii11_apr2001.pdf.

4 Technical Guidance: Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities, Volumes I and II. U.S. Environmental Protection Agency. EPA Publication No. EPA-450/3-91-022a and EPA Publication No. EPA-450/3-91-022b. November 1991.

5 Ref. 4, p 3-10

6 CARB. Uncontrolled Vapor Emissions Factor at Gasoline Dispensing Facilities. January 2000.

7 AP-42. Section 5.2, Transportation and Marketing of Petroleum Liquids. January 1995. See http://www.epa.gov/ttn/chief/ap42/ch05/final/c05s02.pdf

source of emissions at GDF is related to positive pressure build-up in the underground storage tank. When the UST pressure is positive, there is potential for increased fugitive emissions and emissions from the UST vent. In general, if an add on pollution control device is employed to reduce the overall storage tank pressure while at the same time capturing and recovering vent emissions, the driving force for fugitive emissions and the vent emissions would be greatly reduced.

In reviewing emissions quantification issues associated with Stage II VRS at GDF, we in EFPAG drafted an issues paper and conducted a public meeting for stakeholders. The purpose of the issues paper and public meeting was to allow stakeholders an opportunity to provide comments and input for EPA's consideration. In addition, we met separately with a few stakeholders to consider their specific issues, and we met with equipment vendors to consider their concerns and comments. Summaries of the public meeting, as well as the stakeholder and vendor meetings are presented in Section II and Section III.

III. Background

After discussions and review within EPA, on August 12, 2004, the EMAD Division provided a copy of the Stage II Vapor Recovery Systems Issue Paper to stakeholders for their review and comment. Purposes of the Stage II Vapor Recovery Systems Issue Paper included:

(1) Providing background information regarding available data,
(2) Discussing EPA's ideas regarding the definition of widespread use,
(3) Discussing ancillary issues related to Stage II VRS, and
(4) Soliciting comments from stakeholders.

More specifically, EPA sought comments on the following issues discussed in the August 12, 2004 Paper:

- **Approach for determining widespread use**, including: (1) using MOBILE6 algorithms for computing widespread use and (2) making the definition of widespread use specific to States, regions, or areas;
- **Options for granting SIP Credits for certain activities,** including: (1) continuing the use of Stage II controls after the determination that widespread use has occurred, (2) opting to require Stage II controls in new areas, and (3) requiring improved monitoring for Stage II control systems to increase rule effectiveness;
- **Associated issues**, including (1) the significance of UST vent emptying and breathing emissions, (2) the significance of fugitive emissions, and (3) the potential need for new emissions factors for VOC and HAP.

A. Description of Stage II Vapor Recovery Systems[6, 8, 9]

The two most common types of Stage II VRS are "vapor balance" and "vacuum assist;" some VRS are referred to as "hybrid" systems that are classified as vacuum assist.[10, 11] The Society of Automotive Engineers (SAE) estimates that 53 percent of VRS in the U. S. are vapor balance systems and 47 percent are vacuum assist systems. California estimates that vacuum assist systems comprise approximately 20 percent of their VRS, while New Jersey estimates they have 10 percent vacuum assist VRS. The Northeast States for Coordinated Air Use Management (NESCAUM) believes that the percent of vacuum assist systems in their region is as high as 70 percent.

The vapor balance VRS is configured with a corrugated boot over the nozzle spout and is designed to capture displaced vapor from the vehicle fuel tank.[12, 13] The vapor balance VRS operates based on the principle of vapor replacement and provides a vapor recovery return line to collect vapors from the vehicle fuel tank displaced by the incoming liquid gasoline.[14] The vapor balance VRS depends on an adequate seal being established between the vehicle being refueled and the faceplate of the fueling nozzle.[15, 16] As gasoline is pumped from the UST, a slight vacuum occurs in the UST which helps pull the vapors into the UST vapor space.

A vacuum assist VRS is sometimes "bootless;" a vacuum (by a pump) is used to pull the gases back through a series of holes (perforations) in the nozzle spout during refueling to the headspace of the UST.[17, 18] The vacuum assist Stage II VRS design concept is based on the need to recapture vapor from the fill pipe of non-ORVR vehicles in equal volume to the gasoline dispensed during refueling. In most cases, liquid along the wall of the vehicle's fillpipe allows the dispensing nozzle to form a seal with the fillpipe. For most vacuum assist VRS, the UST vent is required to be equipped with a pressure /vacuum (P/V) valve designed to open only if the

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8 Refueling Emissions Controls at Retail Gasoline Dispensing Stations in New Jersey. Prepared for API by Tech Environmental, Inc. July 17, 2002.

9 Refueling Emissions Controls at Retail Gasoline Dispensing Stations in Texas. Prepared for API by Tech Environmental, Inc. July 16, 2002.

10 Ref. 4, p. 4-2

11 Enhanced Vapor Recovery: Initial Statement of Reasons for Proposed Amendments to the Vapor Recovery Certification and Test Procedures for Gasoline Loading and Motor Vehicle Gasoline Refueling at Service Stations, Hearing Notice and Staff Report. California Environmental Protection Agency, Air Resources Board. February 4, 2000. pp. 7 and 8.

12 Ref. 11, p. 8.

13 Refueling Emissions Controls at Retail Gasoline Dispensing Stations in New Jersey. Prepared for API by Tech Environmental, Inc. July 17, 2002, p. 2-3.

14 Ref. 13, p. 2-3

15 Ref. 4, p. 4-2.

16 Ref. 13, p. 2-3.

17 Ref. 12, p. 8.

18 Ref. 13, p. 2-3.

pressure or vacuum inside the tank increases beyond a defined threshold.[19, 20] The vacuum assist works well with non-ORVR equipped vehicles, recapturing at least 95 percent of the vapor displaced by the gasoline. However, when refueling an ORVR vehicle, there are no vapors to recapture in the vehicle's fill pipe and the system recaptures ambient air in a roughly equal volume, depending on the air to liquid ratio, to the gasoline delivered and returns it to the UST vapor space.

Stage II VRS is certified to achieve, and can achieve, 95 percent control efficiency. The actual in-use control efficiency achieved, however, is affected by rule effectiveness and rule penetration. The rule effectiveness is impacted by defects/leaks or malfunctions that occur within the VRS. The rule effectiveness and in-use control efficiency can be improved through better monitoring of the VRS and more frequent oversight inspections. With more frequent monitoring, malfunctions and defects/leaks can be repaired more quickly and can be expected to reduce excess emissions, i.e., increase rule effectiveness. Rule penetration accounts for the number of GDF in an area that are actually subject to the Stage II control requirements (e.g., GDFs that dispense less than 10,000 gallons per month are exempt from Stage II controls in an area).

In practice, the range of in-use control efficiencies for Stage II VRS are 62 to 92 percent depending on the inspection frequency (this range is for no exemptions, i.e., 100 percent rule penetration).[21] When rule penetration is accounted for, depending on the exemption level for an area, the in-use control efficiency ranges from 56 to 90 percent.[22] EPA Region 1 indicated that most of their States (Maine, New Hampshire, Vermont, Massachusetts, Connecticut, and Rhode Island) rely on an in-use efficiency of 84 percent for Stage II VRS in their SIP calculations.[23]

B. Description of ORVR

ORVR-equipped vehicles collect the gasoline vapor displaced from the vehicle fuel tank during filling; the gasoline vapors are adsorbed in a canister and, sometime afterwards, are released to the engine. ORVR controls are expected to achieve from 95 to 98 percent reduction of the vehicle refueling emissions (59 FR 16273 and 16279-80; April 6, 1994). When refueling a vehicle with ORVR control only, the ORVR canister does not affect UST vent breathing and emptying losses.[24]

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[19] Ref. 4, p. 4-30.

[20] Ref. 13, p. 2-3.

[21] Ref. 4, p. 4-50.

[22] Ref. 4, p. 4-54.

[23] Electronic mail communication from A. Arnold, EPA Region 1, to T. Driscoll, EPA/OAQPS/EMAD. July 29, 2004.

[24] *Stage II Comparability Study for the Northeast Ozone Transport Region*. U.S. Environmental Protection Agency. EPA Publication No. EPA-452/R-94-011. January 1995, p. 15.

C. Description of Stage II/ORVR Issues

Section 182(b)(3) of the Clean Air Act (CAA), 42 U.S.C. 7511a(b)(3), requires the Stage II vapor recovery program for moderate, serious, severe, or extreme ozone national ambient air quality standards (NAAQS) nonattainment areas. Section 202(a)(6) of the CAA, 42 U.S.C. 7521(a)(6) requires EPA to develop standards for ORVR controls on light-duty vehicles. Section 202(a)(6) of the CAA also states that the section 182(b)(3) Stage II requirement shall not apply in moderate areas after ORVR standards are promulgated. On April 16, 1994, EPA promulgated regulations requiring the phase-in of ORVR controls on new vehicles. In addition, the CAA provides that EPA may revise or waive the Stage II control requirements of section 182(b)(3) for "serious" or worse ozone nonattainment areas after EPA determines that ORVR control systems are in "widespread use" throughout the motor vehicle fleet.

As ORVR equipment is being phased in for new vehicles, there is some concern regarding the compatibility of ORVR controls and Stage II controls. When an ORVR-equipped vehicle refuels at GDF with Stage II VRS, the amount and composition of the vapor returned to the UST by the Stage II control system can be impacted. An increase in the amount of air (in lieu of gasoline vapor) returned to the vapor space of the UST will lead to gasoline evaporation, or vapor growth, in the UST and lead to excess emissions from the UST vent. A larger amount of air is returned to the UST vapor space for some Stage II vacuum assist VRS when refueling vehicles with ORVR controls, and therefore, the excess emissions are greater for some vacuum assist systems.[25]

While considering how to define and calculate widespread use, EPA was presented with issues related to Stage II VRS, ORVR, and their potential for incompatibility, including: (1) excess vapor growth within the UST system, (2) UST system pressure build up, (3) fugitive emissions, and (4) gas station emissions monitoring. Subsequent sections outline and discuss these issues. Detailed comments from the stakeholders and options to address these issues are discussed in Section V.

D. Continued Use of Stage II VRS

Section 202(a)(6) provides that EPA may revise or waive the application of the requirements of section 182(b)(3) of the CAA for serious, severe, or extreme ozone nonattainment areas after EPA determines that ORVR control systems are in "widespread use" in the motor vehicle fleet. If EPA decides to revise or waive these requirements, States or areas could decide to repeal requirements for Stage II VRS, following demonstration of widespread use in the area or State. Under this scenario, there would be many serious, severe, and extreme counties that currently have Stage II controls that would no longer be required to have them after widespread use occurs. The State could also decide that the Stage II requirements will remain in effect. We expect a benefit to retaining Stage II VRS until all vehicles have ORVR. EPA may consider providing additional SIP credits where States (non-OTR) retain Stage II VRS after widespread use occurs. EPA could provide SIP credits from the date widespread use occurs (depending on the definition of widespread use chosen) until the time when combined ORVR and Stage II VRS emissions are no longer less than ORVR emissions only.

[25] Ref. 11, p. 36.

E. Underground Storage Tank Emissions

Emissions from an UST vent could result from one or more of the following conditions:[26] (1) normal emptying and breathing emissions expected from the UST vents without any Stage II controls during refueling (uncontrolled); (2) normal emptying and breathing emissions expected from the UST vents when Stage II VRS are used during refueling, both vapor balance and vacuum assist systems (controlled); or (3) excess emissions from the UST vent related to vapor growth resulting from the incompatibility of combined Stage II vacuum assist VRS with ORVR-equipped vehicles during refueling. (Note: The AP-42 emissions factor for UST vent emptying and breathing emissions also includes vapor loss between the UST and the gas pump, i.e., fugitive emissions.)[27] Lastly and as a separate issue, some studies suggest that there are significant emissions from the UST vents, other than those from refueling vehicles.[28]

F. Fugitive Emissions

Fugitive emissions at a GDF could result from one or more of the following: (1) the normal fugitive emissions expected from GDF without any Stage II controls; (2) the normal fugitive emissions expected from GDF when Stage II VRS is used; (3) the excess fugitive emissions from the GDF resulting from the incompatibility of combined vacuum assist Stage II VRS with ORVR-equipped vehicles during refueling; and (4) the potential fugitive emissions from the deterioration and aging of gasoline dispensing equipment.

CARB studies suggest that pressure-related fugitive emissions resulting from leaks at GDF may be significant. Furthermore, some testing by CARB suggests that pressure-related fugitive emissions may increase when vacuum assist Stage II VRS is used in conjunction with ORVR-equipped vehicles.[29] CARB test method procedures calculate pressure-related fugitive emissions based on pressure measurements in the system. A recent API study measured fugitive emissions simulated in a field laboratory setting and concluded that the CARB calculations overestimate fugitive emissions.[30] We are reviewing data provided by vendors and plan to observe and have emissions testing conducted to quantify fugitive emissions under the various uncontrolled and controlled scenarios at GDF.

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[26] Emissions discussed here include those from breathing and emptying and do not include emissions from filling (i.e., related to Stage I).

[27] AP-42. Section 5.2, Transportation and Marketing of Petroleum Liquids. January 1995. See http://www.epa.gov/ttn/chief/ap42/ch05/final/c05s02.pdf

[28] Membranes, Molecules, and the Science of Permeation. Tedmund Tiberi. *Petroleum Equipment & Technology*. April 1999.

[29] CARB. Preliminary Draft Test Report, Total Hydrocarbon Emissions from Two Phase II Vacuum Assist Vapor Recovery Systems During Baseline Operation and Simulated Refueling of Onboard Refueling Vapor Recovery (ORVR) Equipped Vehicles. June 1999.

[30] API. *ORVR Compatibility Study for the Gilbarco Vaporvac VRS.* February 2004. Includes Phase 1, Phase 2 - Outside, and Phase 2 - SHED.

G. GDF Emissions Monitoring, Inspections, and Maintenance

As discussed previously in the Background section, the in-use control efficiency of Stage II VRS ranges from 56 to 92 percent, depending on the inspection frequency and the exemption levels.[31] After the VRS equipment is installed, associated wear and tear, malfunctions, or system problems can result in reduction of certified efficiency. While Stage II control systems can achieve 95 percent or better control efficiency, in-use efficiency is demonstrated to drop significantly without proper operation and maintenance.[32] Data analyzed during preparation of the EPA's *Technical Guidance Document* indicate that conducting semi-annual inspections provide in-use efficiencies of 92 percent, annual inspections provide in-use control efficiencies for Stage II VRS of 86 percent, and minimal or less frequent inspections provide 62 percent in-use efficiencies (these values assume no exemptions).[33] The in-use control efficiency for Stage II is directly related to the inspection frequency and subsequent repair of systems. Based on the inspection program conducted by an area, SIP credits may be provided above the typical in-use efficiency demonstrated from Stage II VRS operation.

We believe that better (and more frequent) monitoring, coupled with good operation and maintenance programs, results in emissions reductions. GDF include several potential VOC emissions points other than the refueling interface that are monitored infrequently, at best. Several types of improved monitoring are being conducted by States that result in increased control efficiencies of the Stage II VRS equipment and increased emissions reductions. Improved monitoring may include: (1) oversight inspections and (2) requirements for in-station diagnostics (ISD).

Oversight inspections of the Stage II VRS at GDF are conducted by area inspectors and generally focus on Stage II VRS equipment defects and: (1) visual inspection of the nozzles, boots, faceplates, and hoses for cuts, tears or other disrepair (some States require more than visual inspections); (2) checks of the nozzle check valves, nozzle latches, etc.; (3) inspection of the air pollution control device (APCD) on the UST, if any (i.e., the processor); (4) on-site paperwork and records; and (5) confirmation that the installed VRS matches the permitted VRS. Some areas have an equipment checklist or an inspection form that inspectors use at each site, while others do not. The inspection frequency ranges from once every 5 years to two to three inspections each year. Some areas have priority inspection programs, where GDF with recurrent problems are inspected more frequently and conscientious GDF are inspected less frequently, perhaps only once per year.[34]

Another closely related option for improved monitoring might include a maintenance program for dispenser components. A GDF could implement a program of scheduled replacement of components that may leak. In this program, each component would be date-stamped and replaced on a scheduled basis, regardless of detected leaks or other defects/malfunctions. This maintenance program may prevent leaks from occurring.

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[31] Ref. 4, p. 4-54.

[32] Ref. 4, p. 4-53.

[33] Ref. 4, p. 4-50.

[34] Ref. 4, pp. 6-22 through 32.

In-Station Diagnostics (ISD) is a program that measures operating parameters of the Stage II VRS and GDF equipment to ensure it is operating properly. The ISD program provides real-time monitoring of critical VRS components and signals when failure modes are detected. The parameters monitored depend upon the type of VRS. For vapor balance VRS, UST pressure, pressure drop across hose, nozzle, etc. (to detect liquid blockage), and vapor returned to liquid dispensed (V/L) ratio[35] with a flow meter would be measured.[36] For vacuum assist VRS, UST pressure and V/L ratio with a sensor would be measured; if the V/L ratio is out of limits, the vapor pump flow is adjusted to achieve the correct V/L ratio.[37] If the assist VRS also has an air pollution control device (APCD) or processor on the UST, operating parameters of the APCD such as hydrocarbon concentration, flow rate, flame detection, and pressure would be monitored.[38] California has indicated that the goal of the ISD program in their State is to bring the in-use control efficiency to the 90 percent currently assumed in the inventory.[39] For other States that adopt ISD programs, SIP credits may be provided if it is determined that the in-use control efficiency in their SIP has been exceeded.

H. Widespread Use Determinations

As previously mentioned, when EPA determines that ORVR control systems are in widespread use throughout the motor vehicle fleet, States will have the option to remove Stage II VRS. This determination has several components, including: (1) defining "widespread use," (2) predicting when it will occur, and (3) how it can be demonstrated and verified. We know the definition and occurrence of widespread use is integral for State and local air pollution control agencies, so they can revise their control strategies and update their SIPs. Some of the ways to interpret and define widespread use include:

a. When "x" percent of the vehicles in service are ORVR-equipped,

b. When "x" percent of the vehicle miles traveled (VMT) are from ORVR-equipped vehicles,

c. When the total VOC emissions from ORVR-equipped vehicles are equal (or equivalent) to the total VOC emissions from Stage II VRS programs, or

d. When "x" percent of gasoline sold is dispensed to ORVR-equipped vehicles.

Some of the widespread use definitions are simple approaches and some are more complex. In each of these definitions, the requirement for what percentage represents widespread use would be established first (i.e., 95 percent, 90 percent, 85 percent, etc.). The analysis/computation would then be conducted based on State-specific data, or region-specific

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[35] The vapor returned to liquid dispensed (V/L) ratio is an important operating factor of VRS. The V/L ratio is also referred to as the air returned to liquid dispensed, or A/L ratio. The V/L ratio refers to the ratio of the quantity of vapor and air returned to the UST headspace to the quantity of gasoline pumped out of the UST.

[36] Ref. 11, p. 66.

[37] Ref. 11, p. 67.

[38] Ref. 11, p. 67-68.

[39] Ref. 11, p. 94.

data if a larger or smaller area than a State would be analyzed. Each of the possible definitions are discussed below, along with the advantages and disadvantages of each.

Definition (a) (percentage of ORVR-equipped vehicles). Definition (a) is a simple approach for widespread use. In this definition, the analysis would be conducted based on vehicle registration data, projections of that data into the future, and the phase-in schedule for ORVR. While the approach accurately represents the vehicle fleet, it is important to note that more vehicle miles are traveled for newer vehicles, as people tend to drive newer vehicles more often and for longer trips than older vehicles. Definition (a) does not reflect this, and also does not reflect some general differences in vehicles such as fuel economy (miles per gallon) and useful life.

Definition (b) (percentage of VMT by ORVR-equipped vehicles). Definition (b) is also a fairly simple approach. Definition (b) would be based on all of the data inputs for definition (a) plus the VMT data by class of vehicle. This approach addresses the VMT by ORVR vehicles issue mentioned under definition (a); an area or State is more likely to reach the criterion in definition (b) before reaching the criterion in definition (a) (i.e., widespread use would occur earlier with definition (b)). VMT data are generally available for States and regions. This approach may not address differences in vehicles such as fuel economy (miles per gallon) and useful life.

Definition (c) (VOC emissions with ORVR controls equal VOC emissions with Stage II VRS only). Definition (c) is a slightly more complex approach that would require calculation and comparison of vehicle refueling emissions based on two different refueling control measures. This definition would require the data inputs for definitions (a) and (b) along with data on ambient temperature, Reid vapor pressure, rule effectiveness, rule penetration, and the percentage of GDF with vacuum assist Stage II VRS (to determine incompatibility excess emissions). The advantage of this approach is that it addresses and compares emissions levels directly. A disadvantage with this approach is that the in-use control efficiency of the Stage II VRS must be correctly determined (range was provided as 56 to 90 percent).[40]

Definition (d) (gasoline dispensed to ORVR-equipped vehicles). Definition (d) would require data on the volume of gasoline sold in addition to the data inputs needed for definition (b). A disadvantage of this approach is that gasoline quantities dispensed typically are not available on a county or area basis and must be estimated based on either VMT data and fuel economies or county gasoline sales (in dollars). This approach does, however, address differences in vehicles such as fuel economy for each vehicle type. Included as part of the Regulatory Impact Analysis (RIA) conducted for the ORVR regulations in January 1994, the widespread use analysis was based on gasoline dispensed to ORVR-equipped vehicles.[41]

[40] Ref. 4, p. 4-54.

[41] Final Regulatory Impact Analysis: Refueling Emission Regulations for Light Duty Vehicles and Trucks and Heavy Duty Vehicles. U.S. Environmental Protection Agency, Office of Mobile Sources. January 1994.

I. Description of SIP Credit Opportunities

In prior meetings and discussions with stakeholders, several questions arose regarding SIP credits related to the widespread use date and Stage II control requirements. The questions include how SIP credits might be impacted by: (1) continuing to use Stage II controls after the widespread use date, (2) requiring Stage II controls in new areas, and (3) applying improved monitoring to Stage II control systems to decrease emissions and increase rule effectiveness. ***Figure 1*** shows the relative emissions for several control measures and in-use efficiencies. The figure shows the full range of possible in-use efficiencies and their relation to the ORVR only control scenario (point B versus point B' depending on the Stage II control efficiency). The figure also shows that the combined use of ORVR and Stage II VRS controls results in lower VOC emissions than either control measure alone. If a State applied both control measures in its projected emissions baseline, it could not receive additional SIP credit for those same measures, i.e., to avoid double-counting.

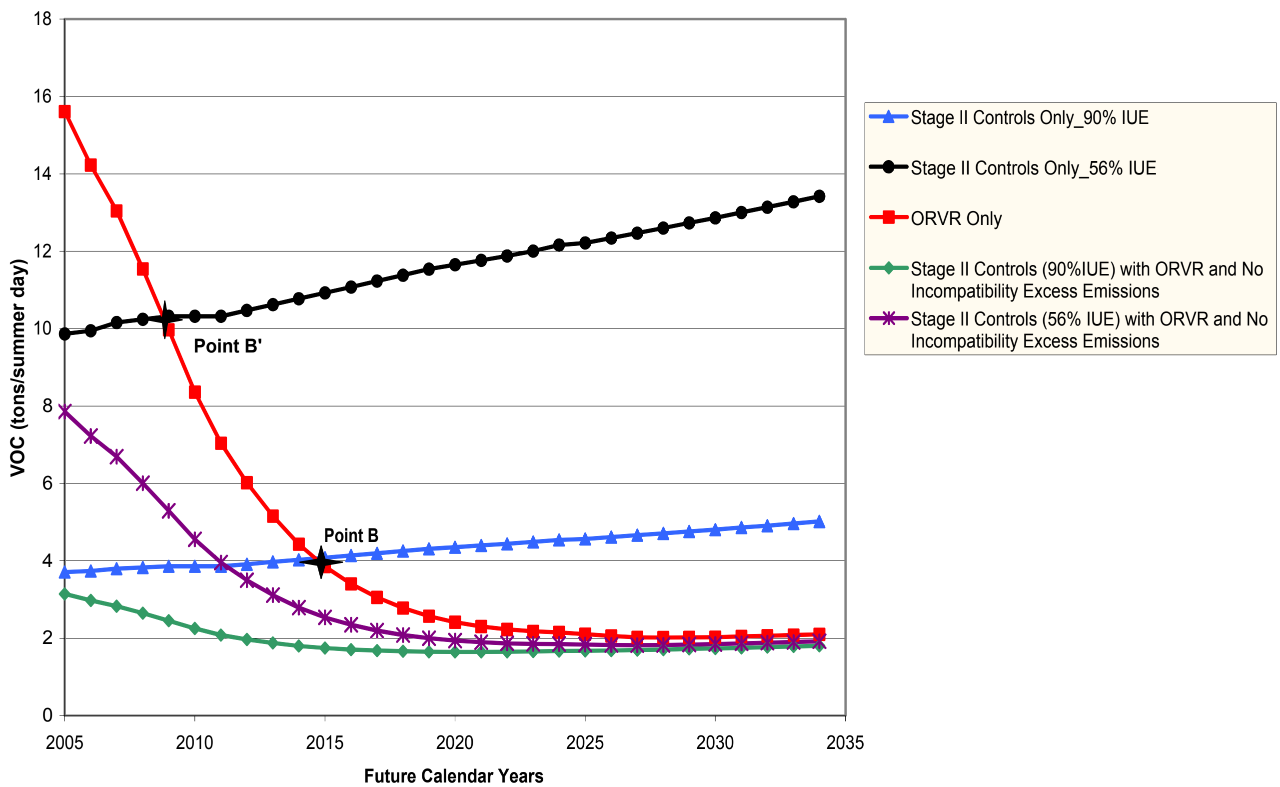

Figure 1. General emissions trends expected for refueling emissions in future calendar years for a hypothetical State, no incompatibility excess emissions (based on API studies).

1. SIP Option for States to Include Stage II VRS in Additional Areas.

States could require Stage II VRS in areas where they are not currently required and/or located, even knowing that Stage II VRS may not be required after relatively few years. Under the new 8-hr ozone designations: (1) several MSAs were revised and additional counties were included in ozone nonattainment areas, (2) several MSAs that were serious or severe under the 1-hour standard are newly classified as moderate under the 8-hour ozone standard, and (3) several areas have been newly classified as ozone nonattainment areas (added to the moderate nonattainment classification). Where MSAs were revised and counties were added and the MSAs were previously classified as serious or severe, the added counties are not likely to have Stage II controls in place. If the State decides to retain Stage II controls in these MSAs after the widespread use date, States could require these added counties to also control Stage II emissions. In the second scenario, a State could require Stage II in moderate nonattainment areas that have been newly added to the ozone nonattainment areas.

State and local agencies may be reluctant to require Stage II VRS for a limited number of years. However, some States may be interested in requiring Stage II VRS for GDF that are not currently required to have Stage II controls, if adequate SIP credits are granted. A few moderate areas (outside of OTR) retained Stage II controls following the April 1994 promulgation of ORVR controls (e.g., counties in Florida). If SIP credits can be granted for requiring Stage II VRS in additional areas, the credit calculation would include the emissions reductions that reflect combined Stage II and ORVR controls. For these counties, the emissions from GDF would be affected significantly.

2. Other SIP Credit Options.

SIP credit may also be an option for States where stations install UST vent controls or other control measures after Stage II VRS requirements are removed. The other control measures may include a P/V valve or an UST add-on APCD (processor) or possibly other CARB EVR requirements.

Groundwater Contamination from Stage II VRS.

Some studies suggest that leaking USTs, including liquid leaks and possibly vapor leaks, are contaminating the groundwater with MTBE. MTBE is a component of gasoline and is added to reformulated gasoline, oxygenated fuels, and premium grades of unleaded gasoline. EPA has not set a national standard for MTBE in drinking water, but many States have set their own limits.

EPA-promulgated federal UST regulations have contributed significantly to the reduction of soil and groundwater contamination (by MTBE and other fuel components). Unfortunately, even with these regulations in place, there are sometimes equipment failures and installation mistakes that result in releases of fuel to the environment; in addition, there are also some concerns that vapor leaks occur from the UST when the tank becomes pressurized. EPA is currently working with States to improve the compliance rate of the leak detection requirements through compliance assistance programs, UST inspections, and enforcement actions. As of December 22, 1998, substandard USTs not meeting requirements for spill, overfill, and corrosion were required to be upgraded or closed.[42]

– UST Regulations

New UST. Federal UST regulations specify that new UST installed after December 22, 1988 must meet four requirements: (1) that the installation of the tank and piping be certified to meet industry codes, (2) that the tank be installed with leak detection, (3) that the tank be

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[42] See: http://www.epa.gov/swerust1/mtbe/index.htm

installed with spill and overfill protection, and (4) that the tank be installed with corrosion protection.[43, 44] All of these requirements are crucial in ensuring that the UST does not contaminate groundwater. The leak detection requirements include three components; the leak detection system must:

- Detect a leak from any portion of the tank or its piping,
- Be calibrated, operated, and maintained as directed by manufacturer's instructions; and
- Meet performance requirements contained in 40 CFR 280.43 and 280.44.

A GDF must conduct monthly monitoring of the UST using the leak detection system and must select at least one of the following methods to determine if leaks exist:

1. Interstitial Monitoring: determine if there are leaks in the space between the UST and the second barrier.

2. Automatic Tank Gauging Systems: use automation to monitor product level and inventory control.

3. Monitoring for Vapors in the Soil: sample vapors in the soil surrounding the UST.

4. Monitoring for Liquids in the Groundwater: monitor the groundwater table near the UST for the presence of released free product on the water table.

5. Statistical Inventory Reconciliation: requires that a trained professional use sophisticated computer software to perform a statistical analysis of gasoline inventory, delivery, and dispensing data.

6. Other Methods Approved by the Regulatory Authority: a comparable proven method to the above methods.

As an alternative to the monthly monitoring methods, a GDF may combine inventory control with tank tightness testing for the first ten years after the installation of a new UST. After ten years have passed, the GDF would then have to use one of the six monthly monitoring methods mentioned above. An inventory control program consists of taking daily measurements of UST contents and recording deliveries and the amount of product pumped from the UST. This information along with daily and monthly calculations indicates if there is a leak. A tank tightness test must be conducted every five years.

Leak detection monitoring is also important for UST piping. Pressurized piping must meet one of the following requirements: (1) piping must be installed with devices that automatically shut off, restrict flow, or sound an alarm; or (2) conduct an annual tightness test or

[43] Straight Talk on Tanks: Leak Detection Methods for Petroleum Underground Storage Tanks and Piping. U.S. Environmental Protection Agency. EPA Publication No. EPA 510-B-97-007. September 1997.

[44] Musts for USTs: A Summary of Federal Regulation for Underground Storage Tank Systems. U.S. Environmental Protection Agency. EPA Publication No. EPA 510-K-95-002. July 1995.

one of the six monthly monitoring methods noted above for UST. If the UST piping is suction piping, the leak detection requirements are dependent on the type of suction piping used.

New USTs must also meet spill and overfill requirements. All new installed UST must be installed with a catchment basin. A catchment basin, also referred to as a spill containment manhole or spill bucket, is a bucket sealed around the UST fillpipe. Most catchment manholes are equipped with pumps or drains to remove liquid spills. New USTs must also have overfill protection upon installation. Three commonly used overfill protection devices provide either automatic shutoff, overfill alarms, or ball float valves.

Lastly, a new UST must have corrosion protection. The UST and associated components must be comprised of either (1) non-corrodible material such as fiberglass or jacketed in non-corrodible material, (2) made of steel that is coated with a corrosion-resistant coating and with cathodic protection, or (3) made of steel clad with a thick layer of non-corrodible material (does not apply to piping).

Existing UST. Existing UST that were installed before December 22, 1988 were required to meet the leak detection requirements by December 1993. Both spill and overfill protection requirements and corrosion protection requirements were required to be met by December 22, 1998.

The leak detection requirements for existing UST are similar to the requirements for new UST. Existing UST can use any of the six monthly monitoring methods as described for new UST. Spill and overfill requirements are the same for existing and new UST. Existing UST must also meet the corrosion protection requirements. If the existing tank does not currently meet the corrosion requirements specified for new UST, the existing UST must be modified. If the existing UST is made of steel, one of following methods must be chosen to add corrosion protection: (1) add cathodic protection, (2) add interior lining to the UST, i.e., non-corrodible material, or (3) combine cathodic protection and interior lining. The existing UST piping that is made of steel must also have cathodic protection.

– SIP Credits Associated with Preventing UST Leaks

Currently, the federal UST regulation requires a GDF to pick one of six monthly monitoring methods for identifying UST leaks (described above), or as an alternative to the monthly monitoring methods, a new UST may combine inventory control with tank tightness testing for the first ten years after the installation of the UST. While these monitoring requirements are mostly in place to detect liquid leaks from UST, some of the monitoring methods may also detect vapor leaks, for example, the tank tightness requirements. In addition, periodic pressure testing of the UST such as static pressure tests or pressure decay tests will confirm that there are no vapor leaks from the tank and fittings. We believe that SIP credits may be warranted for areas that require GDF to perform a combination of monitoring methods to monitor for UST liquid and vapor leaks. A GDF utilizing more than one monitoring method would have a back-up method in the event one monitoring method failed to detect a leak. SIP credits may also be warranted for areas that require more frequent monitoring than monthly monitoring.

IV. Stage II Discussion Meetings with Stakeholders and Vendors

During Stage II data collection, we met one-on-one with HERTZ, Alliance of Automobile Manufacturers (AAM), ARID Technologies, Inc. (ARID), Vapor Systems Technologies, Inc. (VST), Healy Systems, Inc. (Healy), EMCO Wheaton, and the American Petroleum Institute (API). The information discussed and/or data received from these meetings are summarized below.

A. Hertz Meeting Summary

At the request of Hertz Rent-a-Car (Hertz), we met to discuss a waiver from Stage II VRS requirements for existing and new rental car facilities. Hertz currently maintains a vehicle fleet where approximately 97 percent of the vehicles have ORVR equipment. Hertz believes that because their vehicle fleet is almost entirely comprised of vehicles with ORVR equipment and because maintaining Stage II VRS is redundant, removal of Stage II VRS at their facilities would not result in an increase in VOC emissions. Although we cannot provide a direct waiver from Stage II VRS requirements to Hertz, we have discussed providing a memorandum to States and Regions that would support the granting of a waiver of Stage II VRS by a State.

In order to obtain emissions data to support development of such a memorandum, we have discussed with Hertz a monitoring schedule for emissions points at GDF under several scenarios. The objectives for such monitoring are to: (1) demonstrate that VOC emissions would not increase if Stage II VRS are removed at existing Hertz airport GDF facilities, (2) demonstrate that VOC emissions would not increase if Stage II VRS are not installed at newly constructed Hertz airport GDF facilities, and (3) demonstrate that VOC emissions reductions from refueling a high percentage of ORVR-equipped vehicles are at least equivalent to emissions reductions obtained from a Stage II VRS.

B. Alliance of Automobile Manufacturers (AAM) Meeting Summary

Also, at the request of AAM we met to discuss a waiver from Stage II VRS requirements at automobile manufacturing facilities. AAM believes that because almost all of the new vehicles being refueled at manufacturing facilities have ORVR equipment and because maintaining Stage II VRS is redundant, removal of Stage II VRS at their manufacturing facilities would not result in an increase in VOC emissions. Again, we informed them that although we cannot provide a direct waiver from Stage II VRS requirements to automobile manufacturers, we have discussed providing a memorandum to States and Regions that would support the granting of a waiver by a State. Although such a waiver request would be very similar to the rental car agency waiver described above, there are several key differences in the refueling operations for the automobile manufacturers, such as: (1) there are no vapors in the vehicle gasoline tanks before they are fueled for the first time, so there are no vapors to be expelled from the vehicle tank (also called the “green tank effect”) and (2) the line from the gasoline dispenser to the UST may be several miles long, which may cause some additional emissions due to the expansive piping necessary to move the gasoline to the dispensing area. The automobile manufacturers have submitted some emissions test data monitoring these conditions. These data are summarized in Section VI.

C. ARID Technologies Meeting Summary

We met with representatives of ARID Technologies, manufacturers of add-on APCD for UST vents. The APCD is a membrane technology (called PERMEATOR) that prevents UST venting of gasoline vapors. ARID claims the technology can be used with balance Stage II VRS and vacuum assist VRS. ARID believes the technology allows for improved UST vapor recovery efficiency during UST breathing and emptying; the technology has the potential to recover gasoline product that would otherwise be emitted to the atmosphere as vapor.

ARID believes there is an increase in emissions that results from the combined use of vacuum assist Stage II VRS and ORVR. ARID also maintains that counting UST emissions as either fugitive or vent emissions is largely academic. The important point is that an excess vapor generation rate is present within the UST system. The excess vapor volume will result in an observed pressure increase within the UST. A relatively "tighter" system will yield higher UST vent emissions (ARID includes emptying, breathing, and incompatibility excess emissions) and a relatively leaky system will yield higher fugitive emissions. In general, if an UST add-on APCD is employed to reduce the overall storage tank pressure while at the same time capturing and recovering UST vent emissions, the driving force for fugitive emissions is greatly reduced, and both the fugitive and UST vent emissions are significantly reduced.

D. Vapor Systems Technologies, Inc. (VST) Meeting Summary

We met with representatives of VST, manufacturers of another add-on APCD for the UST vent. VST's product, a membrane processor that reduces fugitive emissions, is undergoing CARB testing to determine if it is compatible with refueling ORVR-equipped vehicles. VST has 3 test sites in California and is working to establish additional test sites in other regions in the U.S. VST believes that its monitoring data show: (1) most, if not all, positive tank pressure fugitive emissions to the atmosphere are from leaking UST systems, (2) the increase in ORVR vehicle penetration is causing increased fugitive emissions when used with vacuum assist Stage II VRS, and (3) VST's new technologies provide the ability to use ORVR and Stage II VRS systems simultaneously while reducing UST systems pressures and eliminating fugitive vapor emissions.

VST believes the fugitive vapor emissions at GDF are more severe than previously considered. VST believes that the growing rate of ORVR equipment in the vehicle population is contributing to an increase in fugitive vapor emissions. VST believes that UST systems have a high leak rate, resulting in increased fugitive emissions, and the UST systems require a high level of maintenance to remain tight.

E. Healy Systems, Inc. (Healy) Meeting Summary

Healy believes that the assumption that ORVR fleet penetration at some point will make Stage II VRS redundant is not accurate. Healy believes that 20 percent of gasoline dispensed in the foreseeable future will fuel non-ORVR equipped vehicles and other motor driven units. If Stage II VRS equipment is removed, then 100 percent of the refueling vapor emissions associated with non-ORVR equipped vehicles and other motor driven units will be emitted to the atmosphere. Healy also maintains that the source of emissions at GDF is positive pressure build-up in the ullage space of the UST and that the problem is associated with the design of Stage II vacuum assist VRS. Healy suggests that fugitive leaks are in the magnitude of 1 gallon per minute. Healy manufactures an UST add-on APCD, the Clean Air Separator (or bladder tank), that acts as a pressure management system. Any excess vapors from the UST vent due to pressurization are routed to the bladder tank and are contained rather than emitted to the atmosphere. These vapors may be returned/pulled back into the UST from the bladder through the UST vent when the UST pressure drops below -8.0 inches of water column (in. w.c.). The bladder collapses as the contained vapors are returned to the UST.

F. EMCO Wheaton Retail Meeting Summary

EMCO Wheaton manufactures various gas dispensing nozzles, including a dripless nozzle, P/V valves, Stage I fittings for UST, manhole covers, and other equipment. EMCO Wheaton believes that nozzles are not being replaced frequently enough; many nozzles at GDF deteriorate to the point where the nozzle can no longer shut itself off during vehicle refueling. EMCO Wheaton referenced a study conducted in Southern California that showed, on average, that nozzles are approximately 18 months old. EMCO Wheaton sells a standard nozzle for approximately $20, while a Stage II VRS nozzle costs approximately $110. One of EMCO Wheaton's test sites in California with a balance Stage II VRS showed that the P/V valve never opened and that the tank pressure never exceeded 3 in. w.c. over a one-year period. EMCO Wheaton also stated that new UST are structurally sound and are extremely tight, and as a result, vapor leaks are not likely to occur. Vapor leaks may occur, however, around the tank's fittings. Tank inspections aid in the ability to keep the UST tight and are often performed every 6 months in California. EMCO Wheaton believes underground contamination is caused by residual contamination and not new leaks and that drips from GDF may also be contributing to groundwater pollution. In summary, EMCO Wheaton believes that (1) balance Stage II VRS should be retained because these systems are already ORVR compatible, and very little expense is required to convert a vacuum assist VRS to a balance VRS, (2) GDF should be inspected frequently, (3) UST vents need to be tested, (4) CARB's EVR program is too stringent and expensive and does not result in corresponding emissions reductions, (5) the widespread use definition should retain Stage II VRS for as long as possible, and (6) in-station diagnostics (ISD) are inexpensive and effective.

G. American Petroleum Institute (API) Meeting Summary

API began the discussions with a general presentation of the Stage II VRS, widespread use, and ORVR/Stage II VRS incompatibility issues. A description of widespread use studies conducted by API followed. API also described a study conducted by the University of Tennessee on the costs associated with operating and maintaining Stage VRS. During a discussion of in-use control efficiency claimed by State and local air pollution control programs (States), API indicated that States claim 77 percent, while EPA said that some States claim up to 90 percent. MOBILE6, the EPA model for estimating emissions from mobile sources, applies a 98 percent control efficiency for the fill-pipe refueling emissions. A discussion of what CARB is requiring for most California GDF followed. Enhanced Vapor Recovery (EVR) and in-station diagnostics programs were discussed. API said that it would cost each station about $30,000 to comply with the EVR program and that few, in some cases none, equipment vendors had developed equipment to comply with CARB's EVR requirements.

The key discussion concerned the differences between CARB's and API's incompatibility excess emissions (IEE) that occur when refueling a car. API disagreed with the way CARB conducted the tests and with the way CARB interpreted the results of their testing. Further, API explained how their testing was more realistic and showed the IEE to be less than half of CARB's IEE levels. CARB estimated IEE to be 2.5 to 4.5 tons per day for the entire state. Discussions of emissions from USTs followed and API disagreed with the way that CARB estimated the pressure-related fugitive emissions.

API described a collaborative effort by CARB and the Western States Petroleum Association (WSPA) to collect more information about pressure-related emissions. The results of this project may be very informative for any decisions EPA would make. However, it is our understanding that this project has not been started and may have been cancelled. API also described some other IEE, UST, and widespread use testing they have been doing in an Arizona laboratory.

A discussion of the issues paper (see aforementioned references) ensued and EPA indicated that if a definition requires calculation of emissions, EPA would probably use MOBILE6. EPA also thought that there may be enough information to quantify IEE. API disagreed and added that CARB does not believe there are enough data to quantify IEE. This discussion led to a discussion of incompatibility emissions factors and their validity.

There was some final discussion of the industry in general and whether "majors" or "independents" owned the gas stations. Independents own most of the GDFs. There was also some discussion of potential SIP credit ideas, especially where States may add or retain Stage II VRS after the widespread use date.

V. Public Meeting – September 2004

On September 20, 2004, EPA held a public meeting to provide stakeholders and other interested parties the opportunity to present data or views concerning Stage II VRS, widespread use, or other pertinent Stage II issues. Approximately 30 non-EPA people attended the meeting in Research Triangle Park, along with 10 EPA staff and 12 participants by phone, including 2 EPA regional staff and a representative from the California Air Resources Board. Thirteen representatives of refining trade associations, marketing trade associations, States, equipment vendors, and gasoline station inspectors made presentations at this meeting. EPA asked clarifying questions during the presentations but did not respond to specific or direct questions raised during the meeting.

At the conclusion of the meeting, EPA encouraged stakeholders to provide their presentations either electronically or in hard copy, as well as to provide any data pertaining to Stage II emissions or other pertinent data. EPA posted papers, presentations, and data on an EPA website accessible to the public (http://www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/). EPA also said that it would not respond to individual comments from stakeholders but would respond generally in a rule or policy regarding Stage II.

A. Comments from the Public Meeting and on EPA's Issues Paper

Twenty-two representatives of refining trade associations, marketing trade associations, States, equipment vendors, and gasoline station inspectors submitted comments. A list of the stakeholders who submitted comments and a general overview of the comments are presented below.

Table 1. List of Stakeholder Commenters

Entity	Contact(s)	Comment Reference
NESCAUM	Ken Colburn Executive Director, (Lisa Rector)	Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/nescaum_09-30-04.doc
Connecticut Department of Environmental Protection (Connecticut DEP)	Chris James, Director, Planning & Standards, (Ariel Garcia, Debbie Tedford)	Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/state_of_conn_9-30-04.pdf
New Jersey Department of Environmental Protection (NJDEP)	Judith Rand	Letter dated September 29, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/state_of_new_jersey_09-29-04.doc
Commonwealth of Virginia (Virginia)	James Ponticello	Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/comonwealth_of_va_9-30-04.pdf
California Air Resources Board (CARB)	Cindy Castronovo	Letter dated October 4, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/calif_air_resources_board_10-4-04.pdf
Texas Commission on Environmental Quality (TCEQ)	David Schanbacher, Chief Engineer, (Kim Herndon, Eddie Mack, Jason Harris)	Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/state_of_texas_09-30-04.wpd
Wisconsin Department of Natural Resources (Wisconsin DNR)	Lloyd Eagan, Director, Bureau of Air Management, (Ralph Patterson)	Letter dated September 29, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/state_of_wisconsin_09_30_04.pdf
Ohio Environmental Protection Agency (Ohio EPA)	Bill Juris, Compliance and Enforcement	Letter received September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/state_of_ohio_9-30-04.doc
Missouri Department of Natural Resources (Missouri DNR)	Leanne Tippett Mosby, Director (Bud Pratt)	Letter dated September 15, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/state_of_missouri_9-15-04.pdf
Collier Shannon Scott, Counsel to National Association of Convenience Stores (NACS) and Society of Independent Gasoline Marketers of America (SIGMA)	R. Timothy Columbus, Gregory Scott, Joseph Green	Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/nacs_sigma_09-30-04.pdf
BP US Convenience Operations (BP)	James S. White, Regulatory Affairs	Letter received September 28, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/bp_us_convenience_operations_09-30-04.doc

Entity	Contact(s)	Comment Reference
Veeder-Root	Kent Reid, Director of Strategic Development	Letter dated September 14, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/veeder_root_%209-15-04.doc
Healy Systems, Inc. (Healy)	James Healy, President	Letter dated September 15, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/healy_systems_9-15-04.pdf Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/healy_systems_9-30-04.pdf
EMCO Wheaton Retail (EMCO)	Jim Lawrence, (Ken Turcotte)	Letter dated September 29, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/emco_wheaton_09-30-04.doc Letter Attachment 1 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/emco_wheaton_attachment_1_09-30-04.pdf Letter Attachment 2 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/emco_wheaton_attachment_2_09-30-04.pdf
Vapor Systems Technologies, Inc. (VST)	Glenn K. Walker, President, (Scott Brown)	Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/vapor_systems_technology_09-30-04.pdf
American Petroleum Institute (API), NACS, Petroleum Marketers Association of America (PMAA), SIGMA	Prentiss Searles, representing 44 state and regional trade associations, 8000 independent petroleum marketers, 1,700 retail member companies (100,000 stores employing 1.4 million workers), 250 independent fuel marketers, and 28,000 retail outlets employing more than 270,000 workers.	Letter dated September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/nacs_sigma_pmaa_api_09-30-04.pdf Attachment (Letter to API from Sonoma Technology , Inc. [STI]) www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/nacs_sigma_pmaa_api_attachment_09-30-04.pdf
Costco Wholesale, Inc. (Costco)	Tim Hurlocker, Director of Gasoline Operations	Letter received September 30, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/costco_wholesale_09-30-04.doc
Husky Corporation (Husky)	Art Fink, VP Engineering	Letter received September 28, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/husky_09-28-04.doc Letter dated August 31, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/husky_8-31-04.pdf
Crompco Corporation (Crompco)	Edward Kubinsky Jr.	Letter received September 23, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/crompco_09-23-04.doc
Frank & Gramling, Counsel to Florida Petroleum Marketers Association (FPMA)	Robert Fingar	Letter dated September 27, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/fpma_%2009-27-04.doc

Entity	Contact(s)	Comment Reference
ARID Technologies, Inc. (ARID)	Tedmund Tiberi	Letter dated September 28, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/arid_technologies_9-30-04.pdf
Remote Sensing Air, Inc. (RSA)	Judith Zwicker	Letter dated September 10, 2004 www.epa.gov/ttn/naaqs/ozone/ozonetech/stage2/remote_sensing_air_09-10-04.doc

B. Stage II Vapor Recovery Systems – Balance vs. Vacuum Assist

As discussed earlier in this paper, the two most common types of Stage II VRS are balance and vacuum assist.

1. Comment Overview

Two stakeholders indicated that they prefer the balance VRS over the vacuum assist VRS. Other stakeholders indicated that they have concerns regarding the effectiveness of vacuum assist systems, mainly due to the incompatibility issues associated with vacuum assist VRS and ORVR, which is discussed further in Section V.C. One stakeholder commented that they had no choice but to use a vacuum assist VRS due to their operational model design (single direction traffic through the GDF requires longer hoses to fuel from either side of the vehicle).

The Missouri DNR stated that its Air Pollution Control Program (APCP) determined that a Stage II vacuum assist VRS does not perform as well as a balance VRS. The APCP was able to make this determination from inspector observations. The APCP specifically observed excess emissions [not related to incompatibility excess emissions] from the P/V valves or excess emissions from the nozzle interface for vacuum assist systems. The inspectors also observed problems with vacuum assist VRS vapor processors (i.e., UST vent add-on APCD, or processors) and perpetual maintenance issues. In contrast, the APCP system testing performed on balance VRS indicated that the balance system is more reliable and more economical to maintain. Missouri DNR suggested that EPA closely consider requiring the conversion of vacuum assist Stage II VRS to balance Stage II VRS.

A representative from RSA asked the question, "Does it make sense to allow the continued use of Assist VRS with their higher emissions than Balance VRS even without the ORVR incompatibility…" issue? RSA suggested that balance Stage II VRS are less expensive and more efficient than vacuum assist VRS and that Missouri has proven that the conversion of most vacuum assist VRS to balance VRS is easy and relatively inexpensive. RSA also stated that UST vent emptying and breathing emissions are significant for vacuum assist systems and that Missouri DNR and CARB have shown that these emissions are much less significant for balance systems that use the natural pressure balance of the system to keep pressures around an average of -0.5 in. w.c. Fugitive emissions are also much less significant for a balance VRS because of the system's relative steady low pressures. RSA stated that system pressures greater than 2 in.w.c. for any significant amount of time causes the release of pressure-related fugitives through nozzle check valves, breakaways, etc.; vacuum assist VRS are more likely to reach these pressures than balance VRS.

2. Discussion and Recommendation

As mentioned above, there are basically two types of Stage II VRS – balance and vacuum assist. The balance VRS is a relatively benign system that relies on a tight seal between the vehicle being refueled and the faceplate of the nozzle. During refueling, a slight vacuum occurs in the UST that helps pull the vapors into the UST vapor space. These VRS are relatively inexpensive and easy to maintain. Another feature of the balance Stage II VRS is that the entire system (including the UST) typically does not result in pressurization (and stays at mostly negative pressure), which may prevent fugitive leaks. Conversely, vacuum assist VRS dispensing equipment costs up to $40,000 and cost approximately $4,100 to maintain.[45] Vacuum assist Stage II VRS may require an UST pressurization system (i.e., an UST add-on APCD or UST processor) to maintain a negative pressure.

UST pressure data indicates, for the most part, that balance VRS are either not pressurized or less pressurized than the vacuum assist VRS. We believe that low or no pressurization, generally, would result in fewer or no fugitive emissions throughout the system. However, we believe that it would be difficult to defend requiring only balance VRS if: (1) Stage II VRS requirements were retained, or (2) EPA provided SIP credits for State or local authorities that choose to retain Stage II VRS. One UST add-on APCD, the ARID Permeator, was tested at a GDF with vacuum assist Stage II VRS to provide information about its efficiency for pressurized systems. This testing included emissions measurement of the UST emissions and showed greater than 99 percent reduction in UST vent emissions over uncontrolled levels (with a P/V valve and with an add-on APCD). This same add-on APCD is to be tested at a new GDF with no Stage II VRS; this test will provide information about its efficiency for non-pressurized systems (no P/V and with an add-on APCD).

We do not recommend a policy dictating the type of Stage II VRS to be used. We do recommend a policy or regulation requiring GDFs to completely dismantle or disable the VRS in a way that will not exacerbate fugitive leaks.

C. On-Board Refueling Vapor Recovery (ORVR) Control Efficiency

ORVR is a fairly new technology (ORVR installation commenced in model year 1998 vehicles) that collects the gasoline vapor displaced from the vehicle fuel tank during filling; the gasoline vapors are adsorbed in a canister, and sometime afterwards, are released to the engine. ORVR controls are expected to achieve from 95 to 98 percent reduction of the vehicle refueling emissions.

[45]Letter from P. Searles, API, to L. Rector, NESCAUM. ORVR Widespread Use. March 9, 2005.

Table 2. Stage II VRS Comment Summary

Stakeholder	Comment Summary	Comment Details
Missouri DNR	Missouri DNR stated that Stage II vacuum assist VRS are more problematic than balance VRS. Missouri DNR contended that balance systems are more effective and easier to maintain.	- Missouri DNR's APCP has observed from a vacuum assist system excess emissions from P/V valves or excess emissions from the nozzle interface. There are currently no Stage II vacuum assist VRS in Missouri now. - Missouri DNR stated, "It seems surprising that VA systems have been used at all since they are more expensive to purchase, install and maintain than balance systems and have a lower efficiency than balance systems."
RSA	RSA indicated that balance VRS are more effective than vacuum assist VRS. RSA stated that higher UST pressures lead to more emptying and breathing emissions and fugitive emissions. Vacuum assist VRS were more likely to reach higher pressures, which lead to emissions.	
Costco	Costco stated that they typically do not use balance VRS because their high-volume operational model requires extra-long hoses.	Costco stated that Stage II balance VRS do not work with Costco's operational model due to the need for extra-long hoses. CARB has only approved a short (9 foot) balance hose.

1. Comment Overview

Concerns were expressed regarding the control efficiency of ORVR canisters and the long-term control efficiency these canisters will continue to achieve. Eight stakeholders and one equipment vendor expressed concern regarding the effectiveness of ORVR canisters over the life of the vehicle. Another stakeholder suggested that there was sufficient data to support the long-term use of ORVR.

NESCAUM and the Connecticut DEP stated that before determining when widespread use occurs, EPA should determine the effectiveness of ORVR canisters over the life of the vehicle. NESCAUM is concerned about the effectiveness of the OBD systems that indicate ORVR malfunctions; these systems should be tested and verified by EPA before any decisions are made about widespread use. The Wisconsin DNR, Missouri DNR, and CARB indicated that they are concerned that ORVR control efficiency will degrade over time. Both NESCAUM and Healy stated that EPA should test high mileage ORVR-equipped vehicles to determine the ORVR efficiency over time. TCEQ has requested that EPA provide to States technical documentation demonstrating the ORVR actual in-use efficiency of 98 percent, as well as information detailing how EPA plans to ensure continued compliance of the ORVR control efficiency.

The Wisconsin DNR asked if ORVR compatible Stage II VRS could be viewed as a backup for those ORVR systems that fail to operate correctly. The Ohio EPA stated that the effectiveness of ORVR with and without vehicle inspection and maintenance programs should be addressed.

API suggested that solid testing methodologies are used to demonstrate ORVR effectiveness. NACS and SIGMA stated that they believe sufficient data already exists to support the long-term use of ORVR.

2. Discussion and Recommendation

We believe that ORVR control efficiency can achieve from 95 to 98 percent reduction of the vehicle refueling emissions based on ORVR canister design. There are currently no data confirming the long-term control efficiency, per se, of ORVR canisters, however, EPA does have data that indicate that ORVR canisters are meeting their emissions limit of 0.2 grams per gallon (g/gal). These data show some difference in performance for high and low mileage vehicles but additional testing is planned. EPA has also been actively testing the performance of OBD systems, the OBD evaporative emissions monitor, and the ORVR system integrity checks. Vehicles are equipped with an on-board diagnostics (OBD) system that, in addition to a number of other functions, checks the integrity of the vehicle's evaporative system, stores diagnostic trouble codes (DTC), and alerts the operator/driver with a malfunction indicator light (MIL) on the dashboard of the vehicle that a repair may be needed. The OBD is designed to identify malfunctioning emissions control components on the vehicle before emissions standards are exceeded. Studies have shown that OBD systems identify deteriorated or broken components or systems that lead to higher emissions.

One of the OBD functions is to monitor the ORVR system integrity by periodically checking the evaporative system pressure as well as the ORVR canister purge function. If the OBD detects a problem with the ORVR system, a warning light (a MIL) indicating an engine-problem comes on so that the vehicle operator knows to seek service and repair. ORVR system failures detected by the OBD fall into two categories: (1) failure of the purge function, and (2) loss of system integrity. The purge diagnostic checks to see that a controlled volume of air is drawn through the canister. The air desorbs hydrocarbons from the canister carbon and then carries them to the engine to be burned. If the air purge is not functioning, the carbon in the ORVR canister becomes saturated and cannot hold any additional refueling vapors. The OBD also checks to identify any leaks occurring in the hoses and connections that route the gas vapors to the canister and to the engine, as well as the mechanical integrity of the tank and fill-neck. The hoses and connections of the ORVR system must be leak proof for the ORVR control system to work.[46]

From April 1999 to May 2000, EPA conducted a 30-vehicle study to evaluate the effectiveness of OBD evaporative emissions monitors in identifying in-use vehicles (model years 1996 through 2000) with excess evaporative emissions. In this study, 22 of 25 OBD evaporative emissions monitors registered DTCs when failure conditions were induced, suggesting that OBD evaporative emissions monitors work satisfactorily. Five vehicles were tested with small leaks; 3 of the 5 vehicles were calibrated to meet the 0.040 in. OBD leak standard but were tested with a

[46] The Long-Term Durability of Onboard Vehicle Vapor Recovery (ORVR) Control Systems, Draft. Prepared for API by Harold Haskew & Associates, Inc. February 2005.

smaller 0.020 in leak and illuminated DTCs. This suggests that some OBD systems are quite robust and have leak detection capability well below the minimum federal requirement.[47]

Two other major programs concerning OBD performance have been or are being conducted: (1) EPA has conducted a high-mileage OBD study on model year 1996 through 1999 vehicles with greater than 100,000 miles, and (2) EPA has begun to receive data from automobile manufacturers on OBD performance in calendar year 2005 on model year 2001 high-mileage (50,000+) vehicles and model year 2004 low-mileage (10,000+) vehicles as part of the In-Use Verification Program (IUVP).[48] This program includes approximately 2000 FTP emissions data tests per year and OBD information (MIL illumination and DTC). In conjunction with the manufacturer testing, EPA will also conduct confirmatory tests on approximately 150 vehicles per year to verify the results of the manufacturer in-use testing. The data from these two programs should provide sufficient information to evaluate and confirm that OBD systems are working effectively and increase confidence in their use.

Some preliminary data from EPA's IUVP program are provided in section VI.B. These data indicate that the majority of OBD systems perform well and that the majority of ORVR canisters are performing at or above the required emissions standard. Of 151 tests on the ORVR canisters, 91 percent reduced refueling emissions to 0.2 g/gal or less. There were some differences in low mileage vehicles versus high mileage vehicles (with a larger percent of the low mileage vehicles passing the emissions limit).

Based on evaporative system testing, of which ORVR is one part, the system does appear to remain intact and operate properly, with a low failure rate. The OBD evaporative emissions check has been found to be a suitable replacement for functional evaporative emission I/M tests. Based on testing of ORVR canisters that are in-use on vehicles, these canisters appear to continue controlling refueling emissions after several years of operation. See Section VI.B for additional data. Given the preliminary results from these studies, we are comfortable with the long-term functionality of the vehicle evaporative system and the ORVR canister controls. EPA is continuing to evaluate these systems and collect the testing data from automobile manufacturers and conduct testing itself.

An idea was suggested that with retention of Stage II VRS on GDF, even retention of ORVR-compatible VRS, that the Stage II VRS could possibly be viewed as a backup for those ORVR systems that fail. API submitted a paper that indicated that the design of the fillpipe on an ORVR-equipped vehicle has a seal (either liquid or mechanical) that prevents vapors from exiting to the atmosphere.[49] The seal is designed to ensure that vapors from the vehicle gasoline tank are routed to the ORVR canister and do not escape through the fillpipe. With such a design, a Stage II VRS is not likely to control refueling emissions from failing ORVR vehicles, even with an "ORVR-compatible" system at the GDF.

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[47] Effectivness of OBD II Evaporative Emissions Monitors – 30 Vehicle Study. U.S. Environmental Protection Agency. EPA Publication No. EPA420-R-00-018. October 2000.

[48] On-Board Diagnostics (OBD) Policy Workgroup: Findings and Recommendations, by the Mobile Source Technical Review Subcommittee, Clean Air Act Advisory Committee. November 2002. p. 11 and 16.

[49] The Long-Term Durability of Onboard Vehicle Vapor Recovery (ORVR) Control Systems. Prepared for American Petroleum Institute (API) by H. Haskew, Harold Haskew and Associates. May 27, 2005.

Table 3. On-board Refueling Vapor Recovery (ORVR) Comment Summary

Stakeholder	Comment Summary	Comment Details
NESCAUM	NESCAUM indicated that they are concerned about the effectiveness of ORVR canisters. NESCAUM suggested that EPA review relevant test data to ensure that a reasonable efficiency factor is attributed to ORVR.	NESCAUM suggested the following: 1. A need to provide support and oversight of the automotive industry so as to ensure failing ORVR systems are properly maintained. 2. A need to understand the types of malfunctions that a vehicle's OBD can detect. 3. EPA should test high mileage vehicles and those vehicles that have been in service for a number of years to determine the efficiency of the ORVR system over time. 4. Develop a system to track ORVR system problems. The system should resemble the procedures used to verify proper operation of Stage II VRS.
Connecticut DEP	The Connecticut DEP stated that the phase out of Stage II should not occur until ORVR effectiveness has been determined over the lifespan of the ORVR canister.	Connecticut DEP believes the possibility of ORVR system failures exist and if such failures were to occur after Stage II VRS removal, refueling vapor emissions would be too serious of an occurrence to risk.
Wisconsin DNR	Wisconsin DNR asked, 'Could ORVR-compatible Stage II systems be viewed as "insurance" or back-up for those ORVR systems that fail to operate correctly or efficiently?'	Wisconsin DNR also stated their need to know what EPA's expectations are in terms of in-use efficiency of ORVR, asked whether there will be an ORVR degradation factor, and what is the technical basis for these expectations.
Ohio EPA	The Ohio EPA indicated that I/M issues related to ORVR should be addressed.	"The effectiveness of ORVR with and without a motor vehicle inspection and maintenance program."
Missouri DNR	Missouri DNR indicated that ORVR carbon canisters eventually break down.	Missouri DNR stated that there is not sufficient data to know with any level of confidence that ORVR vehicles will maintain their initial efficiency; older vehicles will eventually most likely need Stage II VRS to control refueling emissions.
TCEQ	TCEQ stated that the Issues paper did not cite any studies that determines the actual in-use control efficiency of ORVR systems.	TCEQ suggested that EPA "…provide the states with technical documentation demonstrating the stated ORVR IUE of 98 percent as well as information detailing how EPA plans to ensure that automobiles continue to comply with this standard. Texas believes that EPA should analyze IUE and provide results of their analysis to the states."
CARB	CARB stated that API's study and the Issues Paper did not consider the possible degradation of the ORVR efficiency of 98 percent.	
Healy	Healy commented that the in-use control efficiency of ORVR was not addressed in the Issues Paper.	Healy recommended that EPA evaluate a selection of 1998 ORVR-equipped vehicles with high mileage using SHED test methods or equivalent test methods to determine in-use control efficiency.

Stakeholder	Comment Summary	Comment Details
API	API stated that the effectiveness of ORVR has been demonstrated using solid testing methodologies.	API stated, "The effectiveness of ORVR is required to be demonstrated using solid testing methodologies (Sealed Housing for Evaporative Determinations) in new vehicles and has also been confirmed in tests conducted using California testing methodologies on in-use vehicles at actual gasoline dispensing facilities (GDFs), without any need for regulatory agencies to have to hire personnel to inspect the systems on a regular basis."
NACS and SIGMA	NACS and SIGMA referenced in-use evaporative system testing data for ORVR-equipped vehicles submitted by the North Carolina Petroleum Marketers Association to EPA.	NACS and SIGMA stated that the evaporative test data confirmed the performance of ORVR as an effective control technology for refueling emissions; these data supported the assumptions that underpin the policy choice by Congress to utilize ORVR for the long-term.

D. ORVR and Stage II VRS Compatibility Issues

When an ORVR-equipped vehicle refuels at GDF with Stage II VRS, the amount and composition of the vapor returned to the UST by the Stage II VRS controls can be adversely impacted. An increase in the amount of air (in lieu of gasoline vapor) returned to the vapor space of the UST will lead to gasoline evaporation, or vapor growth, in the UST and lead to excess emissions from the UST in the form of fugitives and vent emissions. A larger amount of air is returned to the UST vapor space for some vacuum assist Stage II VRS when refueling vehicles with ORVR controls, and therefore, the excess emissions are greater for some vacuum assist systems.

1. Comment Overview

Eight stakeholders and two equipment vendors believe that there are incompatibility issues associated with vacuum assist Stage II and ORVR. Two stakeholders believe there are incompatibility issues but these issues become negligible when taking into account that ORVR reduces vehicle fillpipe/nozzle emissions and minimizes puff emissions from the removal of a vehicle's gas cap. Two stakeholders and two equipment vendors support the use of balance Stage II VRS because these systems are proven to be compatible with ORVR. One equipment vendor said that they have data that demonstrates an increase in fugitive emissions as ORVR vehicle fleet penetration increases due to the incompatibility of vacuum assist Stage II VRS and ORVR.

The Connecticut DEP and NESCAUM requested that EPA completely evaluate and quantify the incompatibility issues associated with Stage II VRS and ORVR so that States can make better informed decisions. Connecticut DEP also stated that EPA should consider implementing technology to reduce or eliminate excess emissions from incompatibility as the widespread use date approaches (i.e., UST add-on APCD, CARB's EVR program, and P/V valves). ARID also requested that EPA conduct testing to accurately quantify IEE.

API and STI stated that the incompatibility issues associated with vacuum assist Stage II VRS and ORVR are not significant when taking into account that ORVR reduces vehicle fillpipe/nozzle emissions and minimizes puff emissions. STI noted that the magnitude of emissions decrease at the fillpipe (due to ORVR) is greater than the magnitude of the emissions increase due to pressurization of the UST (due to the incompatibility of vacuum assist Stage II VRS and ORVR).

The Missouri DNR, RSA, Husky, and EMCO stated their support for balance Stage II VRS because these systems are proven to be compatible with ORVR. The Missouri DNR and Husky stated that the combination of balance Stage II VRS and ORVR enhances the overall control efficiency of the Stage II VRS.

2. Discussion and Recommendation

The incompatibility between the ORVR technology and the Stage II VRS (vacuum assist technology only) is a key issue for the Stage II VRS program. However, some of the stakeholders consider this issue moot because they believe Stage II VRS should be completely removed as it is a redundant control technology. These "redundant" VOC control devices (ORVR and some vacuum assist VRS) cause excess emissions when both are employed. However, when both balance VRS and ORVR are employed, the VOC emissions reductions approach 99 percent according to research by Missouri DNR; thus Missouri DNR plans to continue requiring balance Stage II VRS after any widespread use determination. In addition, CARB will probably be requiring Stage II VRS (both balance and vacuum assist) despite widespread deployment of ORVR and will require gasoline dispensing equipment to be certified through their testing program to ensure that excess emissions are not caused by the incompatibility of the ORVR and VRS technologies. Some emissions testing conducted by API indicates that the excess emissions from the incompatibility of ORVR and vacuum assist VRS are not significant, are dependent on which type of vacuum assist VRS is used (i.e., the V/L ratio is an important factor), and that the costs for implementing compatible ORVR and vacuum assist VRS are very expensive.

Despite what some stakeholders believe about the need to eliminate Stage II VRS, we believe that there is merit to the idea to provide SIP credits for State and Local air pollution control agencies (APCA) that choose to retain Stage II VRS after the widespread use date; many APCAs were in favor of this idea. If so, then it would be desirable for EPA to collect additional data to further characterize the excess emissions from ORVR-Stage II vacuum assist incompatibility.

There are some data from emissions testing by CARB and API showing there are excess emissions caused by the incompatibility of the vacuum assist VRS and ORVR (see section VI.A). However, their emissions testing results do not agree and, as a result, we believe it would be desirable to obtain additional emissions monitoring data to better understand this relationship. CARB and the Western States Petroleum Association (WSPA) plan to conduct some emissions testing to better define these emissions, however, when their testing will occur is unclear. Hertz is planning to conduct some emissions testing that will include vehicle refueling fillpipe interface and UST vent testing and tank pressure tracking. In addition, Hertz will be conducting testing to demonstrate that withdrawing vacuum assist Stage II VRS will not adversely impact VOC emissions from their GDFs. As part of this testing, they will be monitoring fillpipe emissions.

Because most of their vehicles are ORVR-equipped and the Stage II VRS are vacuum assist, there will likely be excess emissions data from incompatibility. NH DES, University of New Hampshire (UNH), Gilbarco/Veeder Root (GVR), and EFPAG are planning an emissions monitoring project that will provide more data on the excess emissions from incompatibility. We believe all of the aforementioned testing will enable EPA to better quantify the excess emissions from incompatibility and develop policy based on the "better" data. These tests are scheduled to be conducted in 2006. See section VI.D for more information.

We recommend that the AQSSD's Ozone Policy and Strategies Group (OPSG) wait until the results of these studies are finalized before coming to any conclusions about the excess emissions from the incompatibility of Stage II VRS (some vacuum assist) and ORVR. We are working closely with the participants in these studies to set up monitoring protocols that provide quality data. We have and will observe the testing to ensure that the data collected are quality data.

Table 4. ORVR and Stage II VRS Compatibility Comment Summary

Stakeholder	Comment Summary	Comment Details
Connecticut DEP	Connecticut DEP asked EPA to evaluate and quantify the incompatibility issues related to Stage II VRS and ORVR.	The Connecticut DEP stated that EPA should consider implementing technology to reduce or eliminate excess emissions from incompatibility as the widespread use date approaches.
Costco	Costco commented that prior to the installation of a membrane processor, vent episodes were measured, and these measurements showed that the UST vent was venting almost all day long due to the incompatibility of their vacuum assist VRS and ORVR.	Costco commented that their policy was to install vacuum assist Stage II VRS at all their GDF, even in areas where it was not required. Their policy has changed due to the incompatibility of vacuum assist VRS and ORVR. Costco also stated, "Perversely and ironically, Stage II VRS increase emissions when used to fuel ORVR vehicles."
Ohio EPA	Ohio EPA stated concern regarding the need for area-specific Stage II VRS data (i.e., whether vacuum assist or balance, and if vacuum assist, what brand or type of system) when addressing incompatibility.	The Ohio EPA stated, "If a state chooses to address incompatibility in its SIP, or if USEPA requires SIPs to address incompatibility, shouldn't there be data on the types and relative numbers of Stage II VRS control systems regarding incompatibility?" Ohio EPA suggested that the data could be area-specific or use EPA default values.
TCEQ	The TCEQ stated that their Stage II VRS program is affected by the high percentage of vacuum assist VRS present in Texas.	TCEQ commented that the Houston-Galveston nonattainment area has approximately 92 percent vacuum assist VRS compared to a national average of 47 percent. TCEQ also stated that, most current vacuum assist systems have varying degrees of incompatibility with ORVR systems, some of which result in excessive fugitive and vent emissions from GDFs.

Stakeholder	Comment Summary	Comment Details
NESCAUM	NESCAUM indicated that they are concerned about the number of vacuum assist VRS that are located in their member states; the potential excess emissions that result from ORVR-equipped vehicles refueling at these stations may result in a significant source of new emissions. NESCAUM further stated, "Given the nonattainment status of some of these areas, allowing these emissions to remain unchecked could have significant air quality and public health ramifications."	NESCAUM stated "[s]tates are concerned with the potential public health threat that might result as a consequence of ORVR incompatibility with vac-assist Stage II systems. States urge EPA to immediately undertake a detailed study to quantify and document the potential emissions attributable to ORVR incompatibility. If ORVR incompatibility is determined to be a significant source of emissions, NESCAUM recommends that the EPA develop strategies that will not result in a detriment to public health. Such a finding must also not result in any penalty to the program effectiveness of Stage II currently claimed in state ozone SIPs."
Missouri DNR	Missouri DNR stated that they do not believe that there is a compatibility issue with the Stage II vapor recovery program for balance systems. Missouri DNR indicated those Stage II vacuum assist VRS in their present form are incompatible with ORVR.	- Missouri DNR said that the balance system only enhances ORVR and that the two technologies together are capable of achieving over 98 percent efficiency. - Missouri DNR maintained that by eliminating vacuum assist VRS, incompatibility excess emissions are also eliminated.
RSA	RSA suggested that Stage II VRS requirements should be maintained and only the use of balance VRS should be allowed.	RSA asked the question, "Does it make sense to allow the continued use of Assist VRS with their higher emissions than Balance VRS even without the ORVR incompatibility and increasingly higher emissions with the ORVR incompatibility?"
CARB		CARB stated that they disagree with the Stage II Issues Paper statement that "API data show the miniboot reduces excess emissions" because "CARB tests define excess emissions due to ORVR incompatibility as additional fugitive and vent emissions during fueling of ORVR vehicles."
API	API stated that there are incompatibility issues with vacuum assist Stage II and ORVR. API further stated that these incompatibility issues become negligible when taking into account that ORVR reduces fill pipe emissions and minimizes puff emissions from the removal of a gas cap.	API commented, "As described in the API ORVR compatibility study and the attached STI technical comments, some vacuum assist systems are less compatible with ORVR than others. Accounting for these different systems and their relative vapor-emission control capabilities would be difficult at best."

<table>
<tr><th>Stakeholder</th><th>Comment Summary</th><th>Comment Details</th></tr>
<tr><td>STI</td><td>STI indicated concern with respect to issues of clearly defining the terms “ORVR compatibility” and “excess emissions,” and the quantification of emissions. STI suggested that the terms “excess emissions” and “incompatibility emissions” be defined so that the definitions incorporate the total emissions due to refueling.
STI discussed testing conducted by CARB and API, specifically that CARB testing did not take into account the reduction of fillpipe emissions from ORVR, which was quantified in the API testing.
STI also suggested that ORVR may reduce emissions from the initial puff that is emitted from the removal of a vehicle’s gas cap.</td><td>STI stated, “If the magnitude of the emissions decrease at the fillpipe is greater than the magnitude of the increase in emissions due to pressurization, the net effect of ORVR systems is beneficial, i.e., they are reducing total refueling emissions. However, it appears that EPA’s issue paper (p. 10) defines the terms “excess emissions” and “incompatibility excess emissions” based solely on the change in pressurization-related emissions. This definition can easily be misconstrued, since the terms “excess emissions” and “incompatibility” often result in a perception that emissions from a VRS are increased by ORVR.”
- STI commented that an API-sponsored study found that in seven out of eight tests, puff emissions were lower for ORVR-equipped vehicles than those from non-ORVR vehicles by 3-5 grams per refueling event.</td></tr>
<tr><td>Hertz</td><td>Hertz stated that there are incompatibility issues with current Stage II systems and ORVR, which results in IEE.</td><td></td></tr>
<tr><td>Husky</td><td>Husky stated that the Issues Paper does not take into account that required ORVR compatible Stage II systems are more efficient.</td><td>Husky indicated that an ORVR-compatible Stage II VRS is at least 95 percent efficient verses 85 percent efficiency before ORVR. Husky further commented that ORVR compatible balance Stage II VRS achieves an efficiency of almost 99 percent because ORVR-equipped vehicles cause the VRS to operate at a negative pressure. Husky also stated that ORVR compatible vacuum assist Stage II VRS are also more efficient because the systems maintain a negative pressure.</td></tr>
<tr><td>EMCO</td><td>EMCO noted that balance systems have been proven to be compatible with ORVR by CARB and that converting a VRS to a balance is not expensive.</td><td></td></tr>
<tr><td>VST</td><td>VST stated that they have data that indicate that the increase of ORVR vehicle penetration is increasing fugitive emissions when used in conjunction with vacuum assist Stage II VRS.</td><td>VST indicated that a growing trend of ORVR-equipped vehicles in California is contributing to an increase in fugitive emissions. VST test data indicated the following increase in ORVR fleet penetration:
<table><tr><td>Test Date</td><td>8/02</td><td>2/04</td><td>7/04</td></tr><tr><td>ORVR Penetration</td><td>26%</td><td>38%</td><td>44%</td></tr></table></td></tr>
</table>

Stakeholder	Comment Summary	Comment Details
ARID	ARID suggested that EPA conduct testing to accurately quantify the incompatibility excess emissions (IEE).	ARID stated that their measured and modeled data show a remarkable increase in the incompatibility excess emissions generated in the UST as a result of the fundamental incompatibility of Stage II vacuum assist and ORVR technologies. ARID provided IEE data from two test sites.

E. Widespread Use Calculation and Date

As discussed earlier in this paper, EPA has defined four possible ways to interpret widespread use.

1. Comment Overview

Five stakeholders commented that they support definition (c), or a similar definition, for widespread use (VOC emissions from ORVR controls equal VOC emissions from Stage II VRS only). Five stakeholders commented that they support definitions (a), (b), or (d) primarily due to the simplistic nature of these definitions. A couple of stakeholders stated that definition (c) is much too complex and not consistent with what Congress intended. One stakeholder indicated that the widespread use date may not affect them because they expect to maintain Stage II VRS after the widespread use date. A couple of stakeholders suggested alternative definitions for defining widespread use. One equipment vendor stated that they do not support the idea that Stage II VRS will become a redundant technology when ORVR becomes prevalent in the vehicle fleet, given that 20 percent of gasoline dispensed currently and in the foreseeable future will be to non-ORVR vehicles.

NESCAUM urged EPA to adopt a policy that defines widespread use based on demonstrating that ORVR achieves emissions reductions equal to those reductions claimed by States in their SIPS; the widespread use definition should factor in the effect of vehicles in the fleet that will never have ORVR. The Connecticut DEP stated that they agree with NESCAUM's suggestions for determining widespread use.

Virginia stated that they prefer definition (c) because it is the most appropriate way to determine widespread use. Virginia suggested that EPA use locality-specific inputs in their algorithms to compute IEE and emptying and breathing losses of UST. NJDEP noted their preference for definition (c), but pointed out two concerns that they have with this definition. NJDEP stated that they do not believe that 100 percent rule effectiveness for ORVR is an accurate assumption and that the MOBILE6 model can not run all of the scenarios presented in the Issues paper.

From a modeling standpoint, TCEQ preferred definition (b). Wisconsin DNR suggested using either definition (a) or (b), which are simple approaches. If definition (c) is chosen by EPA, both TCEQ and Wisconsin DNR requested that EPA provide guidelines on how States can use readily available data to determine in-use efficiency of their Stage II VRS.

CARB commented that widespread use may not apply to California because they expect to show an emissions benefit by continuing the use of Stage II VRS even after ORVR-equipped vehicles are in widespread use.

The Ohio EPA suggested that EPA consider a simple and direct comparison for determining widespread use; the simplest comparison is determining when the amount of gasoline dispensed to ORVR-equipped vehicles is equal to the amount of gasoline dispensed by means of Stage II VRS. Missouri DNR stated that removing Stage II VRS would be premature because there will always be a significant number of vehicles in the fleet that will not be equipped with ORVR. Missouri DNR recommended that widespread use be defined at the point where emissions from ORVR crosses the emissions from balance Stage II VRS, which yields a widespread use date near 2030.

API encouraged EPA to determine a widespread use definition that follows Congressional intent; API supported definitions (b) or (d) because these definitions reflect a common sense interpretation of the term widespread use. API suggested that under these definitions, EPA examine when the percentage of ORVR systems installed is equivalent to the Stage II VRS in-use efficiency that is in a given SIP. NACS and SIGMA also recommended that EPA use a common sense approach in determining widespread use; they stated that definitions (a), (b), or (d) reflect a reasonable interpretation and follow a common sense approach. NACS and SIGMA suggested that EPA consider using the median Stage II VRS in-use efficiency value from State SIPs.

Hertz stated that the most conservative definition of widespread use should be when the vehicle fleet is comprised of 95 percent ORVR-equipped vehicles.

2. Discussion and Recommendation

As noted from the comments above, the stakeholders are very concerned about determining a widespread use date and the method used to determine the widespread use. The Clean Air Act Amendments of 1990 give little background to the intent of Congress for widespread use and the language in the Act give little guidance on how to determine widespread use. Mike Thrift of EPA's Office of General Counsel, opined, "…statutory language gives us substantial discretion to define "widespread" and "throughout," and even "the" with respect to "m.v. fleet." Of course, the legislative history may shed some light on how Congress thought we ought to interpret the language, but under the Chevron doctrine, courts have not generally ruled that contrary legislative history, on its own, removes an agency's discretion to interpret ambiguous statutory language. As long as we define these words and phrases reasonably through a notice and comment process (e.g., a rulemaking to waive Stage II VRS in serious, severe, and extreme areas), the courts will give us deference in interpreting the Act, even if they think that a different interpretation is better. Under Chevron, we only have to be reasonable, not "best" in the court's view, unless the court rules that the language leaves us no discretion and that our interpretation is plainly contrary to its one clear meaning."[50] We interpret his statement to mean that we can choose an approach (interpretation) for widespread use as long as we can defend it.

[50] Personal communication (email) from Mike Thrift to Tom Driscoll, February 22, 2005.

Generally, the comments are divided between those, industry and some states, wanting a simple and direct determination of widespread use [supported definitions (a), (b), or (d)] and those, most of the states, wanting the more complicated approach to determining widespread use [supported definition (c)]. Industry believes widespread use should be based on when most of the cars have ORVR canisters installed, when most of the gasoline pumped into ORVR-equipped vehicles, or when most of the VMT are miles traveled by ORVR-equipped vehicles. For a more thorough discussion of the definitions, see the Stage II VRS Issues Paper, pages 18-20. There are a couple of other issues associated with the widespread use date including: (1) if definitions (a), (b), or (d) are chosen, then what percentage of the vehicles, gas pumped, etc. makes sense to use as achieving widespread use; i.e., 85, 90, or 95 percent? and, (2) can the Ozone Transport Region (OTR) States determine a regional widespread use date?

API stated in their comments that definitions (b) and (d) represent a common sense approach and the data to make the decision are easy to obtain. Some States noted that some of the data required for definition (c) may be difficult to obtain. Easy to obtain data is one of the primary benefits to choosing definitions (a), (b), or (d). However, determining a percentage, which is needed for definitions (a), (b), and (d), as having achieved widespread use would be somewhat arbitrary and difficult to defend. For example, is 50 percent ORVR-equipped vehicles considered widespread use, or is 95 percent gasoline pumped to ORVR-equipped vehicles considered widespread use? In their comments, API discussed the merits for using some percentages as opposed to others.

In a follow-up letter from API, they suggested a new definition (c2) that is based on the date when emissions with ORVR-only controls are less than the emissions with combined Stage II VRS and ORVR controls, including incompatibility emissions.[51] This definition would clearly identify the date at which there would be no emissions increase as a result of removing Stage II VRS. We subsequently added a new definition (c2) to our list:

Definition (c2) (VOC emissions with ORVR controls equal the VOC emissions with combined Stage II VRS and ORVR controls, with incompatibility excess emissions). Definition (c2) is similar in complexity to definition (c). One advantage with this approach is that there would be no possible increase in emissions from the decommissioning of Stage II VRS controls, as there might be with definition (c). One disadvantage with this approach, in addition to the in-use control efficiency for Stage II VRS mentioned for definition (c), is that the incompatibility excess emissions (IEE) factor must also be correctly determined. There is some disagreement over the quantity of these emissions.

In comparison to definitions (a), (b), and (d), definitions (c) and (c2) are more tied to actual air quality impacts. These approaches make sense for what EPA is trying to achieve. In other words, we don't want to remove Stage II VRS until we are sure that ORVR will achieve and continue to achieve the equivalent VOC emissions reductions. Using definition (c) makes more sense if EPA provides SIP credits. The negative side to selecting definitions (c) or (c2) is that it requires knowing the control efficiency for Stage II VRS programs in each State, the

[51] Memorandum from T. Tamura, STI, to P. Searles, API. Onboard Refueling Vapor Recovery (ORVR) Systems – Proposed Definitions of Widespread Use. March 3, 2005.

control efficiency for ORVR, and the quantity of IEE. States will be looking to EPA to answer these issues.

There are some other elements that need to be factored into this discussion. Some vehicles (such as motorcycles, lawn mowers, and some large vehicles) will never have ORVR. It will be difficult to quantify the VOC emissions from refueling these types of vehicles. Missouri DNR suggested that up to 20 percent of vehicles will never have ORVR. We are not sure that 20 percent is correct, but we know only definitions (c) and (c2) account for this factor. In a streamlined estimate of the percentage of gasoline vehicles never to have ORVR (based on all gasoline vehicles), based on 1996 national fleet data, 94 percent of <u>all</u> gasoline vehicles will eventually have ORVR controls.[52] The 1996 national fleet data were used as the basis to develop the MOBILE6 defaults. This analysis used conservative assumptions, namely an assumption that no HDGV class 2B vehicles will ever be ORVR, even though some vehicles in this class <u>will</u> be covered (complete vehicles).

An analysis of the gasoline dispensed to ORVR-equipped vehicles has not been conducted. It is true that larger, never-to-be-covered non-ORVR vehicles would likely fuel large amounts of gasoline per vehicle, but they represent a small portion of the fleet (approximately 3.6 percent of the gasoline fleet). While fueling of motorcycles (approximately 2.3 percent of the gasoline fleet) and other motor-driven equipment may represent a large number of fuelings, the individual gasoline volume dispensed for each event is small and may not represent a large portion, either. Vacuum assist Stage II VRS do recover the refueling emissions from motorcycle refueling and filling of other motor-driven equipment, however, balance VRS do not control these refueling emissions. Some states (California and Missouri, for example) may choose to continue Stage II VRS, despite any widespread use determination. We need to ensure any policy or regulation we develop will not undermine their decisions/efforts.

The algorithm needed to determine widespread use depends on the definition chosen. For definitions (a), (b), and (d), relatively straightforward calculations requiring specific information such as the gallons of gasoline pumped and the vehicle registration and age distribution will be needed. We have thought in the past that the more simple definitions, for example definition (a), may be easier for States to use, however, some States have had difficulties in assembling vehicle registration data. The definitions we have termed as "easier-to-use" or "State-friendly" may be just as problematic for some States as the more complicated definitions are for other States. Definitions (c) and (c2) require more information and many specific pieces of information. Algorithms from the MOBILE6 model (with some minor modifications), which most every State uses, can be used to compute widespread use for definitions (c) and (c2). With definition (c2), it will be desirable for EPA to better characterize the IEE. EPA likely will have to determine the IEE for multiple types of vacuum assist systems (GVR, WayneVac, etc.) as the IEE depends on the V/L ratio. In addition, States, if they have not already done so, will have to determine what the Stage II VRS in-use control efficiency is in their State based on I/M programs conducted and any throughput cutoffs for applicability, and EPA will need to make a determination on the long-term in-use control efficiency for ORVR controls. As mentioned previously, the initial data on

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[52] Memorandum from K. Schaffner, RTI, to T. Driscoll, EPA/OAQPS/EMAD. Streamlined Estimate of Gasoline Vehicles Never to Have ORVR. September 30, 2005.

ORVR seems to confirm that ORVR continues to work long-term, and EPA is tracking this issue with continued testing programs.

Because the OTR States have separate requirements for ozone than other States, they have asked for the ability to make a widespread use determination for the entire region. Section 184(b)(2) requires: (1) EPA to conduct a study to identify emissions reductions control measures comparable to Stage II controls (called comparable measures), and (2) OTR States to revise their SIPs to require Stage II or comparable measures. For more specific information regarding OTR requirements, see the EPA Stage II Issues Paper on pages 3 and 4. There were no stakeholders that opposed the proposal to allow separate considerations for the OTR States, and we recommend that the OTR be allowed to proceed in their determination on a regional basis, if that is their preference.

Again, we believe that the planned emissions monitoring described in section VI.D will give us more qualitative information on the IEE to make a better decision regarding widespread use. Nevertheless, based on the information and comment responses we have, we believe definitions (c) and (c2) as the best option for determining widespread use. We believe either of these definitions is defendable. Definition (c2) would not allow increases in VOC emissions when transitioning from the combined ORVR/Stage II VRS to ORVR systems only. Definition (c) would also allow the widespread use date to be determined based on emissions, and SIP credits could be offered for those States who continue requiring Stage II VRS beyond the widespread use date.

As mentioned previously in the Issues Paper, the definitions may be inter-related and may provide similar results, so we have conducted an analysis of the definitions for 3 States to test this hypothesis. We collected data from 3 States and estimated the widespread use date for all five definitions for each State. A preliminary summary is provided in section VII. This analysis allowed us to see the range of values and determine if the definitions are the same or if one is truly different. The results for these States show that definitions (b), (c2), and (d) are fairly similar. For these States, definition (c) would result in the earliest widespread use date; both definitions (c) and (c2) are affected by the in-use control efficiency for Stage II VRS and definition (c2) is affected by the magnitude of the IEE. Initial data from Vermont indicate that definition (a) would provide the latest widespread use date. For these States, a percentage of approximately 85 percent for VMT for ORVR vehicles (b) and for gasoline throughput for ORVR vehicles (d) falls somewhere between the (c) and (c2) definitions.

In conjunction with recommending definitions (c) or (c2), we also recommend that algorithms to determine widespread use be based on the MOBILE6 model. EPA is addressing the issues with respect to these definition choices, namely we have emissions testing planned to quantify the IEE and the EPA Office of Mobile Sources (OMS) is investigating control efficiency for ORVR. Some additional work may have to be done to help States with in-use control efficiencies for Stage II VRS. Finally, we recommend that the OTR States be allowed to have a region-wide determination and we should start the process to allow region-wide determination (by amending the comparability study or other acceptable method).

Table 5. Widespread Use Calculation and Date Comment Summary

Stakeholder	Comment Summary	Comment Details
NESCAUM	NESCAUM preferred a widespread use definition similar to definition (c). NESCAUM urged EPA to adopt a policy that defines widespread use based on demonstrating that ORVR systems achieve VOC emissions reductions equal to those reductions claimed by States in their SIPs.	- NESCAUM asked EPA to issue guidance for States to make a determination. NESCAUM stated, "[i]f EPA decides to use to choose an alternative method (e.g., defining widespread use to the percentage of ORVR vehicles in the fleet or gasoline dispensed to ORVR vehicles) the Agency should still tie these numbers to a technical basis, including air quality modeling, in order to assure that removal of the Stage II program does not degrade air quality." - NESCUAM further suggested that EPA perform a modeling exercise on several "pilot" states to determine if a correlation exists between the one-for-one equivalency and percent of ORVR vehicles in the fleet; if the exercise indicated a statistically significant correlation, NESCAUM would then support that method for determining widespread use. - NESCAUM suggested that EPA factor in the effect of vehicles in the fleet that will never have ORVR when determining widespread use. - NESCAUM also made suggestions for those areas where the Stage II program is not implemented statewide; EPA should calculate emissions in these areas based on gasoline dispensed to ORVR vehicles in those counties where Stage II controls exist.
Connecticut DEP	Connecticut DEP suggested that EPA adopt a definition that preserves the effectiveness of existing Stage II programs. Connecticut DEP stated that they agree with NESCAUM's procedure for determining the definition of widespread use.	Connecticut DEP stated that: (1) Before States are allowed to drop Stage II VRS programs after the applicable widespread use date occurs, EPA needs to complete a study to confirm that ORVR systems will properly operate over the useful life of a vehicle; and (2) EPA should consider implementing technology to reduce or eliminate excess emissions from incompatibility as the widespread use date is reached.
Virginia	Virginia preferred definition (c).	– Virginia stated that definition (c) is the most appropriate way to determine "widespread use." Virginia also supports an uniform nationwide widespread use definition. – Virginia stated that in the development of a widespread use algorithm, EPA should develop an algorithm to compute the magnitude of "incompatibility excess emissions," using locality-specific inputs. - Virginia also stated that an algorithm should be developed for determining emptying and breathing emissions; algorithm should incorporate locality-specific data.
CARB	CARB maintained that widespread use may not apply to California since CARB expects to show an emissions benefit by continuing the use of Stage II VRS even after ORVR-equipped vehicles are in widespread use.	CARB also commented that the Stage II Issues Paper should probably be revised to say that CARB will retain Stage II VRS after the widespread use date, "if there is an emissions benefit."

Stakeholder	Comment Summary	Comment Details
NJDEP	NJDEP preferred definition (c).	The NJDEP had the following two issues with definition (c): (1) does not believe that 100 percent rule effectiveness for ORVR is accurate, and (2) NJDEP cannot run the MOBILE6 model using all the scenarios presented in the Issues Paper. NJDEP added that if the MOBILE6 model is not revised to allow state-specific emissions calculations, then definition (b) may be more appropriate.
TCEQ	TCEQ stated that definition (b) from a modeling standpoint would be the easiest and most realistic way to determine widespread use.	- TCEQ stated that the method of determining widespread use would have a significant impact on their program since promulgating ORVR compatible requirements. "It is possible that widespread use, depending on the definition chosen by the EPA, could occur relatively soon after the TCEQ's ORVR compatibility deadline for existing Stage II systems which is April 1, 2007." – TCEQ requested that if definition (c) is used, then EPA should provide guidelines on how States can use readily available data to determine in-use efficiency for existing Stage II VRS. – TCEQ stated that any widespread use definition requiring data on the percentage of gasoline dispensed would require additional reporting because Texas GDFs are not currently required to report gasoline throughput information.
Wisconsin DNR	Wisconsin DNR suggested using either definition (a) or (b).	– Wisconsin DNR commented, "[i]ncorporating either of the simple approaches with the development of an algorithm may be sufficiently accurate for projecting the approximate time when widespread use occurs." – Wisconsin DNR said that they agree with EPA's suggested approach to use one widespread use definition for all States and having state-specific inputs to make the widespread use date applicable to that state. – Wisconsin DNR also stated that they agree that when Stage II VRS are removed that the continued use of Pressure/Vacuum (P/V) valves should be required. – Wisconsin DNR stated that if EPA chooses option (c), EPA needs to provide states with information on how states can use readily available data to determine in-use control efficiency of Stage II VRS.
Ohio EPA	Ohio EPA suggested that EPA consider a simple and direct comparison for determining widespread use. Ohio EPA stated that the simplest comparison for widespread use is determining when the amount of gasoline dispensed to ORVR-equipped vehicles is equal to the amount of gasoline dispensed by means of Stage II VRS.	Ohio EPA commented, "The issues of incompatibility, rule-effectiveness for Stage II, and spillage for ORVR vs. Stage II would not be considered due to the complexities and relative inaccuracies associated with evaluating such issues. Also, the nominal control efficiencies for Stage II and ORVR would not be considered significantly different. In the event USEPA considers the nominal control efficiencies to be significantly different (e.g., 95 percent for pre-EVR Stage II and 98 percent for ORVR), the comparison of gasoline dispensed to ORVR-equipped vehicles and dispensed by means of Stage II could include an adjustment factor for nominal control efficiencies."

Stakeholder	Comment Summary	Comment Details
Missouri DNR	Missouri DNR stated that they believe that ending Stage II VRS would be premature; balance systems complement ORVR, yielding a control efficiency greater than 98 percent.	- Missouri DNR provided data that indicates there will always be a significant number of vehicles that will never have ORVR; they strongly suggest that Stage II balance VRS not be discontinued. - Missouri DNR suggested another possible definition for widespread use that is derived from Figure 6 from the Issues Paper; widespread use could be defined as the point where ORVR only crosses or joins balance Stage II VRS only, which yields a date sometime near 2030.
API	API stated that they support definitions (d) or (b) because they reflect a common sense interpretation of the term "widespread use." Conversely, the API maintained that definition (c) is too complex and not consistent with what Congress intended. For definition (d), API suggested that quantities of gasoline dispensed on a countywide basis could be calculated from county-specific VMT data by using fuel economy data incorporated into the MOBILE6 model. API indicated that they support a widespread use definition that is applied on an area-by-area and/or regional basis. API also offered to work with EPA on how to determine an alternative baseline for the OTR so that OTR States can take credit for ORVR.	– API stated that "[t]he consumer is already paying for ORVR systems on their vehicles and should not have to pay again for the maintenance of redundant vapor controls at the gasoline dispensing facility. State environmental agencies should not be asked to implement Stage II VRS programs after widespread use is determined since ORVR and Stage II are duplicative technologies." API also commented that it is expensive for states to administer an effective Stage II VRS program and that states should be allowed to focus their air quality improvement efforts on programs other than Stage II VRS. – API added that "[u]nder Definitions (b) and (d), to identify the appropriate percentage that equates to ORVR widespread use, EPA should examine when the percentage of ORVR systems installed is equivalent to the Stage II in-use efficiency that is in a given SIP." API provided the following example: If a state has an 85 percent efficiency for the Stage II VRS, then once 87 percent of vehicles have ORVR, the state would have achieved widespread use. To calculate 87 percent, use the MOBILE6 value of 98 percent efficiency for ORVR technology and then divide the in-use efficiency (in this example, 85 percent) by 98 percent. – API also mentioned the spreadsheet they developed to calculate the percent of gasoline dispensed to ORVR-equipped vehicles based on VMT data and other MOBILE6 input data. API suggested that their spreadsheet could be updated with information with automobile manufacturers regarding when ORVR was actually implemented on the vehicles. – API stated that definition (c) would require data that is extremely difficult to ascertain. - API encouraged EPA to determine a definition of widespread use that follows Congressional intent.
FPMA	FPMA noted that definitions (a) and (b) meet the intent of Section 182(b)(3), and option (d) may meet the intent, while definition (c) goes far beyond whether ORVR is in widespread use and would be the most difficult calculation to make.	

Stakeholder	Comment Summary	Comment Details
Healy	Healy indicated that they do not agree with the Issues Paper assumption that the ORVR fleet penetration will at some point make Stage II VRS redundant.	- Healy commented that a review conducted by CARB concluded that 20 percent of gasoline dispensed currently and in the foreseeable future will be non-ORVR vehicles; if Stage II VRS is removed, then 100 percent of non-ORVR refueling emissions will be emitted to the atmosphere. Healy used an equation to conclude that the vapor recovery efficiency after the widespread use date and dismantle of Stage II VRS would be 76 percent. - Healy suggested that the widespread use calculation take into account the actual in-use control efficiency of ORVR.
EMCO	EMCO suggested setting the widespread use definition at a vehicle population percentage of 98 percent ORVR.	EMCO commented, "Ostensibly both Stage II systems and ORVR vehicles run at 95 percent efficiency. Consequently if Stage II controls were removed from dispensing facilities when the vehicle population is 95 percent ORVR, the net effect on emissions would be zero. The 95 percent ORVR vehicle trigger would then be a logical starting point. However, allowing the 5 percent non ORVR vehicles to begin refueling with no vapor recovery increases their emission rate by a factor of 20. This flies in the face of common sense. Surely any environmental protection advocate worth his weight in VOC's would cringe at the prospect of abandoning the use of effective, proven methods of reducing refueling emissions."
RSA	RSA indicated that definition (c) appears to be the most reasonable since it deals with real emissions and reduction of emissions.	RSA stated that definition (c) requires an accurate determination of annual emissions for VRS and for ORVR under the following scenarios: 1) For VRS emissions with no ORVR. Under this scenario RSA pointed out the following issues/questions: a. Will average annual emissions factors for VRS be used with average annual gasoline sales? b. Will the emissions factors be determined for the VRS in place or as an assumed efficiency multiplied by an uncontrolled emissions factor? c. Will the emissions factors include things such as the nozzle/fillport, spillage/pseudospillage, breathing, and vent emptying? 2) For ORVR emissions. Under this scenario RSA pointed out the following issues/questions? a. Will hybrid vehicles be included along with the percentage of fuel used? b. How will data be broken down for a vehicle type (i.e., model year, make, or combination) c. Will SHED test data be used? 3) For VRS and ORVR. Under this scenario RSA made the following comments: a. For a balance VRS, the nozzle/fillport efficiency increases to greater than 99 percent. b. A vacuum assist VRS may reduce the effectiveness of ORVR.

Stakeholder	Comment Summary	Comment Details
NACS, SIGMA	NACS and SIGMA indicated that they are "particularly concerned" about EPA's preference for definition (c); they stated that definition (c) would contradict the "clear policy choice of Congress in identifying ORVR as a superior technology." NACS and SIGMA stated that definitions (a), (b), and (d) reflect a reasonable interpretation of what widespread use means and these choices reflect a more common sense approach. NACS and SIGMA stated that they would like EPA to give more consideration to definitions (b) and (d).	- These groups stated, "NACS and SIGMA members have spent hundreds of thousands of dollars installing and maintaining Stage II systems over the last decade. These burdens were assumed as part of the compromise reflected in section 202(a)(6) of the Clean Air Act and subsequent promulgation of ORVR requirements: service station owners would install Stage II systems in certain nonattainment areas over the interim period until ORVR was in place in a majority of the vehicle fleet to control these same refueling emissions. The timeframe for achieving widespread use was envisioned as approximately 10-15 years after promulgation of ORVR requirements. We are now approaching, or possibly in some areas at, the point of widespread use of ORVR. NACS and SIGMA members have done their part in controlling refueling emissions. Consistent with what Congress intended, it is now time to phase out Stage II requirements and recognize and promote ORVR as the more equitable and effective approach to controlling refueling emissions." - NACS and SIGMA commented that definition (c) misses the mark in defining widespread use and is an exercise in futility; definition (c) identifies "widespread effect" and not widespread use of ORVR. - NACS and SIGMA suggested that EPA consider using the median Stage II in-use efficiency value from State SIPs, given the difficulty in pinpointing a precise estimate of Stage II in-use efficiency, to identify the percentage that would define ORVR widespread use under Options (a), (b), or (d).
Hertz	Hertz stated that the most conservative definition of widespread use is 95 percent of the vehicle fleet being comprised of ORVR-equipped vehicles.	
ARID	ARID noted that the extreme magnitude of incompatibility excess emissions should strongly influence the thought processes for the definition and supporting algorithms related to widespread use.	

F. Phase Out of Stage II Vapor Recovery Systems

After the widespread use date is determined, EPA may decide to allow Stats or areas to repeal requirements for Stage II VRS

1. Comment Summary

Five stakeholders and one equipment vendor expressed concern regarding the phase out of Stage II VRS. One stakeholder stated that they would like to see the continued use of Stage II VRS because it would remain a critical element of an ozone attainment strategy. Two stakeholders stated that Stage II VRS should not be adopted by new areas because there would only be marginal benefit at significant costs. One stakeholder commented that they would like to see the requirement for Stage II VRS at new GDF revoked in Southeast Florida. Lastly, one stakeholder suggested that Stage II VRS nozzles are costly, complex and difficult to use and believes that sooner rather than later replacement of Stage II VRS with ORVR will allow for nozzles to be built for durability, reliability, and safety instead of specifically for Stage II VRS.

The Ohio EPA requested that an impact study be conducted before discontinuing Stage II VRS in nonattainment areas to determine the impacts of dismantlement. The Wisconsin DNR also indicated that they would like assurances that the disconnection of Stage II VRS would be monitored. TCEQ stated that faulty vacuum assist systems have the capacity to cause more fugitive and vent emissions than a GDF without Stage II VRS, and simply ceasing to investigate GDFs with Stage II VRS would harm air quality as numerous vacuum assist VRS would remain in service without maintenance or oversight.

NESCAUM suggested that EPA take measures to ensure that States do not remove Stage II VRS if the removal would result in an increase in VOC emissions. NESCAUM also stated that new stations should not be required to install Stage II VRS if the widespread use date is near (i.e., within a year or two years) but instead use alternative measures. The CT DEP stated that Stage II VRS is an effective and efficient means of reducing ozone precursor emissions and as such, Stage II should not be phased out. CT DEP believes that continued use of Stage II VRS is necessary because only light-duty vehicles are required to have ORVR. The CT DEP also stated that the phase out of Stage II should not occur until ORVR effectiveness has been determined over the lifespan of the ORVR canister.

The FPMA commented that there are two dates to consider related to the phase out of Stage II VRS: (1) the date after which Stage II VRS will no longer be required for new construction; and (2) the date after which Stage II VRS will not be required to be maintained at existing facilities. FPMA further stated that their primary concern is to obtain an immediate end to requiring Stage II VRS at new GDFs in Southeast Florida.

Both API, NACS, and SIGMA stressed that Stage II VRS should not be adopted by new areas; the costs associated with this adoption would be excessive and are not justified by the diminishing marginal benefit of emissions reductions.

2. Discussion and Recommendations

There are two issues associated with these comments: (1) after the widespread use date is achieved, ensuring existing Stage II VRS are removed in a manner that does not increase VOC emissions from the GDF, and (2) should we allow GDFs built near, but before, the widespread use date to be granted an exemption from installing Stage II VRS? If so, then how long before the widespread use date can a station be built without Stage II VRS and what in-kind measures can we require to compensate for the subsequent VOC emissions from these GDFs? This is an equity issue; some believe it is not fair to existing GDFs with Stage II VRS requirements to allow an exemption to installing Stage II VRS for new GDFs. We agree. NESCAUM suggested that a cost-benefit analysis be conducted by EPA to determine what is the period of time, prior to the widespread use date, that newly built GDFs would not have to install Stage II VRS.

There is a concern that if Stage II VRS are not properly removed from GDF, then there will be resultant leaks as the system deteriorates or as replacement non-VRS equipment are installed. There is potential for fugitive VOC leaks if Stage II VRS remain in place and are not maintained and not sufficiently capped. There is also a potential for leaks if new equipment, such as nozzles, that are not Stage II VRS compliant, replace worn out Stage II VRS compliant equipment. Given the track record for GDF maintenance, we believe this issue is important to address. EPA should strongly consider providing guidance on minimal standards for removal of Stage II VRS equipment. OAQPS should work closely with the Office of Underground Storage Tanks (OUST) on removal requirements.

All the stakeholders that responded were generally in agreement with allowing a waiver or exemption to new GDF built near the widespread use date. There were few comments on what control measures to implement in place of Stage II VRS. NESCAUM mentioned stricter Stage I requirements. Other measures that could be adopted would be more frequent inspections, monitoring of the system pressure, in-station diagnostics, requiring an add-on control device to the UST, etc.

We recommend that EPA develop a policy, guidance, or rule requiring GDF to remove or decommission Stage II VRS equipment in a way that will minimize leaks. Another recommendation is that EPA allow States to grant waivers to GDF that are being built near the widespread use date. We recommend that EPA conduct a cost analysis to determine when new GDF would no longer be required to install Stage II VRS. In addition to waivers granted to these newly built GDF, we recommend that they be required to implement other VOC emissions reductions measures, such as dripless nozzles, UST add-on APCD, in-station diagnostics, or have the State increase inspections of the GDFs. We believe the State should have the latitude to choose the alternative emissions reductions measures, increase inspections, or some other equivalent measures as long as the State can show that the alternative VOC emissions reductions measure (in combination with ORVR emissions reductions) is equivalent to the VOC emissions reductions achieved by Stage II VRS. We recommend that EPA develop additional guidance on control measure options and the control efficiencies that can be achieved. Finally, we recommend that EPA develop guidance for allowing SIP credits for source owners or operators who retain Stage II VRS.

Table 6. Phase Out of Stage II Vapor Recovery Systems Comment Summary

Stakeholder	Comment Summary	Comment Detail
NESCAUM	NESCAUM stated that EPA should take measures to ensure that a State can not eliminate Stage II VRS if removal of these systems would result in an actual emissions increase in VOC.	NESCAUM proposed that new GDF not be required to install Stage II VRS and, instead, implement alternative measures (such as improvements to the control efficiency of the GDF Stage I system) so as not to gain an economic advantage over GDFs that previously had to install Stage II VRS. NESCAUM recommended that EPA conduct a cost-benefit analysis to determine when this "interim" period should start.
TCEQ	TCEQ has concerns that VOC emissions will increase if oversight of VRS ceases/stops once widespread use is achieved.	TCEQ stated, "Because faulty vacuum assist systems have the capacity to cause more fugitive and vent emissions than a GDF without a Stage II VRS, simply ceasing to investigate GDFs with Stage II VRS would harm air quality as numerous vacuum assist VRS would remain in service without maintenance or oversight."

Stakeholder	Comment Summary	Comment Detail
Connecticut DEP	Connecticut DEP commented that they want to see continued use of Stage II VRS and requested that EPA require implementation of Stage II in ozone nonattainment areas as required by the CAA.	Connecticut DEP stated, "Continued use of Stage II systems is necessary because only light duty vehicles are required to have ORVR canisters available. Connecticut DEP believes that Stage II systems will remain a critical element of an attainment strategy into the foreseeable future."
Ohio EPA	Ohio EPA noted that an impact study should be conducted before discontinuing Stage II VRS in nonattainment areas to determine the impact of the discontinuance, while taking into account SIP projections.	Ohio EPA stated, "The US EPA should identify all areas outside of the OTR that implemented Stage II, identify the basis for the implementation (e.g., to meet the 15 percent reduction requirement for 1996, to meet other reasonable further progress requirements, etc.), and identify the years for any emissions projections. This may uncover issues not considered by USEPA or may help resolve issues already considered by USEPA. Those non-OTR areas should be allowed to use either the above-suggested comparison for discontinuance of Stage II or a more complicated comparison of emissions that may include incompatibility, rule-effectiveness, etc. pursuant to USEPA policy that results from this issues paper."
Wisconsin DNR	Wisconsin DNR stated that they have concerns about disconnecting Stage II VRS. Wisconsin DNR indicated that they want assurances that the disconnection of Stage II VRS be properly monitored.	Wisconsin DNR requested that EPA address this issue in the case that Stage II systems are no longer needed.
FPMA	FPMA stated that Stage II is a redundant technology and the VRS equipment has a limited useful life. FPMA noted that their primary concern is to obtain an immediate end to requiring Stage II VRS at new GDFs in Southeast Florida.	- FPMA commented that there are two regulatory considerations to consider for phasing out Stage II VRS: (1) the date after which Stage II VRS will no longer be required for new construction; and (2) the date after which Stage II will not be required to be maintained at existing facilities. - FPMA stated "Our concern is that if EPA does not distinguish between areas formerly designated as "moderate" nonattainment and areas that are "serious" nonattainment or worse, regulators responsible for the previously "moderate" areas will apply the same "widespread use" criteria as EPA will apply to the "serious" or worse areas. It is our position that Stage II regulations in areas where Stage II was not required under the Clean Air Act ought to be repealed before Stage II is revised or waived in "serious" or worse nonattainment areas."
Healy	Healy stated that additional steps, such as quantifying the gasoline dispensed to non-ORVR vehicles, need to be taken before dismantling Stage II systems.	Healy recommended that current data from the US Department of Transportation and other sources be used to determine the actual distribution of gasoline to ORVR-equipped vehicles and to non-ORVR equipped vehicles in order to better calculate the impact of dismantling Stage II VRS.

Stakeholder	Comment Summary	Comment Detail
Costco	Costco stated that they would like to see Stage II replaced with ORVR; replacement of Stage II VRS would allow manufacturers to build nozzles that are built for durability and reliability instead of specifically designed for VRS, which are costly, complex, and difficult to use.	
API	API stated that they do not support the adoption of Stage II VRS in new areas.	API commented, "The cost per ton VOC reduced by Stage II is rapidly growing as the ORVR is implemented in the vehicle fleet."
NACS, SIGMA	NACS, SIGMA stated that EPA should not permit the expansion of Stage II VRS in new areas.	These groups maintained that the costs associated with installing new or enhanced Stage II VRS are not justified by the diminishing marginal benefits that may be achieved before the widespread use date arrives.

G. Phase Out of Stage II Vapor Recovery Systems in the OTR

1. Comment Summary

Two stakeholders indicated that they would like to see a mechanism developed that would allow OTR states the ability to phase out their Stage II VRS.

NESCAUM recommended that EPA determine a regional phase-out date that is consistent with the latest date that an OTR state would achieve widespread use. NESCAUM also requested that EPA provide an early opt-out method for those OTR States that demonstrate that removal of Stage II VRS would not degrade air quality. Virginia also agreed that EPA should provide an additional mechanism for OTR States to phase out of the Section 184(b)(2) Stage II VRS, or comparable measure, requirement; requirement would be similar to the mechanism for moderate or worse nonattainment areas under Section 184(b)(3) to allow the removal of Stage II VRS once ORVR controls are determined to be in widespread use. Both NESCAUM and Virginia recommended updating the "Stage II Comparability Study."

2. Discussion and Recommendations

The discussion and recommendations for this section are similar to those in Section V.F. Again, the recommendation is for EPA to allow OTR States to grant waivers to GDFs that are being built prior to the widespread use date, and we recommend that the GDFs that are granted waivers be required to implement other VOC emissions reductions measures, such as in-station diagnostics, or have the State increase inspections of the GDFs. We believe each OTR State should have the latitude to choose the alternative emissions reductions measures, increase inspections, or some other equivalent measures as long as the State can demonstrate that the alternative VOC emissions reductions measure (in conjunction with ORVR controls) is equivalent to the VOC emissions reductions achieved by Stage II VRS. As with the phase out for the rest of the country, the same guidance document on the decommissioning of Stage II VRS may be necessary. Because the "Stage II Comparability Study" must be updated or otherwise amended to allow removal of Stage II VRS, we recommend that this process begin soon, with input from OTR States.

Table 7. Phase Out of Stage II Vapor Recovery Systems in the OTR Comment Summary

Stakeholder	Comment Summary	Comment Detail
NESCAUM	NESCAUM indicated that they would like to see a pathway developed that would allow OTR states to phase-out their Stage II VRS programs. NESCAUM suggested that EPA determine a regional phase-out date that is consistent with the latest date that an OTR state reaches widespread use.	- NESCAUM stated, "Under current EPA policy, the only pathway for phasing out Stage II in OTR states is the implementation of comparable measures equivalent to Stage II reductions achieved in 1999. Given this scenario, redundant vapor recovery programs (ORVR and Stage II) will run side-by-side in perpetuity unless a policy change is made at EPA. Therefore, the NESCAUM states support a revision of the Comparability Study to develop a pathway that would allow OTR states to phase-out their Stage II programs at the point where this does not result in increased emissions." - NESCAUM would also like to see EPA provide an early opt-out method for those OTR states that are able to demonstrate that the removal of Stage II VRS would not increase VOC emissions nor degrade air quality.
Virginia	VA stated that EPA should provide an additional mechanism for OTR states to be able to phase out of the section 184 (b)(2) Stage II VRS or comparable measure requirement.	VA suggested updating the "Stage II Comparability Study" with a baseline that coincides with the year that ORVR is determined to be in widespread use.

H. Stage II State Implementation Plan (SIP) Credits

As previously discussed in this paper, SIP credits could possibly be granted to States for maintaining Stage II VRS after the widespread use date, implementing Stage II VRS in additional areas, and implementing improved monitoring and/or control measures.

1. Comment Summary

Five stakeholders stated that they support granting SIP credits for maintaining Stage II VRS after the widespread use date. One stakeholder suggested that SIP credits be granted to States for adopting controls that minimize ORVR incompatibility emissions. One stakeholder stated that SIP credits should be granted for continuing to require pre-EVR standards or for requiring any part of CARB's EVR program. Four stakeholders and one equipment vendor stated that EPA should grant SIP credits for States that require equipment such as P/V valves or add-on APCD. Three stakeholders indicated that they support granting SIP credits for improved monitoring of Stage II VRS. Two stakeholders suggested that SIP credits be granted for implementing Stage II VRS in new areas. One stakeholder contended that SIP credits should be granted to States for additional testing of Stage I equipment. Two stakeholders maintained that SIP credits should not be granted for the continuance of Stage II VRS after the widespread use date and for adopting Stage II VRS in new areas.

NESCAUM stated that they support SIP credits for maintaining Stage II VRS after the widespread use date but only if the emissions reductions achieved are greater than those emissions reductions achieved from ORVR. NESCAUM also stated support for granting SIP credits for improved monitoring and inspections of GDF, and the adoption of controls to minimize ORVR incompatibility emissions. NESCAUM further offered to assist the EPA with developing methods to enhance testing and inspection programs.

The Connecticut DEP commented that EPA should grant SIP credits for States that require P/V valves and technology that reduces IEE, and for implementing Stage II VRS in new areas or moderate ozone attainment areas.

The NJDEP suggested that EPA grant SIP credits for improved monitoring of Stage II VRS and for requiring P/V valves and mini-boots on vacuum assist VRS. NJDEP also indicated that SIP credits be granted for maintaining Stage II VRS after the widespread use date, but only if widespread use occurs before 100 percent fleet turnover of ORVR-equipped vehicles.

The TCEQ maintained that EPA should mandate ORVR compatibility for States that choose to continue their Stage II VRS programs in order to be granted additional SIP credits.

The Wisconsin DNR suggested that SIP credits be granted for maintaining Stage II VRS after the widespread use date, for conducting additional testing of Stage I equipment, the installation of a new technology that reduces emissions, and for requiring P/V valves. The Wisconsin DNR also recommended that SIP credits be granted to States for continuing to use pre-EVR standards or for using any part of CARB's EVR program.

Both API, NACS, and SIGMA stated that they do not support the granting of SIP credits for maintaining Stage II VRS after the widespread use date and for implementing Stage II VRS in new areas. These groups also stated that they do, however, support SIP credits for emissions reductions due solely to ORVR. API further noted that SIP credits should not be granted for implementing CARB's EVR program, the installation of an ISD, or the installation of unihose equipment.

2. Discussion and Recommendations

Despite what some stakeholders believe about the need to eliminate Stage II VRS, we believe that there is merit to the idea to providing SIP credits for State and Local APCA that choose to retain Stage II VRS after the widespread use date. SIP credits related to continued use of Stage II VRS would depend on which definition EPA selects. For definition (c2), it is not clear what additional SIP credits would be available for continued use of Stage II VRS; for definition (c), additional SIP credits may be available for the difference in emissions levels with ORVR only and emissions levels with combined Stage II VRS and ORVR plus the incompatibility excess emissions. SIP credits could be provided for continued use of Stage II VRS and ORVR-compatible Stage II VRS for any of the definitions prior to the date associated with definition (c2). For States that use MOBILE6, the State emissions inventory may already account for ORVR emissions reductions.

We believe that there is merit in granting SIP credits to State and Local APCA that choose to install other control measures after Stage II requirements are removed, such as UST add-on APCD, P/V valves at GDF, improved parametric monitoring or ISD systems, dripless nozzles, operating training, and increased inspections. Additional control measures could be used at new facilities waived from requirements to install Stage II VRS, for GDF that remove Stage II VRS, or at other large-emitting GDF. We recommend, as stated previously, that EPA develop a guidance document, such as a CTG, discussing the control measures, efficiencies, and costs associated with each measure. Some control measures could be used in conjunction with continued Stage II VRS or could be used by GDF that remove the VRS systems. Preliminary monitoring shows that there may be additional fugitive emissions from the UST if the UST is not vapor tight. A P/V valve control measure should be accompanied by periodic UST pressure testing to confirm that fugitive emissions are not increasing due to pressurization of the UST and leaks. For balance systems and uncontrolled GDF (i.e., no Stage II VRS), the UST are more likely to remain at negative pressures for longer periods of time and pressurization of the UST may be less of an issue. UST with vacuum assist Stage II VRS will likely be at positive pressure for the majority of the time (generating additional fugitives when the UST is pressurized at 0 to 3 in. w.c.), and these GDF could benefit from addition of a control measure to alleviate positive pressures.

As there are some concerns regarding vapor leaks from UST due to pressurization and contamination of groundwater and soil (discussed later in this section), those additional control measures that alleviate pressurization of the UST should be given close consideration by States in the interim period before the widespread use date, especially for vacuum assist Stage II VRS.

While we have not yet collected data on or tested the UST vent emissions for an uncontrolled GDF, these emissions levels should be quantified and the potential emissions reductions determined for UST control devices. We plan to conduct testing at an uncontrolled GDF that will include measurement of UST emissions (see section VI.D).

We do not recommend requiring Stage II VRS in additional areas. It does not seem prudent to require a system that may be removed in a few years. Again, the cost analysis study to assess when new GDF would not be required to install Stage II VRS relative to the widespread use date may also address this issue.

Additional control measures with respect to Stage I operations will be addressed in an area source standard for GDF. The Stage I source category will not be addressed here.

Table 8. Stage II State Implementation Plan (SIP) Credits Comment Summary

Stakeholder	Comment Summary	Comment Detail
NESCAUM	NESCAUM stated that they support the use of SIP credits to encourage States to maintain stringent vapor recovery programs to control both VOC and air toxics emissions. NESCAUM suggested that SIP credits only be granted when Stage II VRS achieves greater emissions reductions than those achieved by ORVR alone following the widespread use date.	- NESAUM stated, "Once the use of Stage II controls does not garner any actual emission reductions, SIP credits should no longer be granted." - NESCAUM also indicated that SIP credits should be granted for improved monitoring and inspections of GDF's continuing to use Stage II VRS. - NESCAUM stated that States should be granted SIP credits for enhanced enforcement and compliance assistance efforts (such as enhanced monitoring and/or inspection programs) that will improve VRS efficiencies. - NESCAUM stated that EPA should investigate other means for maintaining program effectiveness, such as requirements to implement an equipment change-out schedule; - NESCAUM provided a copy of a report from Vermont's Air Pollution Control Board that was used as a basis for such a program. - NESCAUM offered to work with EPA to develop methods to enhance testing and inspection programs and to quantify the benefits of these activities. - NESCAUM indicated that if ORVR incompatibility proves to be significant then incompatibility emissions should be considered new and not as the result of shortcomings of Stage II VRS design or the Stage II regulations adopted by a state's SIP; states that adopt controls to minimize ORVR compatibility emissions should be given full SIP credit for those incremental reductions achieved.
Connecticut DEP	Connecticut DEP commented that EPA should allow SIP credits for States that require P/V valves and technology to reduce incompatibility excess emissions, and for States that choose to require Stage II VRS in new areas or moderate ozone nonattainment areas.	
Virginia	VA supported SIP credits for areas that maintain Stage II VRS after widespread use has been achieved.	
NJDEP	NJDEP stated that SIP credits should be granted for improved monitoring of Stage II VRS and other improvements such as requiring P/V valve and mini-boots on vacuum assist VRS.	- NJDEP stated that they have upgraded their Stage II VRS regulations to require annual testing of both Stage I and II systems and installation of P/V valves and mini-boots on nozzles (effective June 2, 2003). - NJDEP also believes that SIP credits should be granted if a state continues to require Stage II VRS after the widespread use date, if widespread use does not occur at 100 percent fleet turnover.

Stakeholder	Comment Summary	Comment Detail
TCEQ	TCEQ stated that ORVR compatibility should be mandated for those states choosing to maintain their Stage II VRS in exchange for SIP credits.	
Wisconsin DNR	Wisconsin DNR recommends that EPA allow States to claim SIP credits for Stage II VRS that remain in operation after the widespread use date is reached. Wisconsin DNR also suggests that EPA provide additional SIP credits for additional testing of Stage I equipment.	– The Wisconsin DNR, despite the language in Sections 202(a) (6) and 182(b) (3), plans to retain Stage II VRS in nonattainment areas after the widespread use date is achieved. – Wisconsin DNR recommends that States that require Stage II VRS after the widespread use date is achieved, continue to require periodic testing and emissions monitoring. – Wisconsin DNR recommends that States be granted SIP credits for continuing to require pre-EVR standards and for requiring any part of the CARB Enhanced Vapor Recovery controls, such as ORVR compatibility. – Wisconsin DNR recommends that SIP credits be granted for any new technology installed at a GDF that produces verifiable emissions reductions, even if it is not part of the CARB EVR program. – Wisconsin DNR also recommends that SIP credits be granted for those States that require a P/V valve, if P/V valves prove to be beneficial.
API	API stated that after a state identifies the appropriate percentage of ORVR systems installed is equivalent to the Stage II in-use efficiency that is in a given SIP, SIP credits would then be appropriate for emissions reductions due solely to ORVR. API indicated that they do not support SIP credits for the continued use of Stage II VRS after the widespread use date, or implementing Stage II VRS in new areas. API stated that CARB's program requiring a retrofit to existing GDFs to meet the new EVR is not necessary and as such, SIP credits should not be granted.	– API cited a Tech Environmental Study[53] done in Tennessee that indicated the cost per ton of VOC emissions reductions increases from $10,000/ton in 2007 to $26,000/ton in 2015. API added that when the cost of the State's administration of the program is included that these costs rise to $11,000/ton and $29,000/ton, respectively.[54] – API also cited the Tennessee proposal to implement Stage II VRS requirements in new counties. Tennessee decided against such requirements because Stage II was not a significant strategy and would become even less significant as more and more vehicles have ORVR control and larger activated carbon canisters. Also, Tennessee was not aware of any EAC [Early Action Compact] areas that actually used Stage II as a proposed strategy in the final analysis.[55] – API stated that SIP credits should not be given for retrofitting existing equipment to accommodate CARB's EVR program; both pre-EVR and EVR systems when properly maintained are certified to recover 95 percent of the refueling emissions. – API also indicated that SIP credits should not be granted for ISD installation or for requiring the installation of unihose equipment at GDFs.

[53] Cost Benefit Analysis for Stage II VRS Control in the Knoxville EAC Area. Tech Environmental (prepared for API). April 2004.

[54] Stage II Vapor Recovery System Operations & Systems Installations Costs. API Publication 1645. August 2002.

Stakeholder	Comment Summary	Comment Detail
RSA	RSA stated that they believe it is appropriate to provide additional SIP credits related to the use of VRS.	RSA stated that they support SIP credits for the following actions: 1) Maintaining Stage II controls after the widespread use date as long as the VRS is a balance system or a vacuum assist VRS that has passed CARB's strict [EVR] requirements. 2) Stage II VRS (balance or CARB approved vacuum assist VRS) in new areas in order to reduce the transport of emissions to non-attainment areas or to provide additional health protection. 3) Emissions reductions associated with improved monitoring. All States should be required to have an inspection and maintenance program in place. 4) The installation of P/V valves. EPA should require P/V valves on all stations whether VRS equipped or not. 5) VRS should be equipped with unihose dispensers in order to reduce the number of possible emissions points. 6) Stage I testing should continue after widespread use and Stage II testing should continue for as long as the VRS are in operation.
NACS and SIGMA	NACS and SIGMA stated that they do not believe that SIP credits should be granted for continuing Stage II VRS after the widespread use date and for implementing Stage II in new areas. They did recommend that SIP credits be granted for emissions reductions attributed to ORVR.	NACS and SIGMA commented, "Granting SIP credits after the widespread use date for enhancing or maintaining Stage II in existing areas or, certainly, for extending Stage II into new areas would be inconsistent with this Congressional policy choice. In fact, it would be illogical to grant SIP credits for Stage II controls that address the very same emissions for which credit is granted due to the use of ORVR. Of course, States should receive SIP credit for the emission reductions attributable to ORVR as Stage II is phased out." NACS and SIGMA further noted that the substantial cost associated with installing new or enhanced Stage II are not justified by the diminishing marginal benefits that may be achieved by Stage II before the widespread use date arrives.
ARID	ARID indicated that SIP credits should be granted for installation of APCD systems and for integrated monitoring and local inspection and maintenance programs.	ARID suggested that SIP credits could be given for the designation of BACT, MACT, or RACT for the use of APCD technology and/or inspection and maintenance programs.

[55] *Email communication*, Wayne Davis, PhD, University of Tennessee and Prentiss Searles, American Petroleum Institute, March 31, 2004.

I. Enhanced Vapor Recovery (EVR)

1. Comment Summary

Two stakeholders expressed concern that CARB would no longer support or archive pre-EVR Stage II VRS. One stakeholder suggested that those vacuum assist Stage II VRS that pass CARB EVR approval would be much more complex and more expensive to install and maintain. One equipment vendor commented that CARB's EVR program has certified several new Stage I VRS; full implementation of these new systems will result in decreased hydrocarbon emissions. One equipment vendor stated that a portion of CARB's EVR program will result in decreased emissions, while some EVR requirements may actually increase fugitive emissions. One stakeholder recommended that States be granted SIP credits for continuing to require pre-EVR standards and for requiring any part of the CARB EVR, such as ORVR compatibility.

The TCEQ indicated that they have relied on CARB to test and verify Stage II VRS but are now in the process of continuing to maintain pre-EVR standards without the assistance of CARB. API also indicated that they are concerned that CARB will no longer support or archive pre-EVR Stage II VRS and as such, areas without archived pre-EVR requirements could, by default, adopt EVR. API recommended that EPA archive the pre-EVR certifications and test procedures.

Missouri DNR suggested that vacuum-assist Stage II VRS meeting CARB EVR requirements would be more complex and expensive to install and maintain.

2. Discussion and Recommendations

OPSG should consider adopting certain components of CARB's EVR program, such as those that make the Stage II VRS controls compatible with ORVR as well as the ISD monitoring. All areas where Stage II VRS is required will continue with these controls until widespread use is achieved; some areas of the U.S. will no longer require Stage II VRS once widespread use is achieved and other areas will continue with Stage II VRS after the widespread use date. OPSG's options include: (1) requiring no additional changes for Stage II VRS compatibility with ORVR through the widespread use date and phasing out Stage II VRS requirements once widespread use occurs, or (2) requiring that Stage II VRS be ORVR compatible prior to and following the widespread use date for areas that have and/or will retain Stage II VRS requirements.

Whether or not to require ORVR compatible Stage II VRS will depend on which widespread use definition is selected and how early the date occurs. An early definition, such as definition (c) would not likely warrant additional conversion of vacuum assist Stage II VRS equipment, however, definition (a) would come later and the emissions benefits for ORVR compatible VRS may be worth the effort. The costs associated with this issue could be included as a component of the suggested cost analysis study for new GDF waivers.

The MTBE issue is another consideration in deciding whether to require ORVR compatibility for Stage II VRS, and possibly has an effect in deciding on which definition. While some States have suggested that a later widespread use definition is better from their perspective, an earlier definition may help alleviate any MTBE issues associated with incompatibility of vacuum assist VRS with ORVR.

Another issue related to retaining the existing Stage II VRS requirements is that CARB has changed its program to require EVR compliant systems. Because other States often refer to CARB-certified equipment in their regulations and SIPs, once CARB removes the non-EVR certifications, this will be an issue for those States to deal with.

Table 9. Enhanced Vapor Recovery (EVR) Comment Summary

Stakeholder	Comment Summary	Comment Detail
TCEQ	TCEQ indicated that they had previously relied on CARB to test and verify Stage II VRS equipment and that they are now attempting to continue pre-EVR standards without the assistance of CARB.	- TCEQ stated that TCEQ and other States have relied on CARB to test and certify new Stage II VRS and peripheral equipment; however, since the implementation of EVR, CARB has decided not to certify or provide support for the previous VRS standard of 95 percent. - TCEQ stated that they are attempting to continue the pre-EVR standards while incorporating a requirement for ORVR compatibility.
Wisconsin DNR	Wisconsin DNR supported granting SIP credits for any implementation of EVR.	Wisconsin DNR recommended that States be granted SIP credits for continuing to require pre-EVR standards and for requiring any part of the California Air Resources Board (CARB) Enhanced Vapor Recovery controls such as ORVR compatibility. The WDNR also recommends that EPA allow SIP credit for any new technology installed at GDFs that results in verifiable VOC emissions reductions, even if it is not part of the CARB EVR program.
Missouri DNR	Missouri DNR stated that their pressure data was the basis for CARB's decision to limit UST pressures to no greater than + 0.25"wc as a CARB-EVR requirement.	Missouri DNR stated that vacuum assist Stage II VRS that pass CARB EVR requirements will be significantly more complex and much more expensive to install and maintain.
API	API stated their concern that CARB will no longer support or archive pre-EVR Stage II VRS systems and equipment.	API stated, "Meanwhile, most jurisdictions outside of California have specifically referenced and require CARB certified systems, equipment and testing procedures for their Stage I and/or Stage II regulations without qualification. If these individual jurisdictions fail to archive the pre-EVR references to the CARB certification program, these jurisdictions could, by default, adopt the CARB EVR program. Several states have recognized this dilemma and have archived the pre-EVR certifications and test procedures while allowing the voluntary installation of EVR systems. Another possible alternative to this dilemma is for the EPA to archive the pre-EVR certifications and test procedures."
VST	VST stated that their newest hanging hardware, including the ENVIRO-LOC vapor recovery nozzles, exceeds CARB's EVR front-end emissions standards by 90 percent.	

Stakeholder	Comment Summary	Comment Detail
Healy	Healy commented that CARB's EVR program has resulted in the certification of several new Stage I VRS and when fully implemented will reduce hydrocarbon emissions by 25 tons/day statewide.	Healy indicated that they are the first to pass EVR Stage II testing and that EVR approved Stage I VRS have improved the ability to maintain leak tightness over long periods of time.
EMCO Wheaton	EMCO stated that some of the requirements of the CARB EVR program are "straightforward and will result in decreased emissions." EMCO also noted that some of the EVR requirements may actually increase fugitive emissions.	– EMCO suggested that the following EVR requirements will decrease emissions: dripless nozzles, liquid retention requirements, balance system component pressure drops, and leak tight connectors and fittings. – EMCO stated, "The pressure limit requirement of +0.25 inches w.c. daily average, and +1.5 inches w.c. maximum requirement seeks to minimize pressure related fugitive emissions. These emissions may not actually exist in a properly constructed and tested system. These are the same emissions that are addressed by the phase I EVR requirements. The net result is a requirement that, in effect, chases potential fugitive emissions."

J. Monitoring/Inspections of GDF and Stage II VRS

As discussed previously in this paper, the expected in-use control efficiency of Stage II VRS ranges from 56 to 90 percent, depending on the inspection frequency and the exemption levels. While Stage II control systems can achieve 95 percent or better control efficiency, in-use efficiency is shown to drop significantly without proper operation and maintenance.

1. Comment Summary

A few stakeholders commented that conducting more frequent inspections acts as a mechanism to improve Stage II VRS efficiency. One stakeholder indicated that they would like to work with EPA in developing methods to enhance testing and inspection programs. One equipment vendor commented that incentives should be developed to encourage and assist GDF owners and operators to install monitoring equipment that can help ensure that the VRS is operating properly. One stakeholder commented that ISD systems do not assure compliance, but instead identify failures at GDF that cause excess emissions.

The Wisconsin DNR indicated that fugitive emissions are related to the deterioration and aging of GDF equipment and periodic testing/monitoring would help identify problems, which would lead to an improvement to in-use control efficiency.

NESCAUM stated that they would like to work with the EPA in developing methods to enhance testing and inspection programs and suggested that EPA investigate other means for maintaining program effectiveness. NESCAUM enclosed a report that summarizes the results of a test program conducted by the Vermont Air Pollution Control Program; this test program was the basis for Vermont's enhanced monitoring and inspection program (see section VI.B).

RSA recommended that a nationwide inspection program be developed to inspect Stage I VRS with P/V valves; this program would provide significant reductions in VOC and HAP at a low cost.

Crompco, a provider of Stage II VRS compliance testing, indicated that there is a strong need to require more periodic testing on a basis more frequent than every 5 years. Crompco suggested an annual test. Crompco contends that as the testing frequency goes up, failure rates and emissions rates go down because problems are being identified and fixed; a well-maintained VRS helps control fugitive emissions from the system.

Veeder Root suggested that most Stage II VRS failures are difficult to detect and may go uncorrected until the next inspection; however, an ISD can assist a GDF by alerting the GDF of potential problems. Veeder Root strongly recommended that incentives be made to GDF to encourage installation of ORVR compatible Stage II VRS and monitoring equipment to ensure proper operation.

ARID stated that good housekeeping practices have not been present for GDF. ARID maintained that the use of an UST add-on APCD will give the GDF an incentive to ensure that the hardware is properly maintained. ARID further noted that continuous monitoring of UST pressure can alert GDF of potential problems.

2. Discussion and Recommendations

We believe that improved (and more frequent) monitoring, coupled with good operation and maintenance programs, results in emissions reductions. Use of ISD is a practical, inexpensive approach to better operation of GDF and VRS. EFPAG is currently collecting information regarding costs and that information will be forwarded to OPSG accordingly. We recommend that ISD be included as a control measure option for reducing emissions from GDF not only until the widespread use date is implemented but also continuing for GDF that do not or no longer have Stage II VRS. Control measures such as increased inspections, improved parametric monitoring, ISD, and operating training should be included in the control measures guidance for the States. These systems could be applied to continued use of Stage II VRS, new GDF that are waived of the requirements for Stage II VRS, or at uncontrolled GDF.

Additional control measures with respect to Stage I operations will be addressed in the area source standard for GDF. The Stage I source category will not be addressed here.

Table 10. Monitoring/Inspections of Stage II VRS Comment Summary

Stakeholder	Comment Summary	Comment Detail
Crompco	Crompco indicated that GDF should periodically survey the effectiveness of their VRS on a basis more frequently than every five years to reduce fugitive emissions.	Crompco, a GDF inspection company, indicated that Stage II VRS is a very important component in controlling fugitive emissions from GDFs. Crompco provided data on GDF inspections (pressure decay tests) that showed: (1) inspections were important for ensuring that the Stage II VRS operate correctly, and (2) the more often inspections were conducted, the less frequently VRS equipment failures were found.

Stakeholder	Comment Summary	Comment Detail
CARB	CARB stated that the ISD monitoring identifies failures that cause excess emissions but do not assure compliance.	- CARB indicated that EPA mis-characterized ISD because ISD systems do not assure compliance, but instead identify failures at GDF that cause excess emissions. - CARB also stated that EPA implied that the ISD system automatically adjusts the V/L ratio; this is incorrect. The statement was taken from the February 4, 2000 staff report that discusses a specific sensor and not an ISD requirement.
Wisconsin DNR	Wisconsin DNR stated that periodic testing/monitoring provides an opportunity to improve the in-use efficiency of Stage II VRS.	Wisconsin DNR commented, "The potential fugitive emissions are also related to deterioration and aging of the gasoline dispensing equipment and periodic testing/monitoring would help to identify problem components."
NESCAUM	NESCAUM indicated that they would like to work with the EPA to develop methods to enhance testing and inspection programs and in quantifying the added benefits of such actions.	NESCAUM submitted a report from the Vermont Air Pollution Control Program that was used as the basis for Vermont's enhanced monitoring and inspection program. This report stated that testing was conducted at thirty two GDF to determine how well in-use GDF systems maintain compliance with performance standards and the level of effort required to bring GDF back into compliance.
API	API stated that EPA guidance indicates that in-use effectiveness is a function of the frequency of agency inspections.	
RSA	RSA recommended that there be a nationwide inspection program of Stage I VRS with P/V valves.	RSA stated, "We feel that implementation of certified and inspected Stage I VRS with PV valves nationwide would provide significant reductions in VOC and HAP emissions for the relatively low cost of these systems. They have the additional benefit of having overfill protection to reduce the emissions of liquid gasoline into the soil and waterways near stations as well as the pollution of soil and water from the deposition of vapors."
Veeder-Root	Veeder-Root stated that most failures of VRS result in excess emissions, are difficult to detect, and typically go uncorrected until the next inspection takes place, which in most regions is only required annually. Veeder-Root suggested that ISD equipment can assist a GDF owner and/or operator in keeping their VRS in proper repair and operation.	- Veeder-Root stated, "As components on the vapor recovery system wear out, drift out of calibration or fail, the ability of the system to capture and control vapor loss into the atmosphere is adversely affected and the collection efficiency at the vehicle may be reduced. For example, a station operating at 60% efficiency instead of the required 90% has the potential to emit an additional 450 gallons of liquid gasoline per year into the environment." - Veeder-Root has developed ISD equipment to meet CARB requirements. - Veeder-Root recommends that incentives be developed, "to encourage and assist GDF owners and operators to install ORVR-compatible Stage II VRS and Vapor Recovery Monitoring Equipment that can help insure that the Stage II VRS are operating at or above the levels they were originally designed to meet."

Stakeholder	Comment Summary	Comment Detail
EMCO	EMCO stated that oversight inspections have improved Stage II efficiency.	EMCO commented, "However, oversight inspections are very different animals than planned obsolescence programs. The [equipment component replacement] proposal sketched out in paragraph 1 page 25 of the Issues Paper is simply not realistic. Date stamping and replacing components on a regular basis regardless of any known problem is unduly burdensome to the gas station operators."
ARID	ARID noted that incentives for performing good housekeeping practices have not been present for GDF. ARID maintained that the use of an APCD and recovered product will give the GDF the proper incentive to ensure hardware is properly maintained and the vapor carrying components remain vapor tight.	– ARID stated, "[t]he wise station owner will diligently maintain their APCD equipment with the confidence that their efforts and investment will be rewarded with saved product." – ARID noted that continuous monitoring of UST pressure can alert a GDF of situations that warrant further investigation; a GDF can pinpoint the anomaly by examining typical leak sources, arranging a leak decay test, or arranging a detailed hardware inspection. – ARID suggested that useful monitoring information can be obtained with "macro" variables such as combined UST pressures and APCD run times; this type of monitoring is simple, elegant, robust, and cost-effective.

K. Emissions Factors and Emissions Testing

As discussed in the Issues Paper, the current average AP-42 emissions factor information is almost 20 years old and does not always account for more recent changes in gasoline composition.

1. Comment Summary

Three stakeholders and one equipment vendor commented on the need for new emissions factors. One stakeholder stated that they do not necessarily agree with API emissions factors and that they are working in conjunction with another partner on a test program to collect more information.

TCEQ agreed with EPA that there needs to be new emissions factors for Stage I and II VRS. Wisconsin DNR and RSA noted a potential need for new VOC and HAP emissions factors for GDF. Wisconsin further suggested that EPA study and quantify fugitive emissions under various controlled and uncontrolled scenarios. RSA also commented that the emissions factor used to determine the spillage contributions for Figure 5 in the Issues Paper (Stage II VRS-only emissions levels) did not seem reasonable from CARB documents and Missouri DNR studies.

ARID suggested that more testing be done to determine emissions factors for IEE from combined use of vacuum-assist Stage II VRS and ORVR, UST vent breathing and emptying emissions without Stage II VRS and with and without P/V valves, and fugitive emissions from Stage II VRS.

CARB stated that they do not necessarily agree with the emissions factors determined from API testing. CARB noted that they are working together in conjunction with API and the Western States Petroleum Association (WSPA) on a test program to collect more information. See section VI.C.

2. Discussion and Recommendations

Some of the variables known to affect emissions factors for GDFs include: ambient temperature, seasonal variation in gasoline Reid Vapor Pressure, gasoline throughput, vapor tightness of the GDF and VRS, and percentage of ORVR-equipped vehicles. We recommend updating the emissions factors based on all the data collected from stakeholders and additional emissions testing to be conducted by EPA and stakeholders. Only three emissions measurement tests were submitted by the stakeholders for traditional GDF, EPA is planning to conduct testing at two GDF, and Hertz is planning to conduct testing at their on-site GDF. These data include multiple emissions points in controlled and uncontrolled scenarios, and may be used to develop updated emissions factors. Based on continued discussions with stakeholders, it is clear that there is additional data that could be collected and included in these analyses.

Table 11. Emissions Factors and Emissions Testing Comment Summary

Stakeholder	Comment Summary	Comment Detail
CARB	CARB stated that their staff does not necessarily agree with API emissions factors.	CARB indicated that CARB and API are working together in conjunction with the WSPA on a test program to collect more information to help address differences in emissions data collected to date.
TCEQ	TCEQ indicated that they agree with the EPA regarding the need for new emissions factors for Stages I and II.	TCEQ noted that allowing local inputs, such as liquid temperature and Reid Vapor Pressure, would be beneficial.
Wisconsin DNR	Wisconsin DNR noted the need for new VOC and HAP emissions factors for GDFs.	Wisconsin DNR suggested that EPA study and quantify fugitive emissions under various controlled and uncontrolled scenarios.

Stakeholder	Comment Summary	Comment Detail
RSA	RSA stated that there is a potential need for new emissions factors for VOC and HAPs. RSA also commented that the use of 0.5 of the AP-42 values for spillage emissions for the ORVR vehicles and 1.0 of the AP-42 value for Stage II VRS seems unreasonable. Accurate values for the spillage must be used.	RSA commented, "The HAPs emission factors should be related to the VOC emission factors relative to the composition of the gasoline and the temperature of the gasoline. CARB has done a number of studies analyzing SUMMA® canisters collected from various points in the vapor recovery systems to determine the relative concentrations of various components. MDNR has some similar data. The problem is that there is great variability of composition of gasoline, even the more strictly related RFG fuels. A good survey of data available should be made first to determine exactly what is appropriate for use for the systems and fuels being used in the areas of interest at the present and likely to be used in the next 10 years or so. It is also important to determine the actual emissions of the older ORVR vehicles upon fueling. It probably would be useful to do some specific VOC and HAPs measurements for these since it may be that the distribution of HAPs in relation to total VOC will be different for the ORVR than the VRS (i.e., the adsorption profile may well be different from the vaporization profile)."
ARID	ARID stated that they support the need for field testing to accurately quantify refueling–related emissions.	ARID indicated there needs to be more testing to determine emissions factors for incompatibility excess emissions from vacuum assist Stage II and ORVR, UST vent breathing and emptying emissions from the UST without Stage II VRS and with and without P/V valves, and fugitive emissions from Stage II VRS.

L. Exemptions for Rental Car Facilities

1. Comment Summary

One stakeholder requested a waiver from Stage II VRS requirements for rental car facilities whose vehicle fleet is comprised mostly of ORVR-equipped vehicles. Another stakeholder requested timely guidance from EPA on exemptions for rental car facilities dispensing 100 percent of their fuel to ORVR-equipped vehicles.

TCEQ suggested that EPA provide timely guidance on exemptions for facilities, such as rental car facilities and car dealerships, dispensing 100 percent of their fuel to ORVR-equipped vehicles.

Hertz requested a waiver from Stage II VRS. Hertz indicated that their current vehicle fleet is comprised of 99.3 percent ORVR-equipped vehicles and that this percentage would approach 100 percent by July 2006.

2. Discussion and Recommendations

EPA is considering drafting and releasing a waiver guidance memorandum for rental car facilities for those facilities that can demonstrate that a significant portion of their vehicles are ORVR-equipped, that a significant portion of gasoline throughput is dispensed to ORVR vehicles, or that the emissions reductions achieved with ORVR controls are equivalent to the emissions reductions achieved with Stage II VRS. Because the majority of vehicles fueled are new vehicles with ORVR controls, the refueling emissions will be controlled by the ORVR canister. A similar waiver is also being considered for automobile manufacturing facilities.

Table 12. Exemptions for Rental Car Facilities Comment Summary

Stakeholder	Comment Summary	Comment Detail
TCEQ	TCEQ requested that EPA provide guidance on exemptions from rental car facilities.	TCEQ recommended that EPA provide timely guidance on exemptions for rental car facilities and car dealerships that dispense 100 percent of their fuel to ORVR-equipped vehicles.
Hertz	Hertz requested exclusion from Stage II VRS requirements because their vehicle fleet is largely comprised of ORVR-equipped vehicles.	Hertz stated that the widespread use definition should be applied to them. Hertz indicated that their vehicle fleet is comprised of 99.3 percent ORVR-equipped vehicles and that this percentage will approach 100 percent by July 2006.

M. Stage I and II Equipment and UST Emissions

1. Comment Summary

One stakeholder commented that active tank management with membrane processors is the proper way to address excess emissions from the UST. Two equipment vendors commented that controlling the pressure of the UST will prevent fugitive VOC emissions from the Stage II VRS system. Other stakeholders maintained that processors utilized by vacuum assist Stage II VRS actually increase emissions of some pollutants (referring to incinerator controls). Two stakeholders suggested that CARB's approach to estimating fugitive emissions actually penalizes a VRS that is vapor tight. One equipment vendor stated that required ORVR compatible Stage II VRS were more efficient and that its compatible equipment reduces emissions and maintains UST pressure. Another stakeholder suggested that P/V valves should be placed on all UST vents.

The Missouri DNR suggested that a vacuum assist Stage II VRS that utilizes a combustion processor or incinerator actually increases emissions of polycyclic aromatic hydrocarbons (PAHs), as well as greenhouse gases, and nitrogen oxides; these pollutants would not have been emitted without the addition of an incinerator. RSA agreed with the Missouri DNR regarding an increase in emissions from utilizing a processor. RSA stated, "It does not make sense to create a problem when trying to solve another especially when there are other less polluting means available." Missouri DNR also suggested that P/V valves be installed at all permitted Stage I GDF.

Costco Wholesale stated that prior to installing a membrane processor, their UST vented almost all day due to the incompatibility of ORVR and their vacuum assist VRS; after the membrane processor was activated, the vent episodes ceased. Costco also contends that membrane processors work with all UST systems (controlled and uncontrolled) and regardless of VRS type.

API commented that vapor processors are expensive. Both API and STI stated that CARB's method to calculate fugitive emissions has changed and now penalizes an UST system for being vapor tight. STI indicated that CARB and WSPA have drafted a testing protocol to help resolve this issue but as of yet, the protocol has not been finalized.

Healy stated that ORVR compatible Stage II VRS are more efficient. Healy indicated that their compatible nozzles reduce emissions and that their Clean Air Separator (and UST add-on APCD) acts as a pressurization system.

VST suggested that by keeping the pressure of the UST below positive pressure, fugitive emissions from the UST would be minimized. VST further stated that they have several UST control systems, such as a membrane processor, that will control the pressure of the UST and recover gasoline vapor.

EMCO maintained that P/V valves should be placed on all UST vents and that many vacuum assist Stage II VRS require an UST add-on APCD to deal with ORVR incompatibility.

ARID contended that an APCD is the key factor in reducing the overall pressure of the UST. ARID also stated that a tight VRS system resulted in higher UST vent emissions, while a leaky VRS system resulted in higher fugitive emissions.

2. Discussion and Recommendations

We believe that VOC emissions from UST vents and leaks from USTs may be a major emission point at GDF, and as ORVR-equipped vehicles become more common, the emissions from UST at GDF with vacuum assist Stage II VRS are likely increasing. However, many of the stakeholders have not identified UST vents as a large source of VOC emissions. There have been some recent studies that indicate there are vapor leaks from USTs with resultant MTBE groundwater contamination. Some of the UST staff in the States (and at EPA's Office of Underground Storage Tanks) believe that Stage II VRS, especially the vacuum assist systems, may be responsible for the vapor leaks. OUST has a current project underway to determine the causes and develop prevention measures for these vapor leaks.

There are few data showing VOC emissions from USTs. Many certification tests have been conducted in California, yet there are little emissions measurement data for UST vents (CARB's test procedure calculated UST fugitive emissions based on pressure data). Because CARB's EVR program has requirements to control both tank pressures and UST vent emissions, the current CARB certification testing may not indicate any UST emissions problems. API's comments seem to indicate that any UST emissions would be insignificant; however there are some data that have been supplied from vendors that show positive tank pressures lead to VOC UST emissions. Several vendors have suggested that GDF are emitting significant quantities of gasoline vapors and could save up to $2,000 per month by collecting these vapors.

We have observed one emissions measurement test in Florida in December 2004 where the tank pressure was greater than 3 in. w.c. for the entire test period. When the pressure reached 3 in. w.c., the P/V valve popped open and vented emissions to the atmosphere. The P/V valves are required by Stage I (gasoline tank refilling) provisions in ozone nonattainment areas. If tank pressures are positive, then there will be fugitive leaks either through small cracks, improper fittings, etc. or through the UST vent.

As mentioned above, staff that work with USTs regularly think that pressurized tanks lead to vapor leaks. Gary Lynn of the New Hampshire DEP said that he thinks all USTs leak.[58]

We recommend the use of P/V valves on UST vents nationwide for additional HAP control.

Table 13. Stage I and II Equipment and Underground Storage Tank (UST) Emissions Comment Summary

Stakeholder	Comment Summary	Comment Detail
Missouri DNR	Missouri DNR stated that vacuum assist Stage II VRS that use a combustion processor (incinerator) increase emissions. Missouri DNR also suggested that the EPA require permitted Stage I GDF to install P/V valves.	– Missouri DNR suggested that combustion processors increase emissions of PAHs as well as green house gases, and nitrogen oxides that would not otherwise be emitted. – Missouri DNR stated that Stage I is inexpensive to install and maintain, and would significantly reduce the VOC, HAPs, HC and MTBE issues.
Costco	Costco indicated that they believe membrane technology virtually eliminates vent and fugitive emissions from GDF and is the right way to manage UST pressure.	– Costco stated, "[W]e believe that membrane processors work with all UST systems, whether Stage II is balance, vac assist, or absent. Allowing tank systems to 'breathe' to atmosphere (as all do without tank pressure management, especially at night) is to face the uncomfortable decision of how much pollution is OK. We prefer no pollution at all if the technology is available to prevent it. With membranes, virtually all vent and fugitive emissions are eliminated." – Costco commented, "We do not believe there is any long-term future for Stage II vapor recovery, but we feel that all stations should be built to actively manage their tank pressures to prevent venting."
API	API stated that vapor processors are expensive. API also stated that the approach CARB uses to calculate fugitive emissions has changed significantly and now penalizes an UST system for being vapor tight.	API criticized CARB's EVR cost data for vapor processors. API stated that this data is unrealistically low.

[58] Teleconference with EPA, February 2005.

Stakeholder	Comment Summary	Comment Detail
STI	STI stated that CARB's methodology for estimating fugitive emissions penalizes Stage II VRS that are more vapor tight.	STI indicated that CARB and the WSPA have drafted a testing protocol to help resolve this issue and that the protocol has not yet been finalized.
Healy	Healy indicated that required ORVR compatible Stage II systems are more efficient.	– Healy stated that their Stage II VRS nozzles reduce emissions through reduced spillage, fewer drips, no "spitting", clean fills at 10 gallons per minute; the nozzles also reduce "topping off" spills and potential for fires. – Healy provided data to demonstrate that their Clean Air Separator prevents the ullage space pressure from exceeding CARB's maximum average positive pressure of 0.25 in. w.c.
VST	VST maintained that controlling the pressure of the tank (and keeping it below positive pressure) will prevent fugitive emissions of VOCs from the system.	– VST commented on UST emissions and how they result from the pressure of the tank and fuel delivery system. – VST has several systems that will control the pressure in the tanks and recover the VOC emissions such as a membrane processor. VST stated that new technologies will provide the ability to utilize ORVR systems and Stage II systems simultaneously.
RSA	RSA maintained that vacuum assist Stage II VRS equipped with processors do not solve the pollution problem because the processor causes emissions of other pollutants that would not have been emitted without the processor.	RSA stated, "It does not make sense to create a problem when trying to solve another especially when there are other less polluting means available."
EMCO	EMCO stated that P/V valves should be placed on all UST vents. EMCO also noted that vacuum assist Stage II VRS often require add-on control devices to deal with the incompatibility emissions problem.	EMCO referenced a processor cost of $30,000.
ARID	ARID stated that an APCD is key to reducing the overall UST tank pressure.	– ARID commented that an excess vapor generation rate is present in the UST and that excess vapor within the UST will result in a pressure increase; a tight system will yield higher vent emissions, while a leaky system will yield higher fugitive emissions. ARID notes that an air pollution control device reduces the overall storage tank pressure while at the same time capturing and recovering vent emissions. – ARID stated that testing performed at one of their test sites demonstrated that their PERMEATOR significantly reduced fugitive emissions; the UST vent without the PERMEATOR on resulted in fugitive emissions by more than 200 times.

N. MTBE Groundwater Contamination from UST

1. Comment Summary

One stakeholder provided documentation that contends the UST leaks are from vapors that are released through the innate pressurization of the USTs by the vacuum assist Stage II VRS. Two stakeholders commented that with the removal of Stage II VRS, contamination of groundwater caused by fugitive emissions from the pressurized VRS at GDF would cease. One stakeholder suggested that the MTBE issue is a good example of what can go wrong while fixing one problem but not paying attention to the effects of the proposed solution. One equipment vendor stated that EPA should address the MTBE problem by requiring the use of CARB certified ORVR compatible Stage II VRS.

The Missouri DNR stated that New Hampshire is experiencing MTBE groundwater contamination. Missouri DNR submitted an article that maintained that the leaks are caused by vapors that are released through the innate pressurization of the UST by vacuum assist Stage II VRS.

Both API and BP stated that the removal of Stage II VRS in favor of ORVR would help minimize groundwater contamination. API further stated that they have a group of experts that are examining the groundwater contamination issue. API and BP recommended that more research be done to identify the significance and associated circumstances of groundwater contamination before any widespread regulatory actions are taken.

Healy stated that New Hampshire has been monitoring a large percentage of Stage II-equipped GDF to examine the extent of groundwater pollution. He indicated that New Hampshire's findings indicate that 129 out of 300 GDF show unacceptable levels of MTBE. Healy suggested that the contamination was caused from vacuum assist Stage II VRS due to ORVR incompatibility. Healy recommended that EPA make every effort to address this issue by requiring GDF to use CARB-certified ORVR compatible Stage II VRS.

2. Discussion and Recommendations

UST fugitive emissions are caused by pressurization of USTs. While fugitive emissions may occur when pressurization occurs for either balance or vacuum assist, balance systems seem to minimize the amount of time the UST is at positive pressure and therefore may minimize fugitive emissions. Vacuum assist systems, however, may cause pressurization of the UST during operating hours in addition to off hours. Measures that can be taken to reduce the pressurization of UST vacuum assist systems should be studied and considered. These may include some components of the EVR program that make vacuum assist Stage II VRS compatible with ORVR vehicles. The use of MTBE as an oxygenate in gasoline has resulted in detections of MTBE in drinking water. In the past, it was frequently leaking USTs or spills that caused the contamination of soil and water at and near the GDF site. However, with implementation of stricter UST regulations, the contamination of soil and water is thought to be caused by vapor leaks from the UST. The CAA requires that RFG contain 2 percent oxygen by weight, and over 85 percent of RFG contains MTBE and approximately 8 percent contains ethanol.[56] Some States have banned MTBE use in gasoline, and MTBE may be replaced in favor of other oxygenates such as ETBE, TAME, TAEE, DIPE, ethanol, and TBA.[57] The changes in the gasoline composition may eliminate the MTBE in gasoline, however, because the other oxygenates have similar but not identical chemical characteristics, they may simply result in a shift in the contaminant compound found in soil and groundwater near GDF.[56] The effect of the other oxygenates may not yet be known but fugitive emissions certainly should be minimized as a precaution regardless of the next generation of oxygenates. In any case, EPA could implement requirements to minimize fugitive emissions, such as increased testing of vapor tightness and reducing pressurization of tanks, especially from vacuum assist Stage II VRS.

Table 14. MTBE Groundwater Contamination from UST Comment Summary

Stakeholder	Comment Summary	Comment Detail
Missouri DNR	Missouri DNR indicated that New Hampshire is experiencing MTBE ground water contamination.	Missouri DNR provided an article that contends that the leaks are caused by vapors that are released through the innate pressurization of the UST by the vacuum assist VRS.
API	API stated that discontinuing Stage II VRS in favor of ORVR will help eliminate groundwater contamination issues. API further stated that they have a group of experts working on the groundwater contamination issue and believe more needs to be done to identify the significance and circumstances related to groundwater contamination before any widespread regulatory actions are taken.	API commented that there have been some isolated incidents of groundwater contamination allegedly from UST system vapor leaks. API stated that some recent papers have preliminary data to bolster such allegations; however these papers also acknowledged the need for further research on this matter.
BP	BP stated that with the removal of Stage II VRS in favor of ORVR, contamination of groundwater caused by fugitive emissions from the pressurized VRS at GDF would cease. BP also acknowledged the need for further research on the groundwater contamination issue.	BP commented that API and member companies are concerned about the allegation that GDFs are causing MTBE contamination of groundwater; they are currently working on this issue. BP also cautioned, "… given that this forum includes regulators and rule makers, more needs to be done before taking any widespread regulatory actions."
RSA	RSA stated that the MTBE issue is a good example of what can go wrong when not addressing all the potential pollution problems while trying to solve another problem.	RSA commented, "It does not make sense to create a problem when trying to solve another especially when there are other less polluting means available."

[56] Achieving Clean Air and Clean Water: The Report of the Blue Ribbon Panel on Oxygenates in Gasoline. EPA Publication No. EPA420-R-99-021. September 15, 1999.

[57] Predicted Ground Water, Soil and Soil Gas Impacts from U.S. Gasolines, 2004 First Analysis of the Autumnal Data. EPA Publication No. EPA 600/R-05/032. February 2005.

Stakeholder	Comment Summary	Comment Detail
Healy	Healy shared information from New Hampshire that indicated that some GDF are showing levels of MTBE that are unacceptable. Healy suggested that a vacuum assist Stage II VRS will most likely be polluting the soil and ground water due to ORVR vehicle refueling. Healy stated that EPA should apply every effort to address groundwater contamination by requiring the use of CARB certified ORVR compatible Stage II VRS.	- Healy stated that New Hampshire has been monitoring a large percentage of Stage II equipped GDF to determine the extent of groundwater pollution. New Hampshire's findings showed that 129 out of 300 GDF showed unacceptable levels of MTBE. - Healy further stated that almost all the GDFs with unacceptable MTBE levels were vacuum assist Stage II VRS and no ORVR compatible systems were on the list. - Healy also indicated that studies performed by the University of California, Davis confirmed that MTBE vapor releases are strongly associated with vacuum assist Stage II VRS. - Healy maintained that the source of this pollution is a build-up of positive pressure in the ullage space of the UST.

VI. Emissions Monitoring and Testing Data

A. Previous Data Collected by EPA

Prior to the public meeting in September 2004, EPA collected and analyzed data from several studies conducted to evaluate excess emissions from the refueling of ORVR-equipped vehicles at GDF with Stage II VRS. Each data source and the tests conducted are discussed, the key results and conclusions presented in the data sources are summarized, and a large summary table of all the data is presented. The table is organized to identify the actual measurements conducted and results reported in the study.

Emissions may occur (and may be measured or calculated) at numerous points within the system. CARB's Stage II VRS certification test method, TP-201.2, addresses making measurements or calculating emissions from several points in the system. The measurement points include:

1. Emissions at nozzle/vehicle interface ("fillpipe" emissions),
2. VOC's returned through the vapor passage of the hose,
3. Emissions from the UST P/V valve,
4. Emissions from the assist processor (not applicable in these studies), and
5. Calculated pressure-related fugitives based on UST pressure measurements.

(EPA defines refueling emissions as the evaporative loss emissions during refueling, as well as emissions from spillage. For the purposes of the discussions below, spillage emissions are not addressed and any reference to "refueling emissions" does not include spillage. The emissions data generally are reported as lb VOC/1,000 gallons dispensed. In the actual reports, both lb /1,000 gallons dispensed and grams of VOC per gallon (g/gal) dispensed were used; this often got confusing as the authors switched back and forth. The data in the summary table are presented in lb/1,000 gallons.)

1. CARB's Preliminary Test Report, June 1999 (GDF)

These tests were conducted in August/September 1998 at two GDF with vacuum assist Stage II VRS to quantify excess emissions from vapor growth; each GDF had a different type of vacuum assist system. At the time of the tests, these two types of systems represented 80 percent of VA systems in CA and dispensed 55 percent of the gasoline purchased. The emissions from the Stage II VRS were determined from direct measurement of P/V valve emissions and calculation of fugitive emissions based on UST pressure readings. CARB did not measure or attempt to quantify the emissions at the nozzle/fill pipe interface ("fillpipe emissions") during the study. The testing consisted of two phases: (1) "baseline" normal operations, and (2) simulated ORVR. Because ORVR vehicles were not prevalent when the tests were done, the refueling of ORVR was simulated by modifying the dispensers to ingest ambient air; an ORVR population of approximately 40 to 45 percent was simulated.

Negligible emissions were emitted from the P/V valve, and UST fugitive emissions occurred due to leaks. Excess emissions, which are based on pressure-related fugitive calculations, also occurred when refueling with the simulated ORVR scenario. Table 15 includes a detailed summary of the data for each emissions point. CARB used these data to establish excess emissions factors for refueling of ORVR-equipped vehicles in combination with vacuum assist Stage II VRS of 0.86 lb/1000 gal for the Gilbarco system and 0.06 lb/1000 gal for the Dresser Wayne system with the P/V valve in place. Operation without the P/V valve was considered atypical and these data were not used in CARB's final analyses.

2. Phase 1 of API's ORVR Compatibility Study (GDF)

These tests were conducted at a GDF in California with a vacuum assist (Gilbarco) Stage II VRS to determine the amount of excess emissions from refueling ORVR-equipped vehicles. The tests were conducted using summertime RFG (RVP 7.0 psi) and two types of nozzles. In Test 1, refueling was conducted with standard vacuum assist nozzles for a 100-car matrix. Test 2 also included a 100-car matrix, however, nozzles with "miniboots" were used to limit the influx of ambient air during refueling. The testing was conducted using CARB's certification test procedure TP201.2. These data are summarized in Table 15.

The overall pressure-related emissions for Test 1 (with the standard vacuum assist nozzle) were 1.38 lb/1,000 gal and for Test 2 (with the miniboot nozzles) were 0.494 lb/1,000 gal. Therefore, the miniboot showed a reduction in pressure-related emissions of 0.886 lb/1000 gal (or a 64 percent reduction). The effects of ORVR versus non-ORVR vehicles on UST pressures and UST vent emissions due to interferences from vehicles simultaneously refueling at other pumps connected to tanks could not be differentiated (i.e., quantified).

The emissions from the vehicle fillpipe/nozzle interface were measured, and the test results showed that ORVR controls reduced emissions from the interface by 0.31 lb/1,000 gal. Therefore, it was concluded that the value CARB determined for the excess emission factor due to vapor growth in the UST (0.86 lb/1,000 gal, see above) should be offset accordingly; i.e., total excess emissions should be 0.86 lb/1,000 gal - 0.31 lb/1,000 gal, or 0.55 lb/1,000 gal.

3. Phase 2 of API's ORVR Compatibility Study (Outside)

These tests were outdoor tests conducted at a research facility using a 3,000 gal UST that contained 1,000 gal of gasoline. The gasoline was a summer grade oxygenated fuel with a RVP of 7.8 psi. Six refueling tests were conducted on 3 vehicles (two with ORVR and one without ORVR). The UST emissions from the P/V valve and the pressure-related fugitives were measured; the system was demonstrated to be leak free prior to testing, and a fugitive leak rate was simulated, and controlled, using a calibrated needle valve. The fugitive emissions measured while refueling ORVR and non-ORVR vehicles were compared to determine the incompatibility excess emissions. In addition, the pressure-related fugitives were measured and compared to those predicted by the CARB calculations.

For the standard nozzle tests, the pressure-related excess emissions were calculated to be 0.72 lb/1000 gal. The fillpipe emissions for ORVR-equipped vehicles were 0.39 lb/1,000 gal less than for non-ORVR vehicles (represents a 91 percent reduction). The adjusted ("net") ORVR excess emissions were 0.33 lb/1,000 gal (i.e., pressure-related excess emissions minus the savings at the fill pipe, equal to 0.72-0.39). If these corrections are used on the data generated from MOBILE6, the correct excess emission factor to use would be 0.42 lb/1,000 gal (not 0.33 lb/1,000 gal) because MOBILE6 already accounts for some of the fillpipe reductions achieved by ORVR-equipped vehicles by using a 98 percent control efficiency for ORVR rather than the 95 percent efficiency used for Stage II VRS.

For the miniboot nozzle tests, the pressure-related excess emissions were calculated to be zero (-0.008 lb/1000 gal). It was shown that the fillpipe emissions for ORVR-equipped vehicles were less than for non-ORVR vehicles. The adjusted ("net") ORVR excess emissions were -0.39 lb/1000 gal; i.e., a decrease in emissions [zero pressure-related excess emissions minus the savings at the fill pipe is equal to a reduction of 0.39 lb/1000 gal].

4. Phase 2 of API's ORVR Compatibility Study (SHED)

The emissions testing was conducted in Sealed Housing for Evaporative Emissions (SHED). A total of 36 refueling tests using procedures similar to the federal ORVR certification test were conducted for three vehicles (two with ORVR and one non-ORVR). During these tests, the impacts of the RVP, temperature, the A/L ratio, and the type of ORVR equipment were determined.

First, the ORVR performance was checked (validated) with a baseline certification. The tests were conducted to investigate the impact of several factors, including:

(1) RVP: The tests were conducted with an RVP of 7.1 and 7.8 psi;

(2) Temperature difference: Three summertime temperature scenarios were used: one vapor growth and two vapor shrinkage scenarios. The scenarios included varying the temperature of the fuel dispensed and the temperature of the vehicle gasoline tank.

(3) A/L ratios: standard nozzle and the miniboot.

(4) Type of ORVR equipment: recirculation or not.

The fillpipe emissions for ORVR and non-ORVR vehicles fall within the range of values measured in the Phase 1 and Phase 2 (outdoor tests). The fillpipe emissions for ORVR-equipped vehicles were 0.46 lb/1000 gal less than for the non-ORVR vehicles. For ORVR-equipped vehicles, fillpipe emissions were not sensitive to changes in the RVP, the temperature differences between the vehicle tank and the dispensed gasoline, and the A/L ratio. There was, however, a positive correlation between the fillpipe emissions and the vehicle tank temperature.

For non-ORVR vehicles, there was a positive correlation of the fillpipe emissions with the RVP, a negative correlation of the fillpipe emissions with A/L ratio, and a negative correlation of the fillpipe emissions with delta T, as assumed in MOBILE 6. The fill-pipe emissions for the miniboot (A/L ratio of 0.95) were greater than (approximately double) the fillpipe emissions with the standard nozzle (A/L ratio of 1.15). The emissions are greater for the vapor growth scenario (temperature of the fuel in the vehicle gasoline tank is less than the temperature of the fuel being dispensed). For the ORVR-equipped vehicles, the puff emissions (the puff of emissions when the gas cap is removed) are the same order of magnitude as the fillpipe emissions; the same is true to non-ORVR vehicles.

Table 15. Summary of Previous Data Collected by EPA: Test Data for Excess Emissions.

Data source	Unit type/ test conditions	Fillpipe emissions (a) (b)	P/V Valve emissions (c)	Calculated pressure - related fugitives (leaks) (d)	Total pressure - related emissions (e = c+d)	Total refueling emissions (f =b+c+d)	Excess emission due to ORVR incomp. (g)	ORVR emission reduction at fill pipe (h)	Adjusted excess emission due to ORVR incomp. (i)	VRS return line, HC conc, % (j)	Notes
CARB [1] Scenario 1	Gilbarco VA Baseline:	Not measured	Negligible		0.396			Not measured			
	Gilbarco VA ORVR:				0.782		**0.386**				(p)
CARB [1] Scenario 2	Dresser Wayne Baseline:	Not measured	Negligible.		0.028						
	Dresser Wayne ORVR:				0.0524		**0.0244**	Not measured			(p)
CARB [1] Scenario 3	Dresser Wayne (without P/V valve) Baseline:	Not measured	Negligible	0.026	0.026						
	Dresser Wayne (without P/V valve) ORVR:			0.289	0.289		**0.263**	Not measured			(p)
CARB	Gilbarco VA Dresser Wayne						**0.86** **0.06**				Calculated from Scenarios 1 & 2 (p)
API [2] Test 1	Gilbarco VA Standard nozzle (OPW 11VA1); non-ORVR	0.42	0.823	0.557	1.38					32 %	
	Gilbarco VA Standard nozzle (OPW 11VA1); ORVR vehicles	0.11					Not measured	0.31 (73% less than non-ORVR)		11%	
API [2] Test 2	Gilbarco VA With "miniboot" (OPW 12VW); non-ORVR	0.42	0.008	0.484	0.494					approx 40%	Miniboot reduces pressure related fugitives 0.886 lb/1000 gal (64% reduction)
	Gilbarco VA With "miniboot" (OPW 12VW); ORVR vehicles	0.11					Not measured	0.31 (73% less than non-ORVR)		approx 17%	

Data source	Unit type/ test conditions	Fillpipe emissions (a) (b)	P/V Valve emissions (c)	Calculated pressure - related fugitives (leaks) (d)	Total pressure - related emissions (e = c+d)	Total refueling emissions (f =b+c+d)	Excess emission due to ORVR incomp. (g)	ORVR emission reduction at fill pipe (h)	Adjusted excess emission due to ORVR incomp. (i)	VRS return line, HC conc, % (j)	Notes
API[3]	Outdoor test 5; Standard nozzle non-ORVR	1.53 (check)	0	(Measured) 0.022	(Measured) 0.022		NA			33.2	check run number table 6-4
	Outdoor test 1; Standard nozzle ORVR vehicle with recirc.	0.024	0	(Measured) 0.918	(Measured) 0.918		0.896			3.0	CARB: 0.86
	Outdoor test 3; Standard nozzle ORVR vehicle without recirc.	0.026 (check)	0	(Measured) 0.229	(Measured) 0.229		0.207			0.6	check run number table 6-4
	Standard nozzle ORVR vehicle, wgt. average (calculated)	0.025			0.745 (k)		0.72 (k)	0.39 (m) (91% less than non-ORVR)	0.33	2.4 (RTI)	Note: fill-pipe reductions calculated for these tests = 1.505
API[3]	Outdoor test 6; Miniboot; non-ORVR	2.11	0	(Measured) 0.011	(Measured) 0.011		NA			38.8	
	Outdoor test 2; Miniboot; ORVR vehicle with recirc.	0.002	0	(Measured) 0.004	(Measured) 0.004		- 0.007			5.4	
	Outdoor test 4; Miniboot; ORVR vehicle without recirc.	not available	0	(Measured) 0.002	(Measured) 0.002		- 0.009			7.6	
	Miniboot; ORVR vehicle, wgt average (calculated)				0.003 (k)		-0.008 (k)	0.39 (m) (91% less than non-ORVR)	-0.39 i.e., zero	6.0 (RTI)	Note: fill-pipe reductions calculated for these tests = 2.1

Data source	Unit type/ test conditions	Fillpipe emissions (a) (b)	P/V Valve emissions (c)	Calculated pressure - related fugitives (leaks) (d)	Total pressure - related emissions (e = c+d)	Total refueling emissions (f =b+c+d)	Excess emission due to ORVR incomp. (g)	ORVR emission reduction at fill pipe (h)	Adjusted excess emission due to ORVR incomp. (i)	VRS return line, HC conc, % (j)	Notes
API[4]	SHED Standard nozzle Non - ORVR	0.32									
	SHED Standard nozzle ORVR with recirc.	0.057									
	SHED Standard nozzle ORVR without recirc	0.007									
	SHED Standard nozzle ORVR Vehicle wgt avg. (calc)	0.045						0.275			
API[4]	SHED Mini-boot Non - ORVR	0.69									
	SHED Mini-boot ORVR with recirc	0.054									
	SHED Mini-boot ORVR without recirc	0.007									
	SHED Mini-boot ORVR Vehicle Wgt Avg. (calc)	0.041						0.649			Average for Standard & miniboot = 0.46 (91% less than non-ORVR)

Data source	Unit type/ test conditions	Fillpipe emissions (a) (b)	P/V Valve emissions (c)	Calculated pressure - related fugitives (leaks) (d)	Total pressure - related emissions (e = c+d)	Total refueling emissions (f =b+c+d)	Excess emission due to ORVR incomp. (g)	ORVR emission reduction at fill pipe (h)	Adjusted excess emission due to ORVR incomp. (i)	VRS return line, HC conc, % (j)	Notes
API [4]	SHED Vehicle 3 Non - ORVR	PUFF (n) 0.321									
	SHED Vehicle 1 ORVR with recirc	PUFF (n) 0.030									
	SHED Vehicle 2 ORVR without recirc	PUFF (n) 0..007									
API [4]	Vehicle 1: ORVR Certification	0.017 [0.008]									
API[4]	Vehicle 2: ORVR Certification	0.002 [0.001]									
	EPA Standard for ORVR	0.44 [0.20] (Includes spillage)									

Data source	Unit type/ test conditions	Fillpipe emissions (a) (b)	P/V Valve emissions (c)	Calculated pressure - related fugitives (leaks) (d)	Total pressure - related emissions (e = c+d)	Total refueling emissions (f =b+c+d)	Excess emission due to ORVR incomp. (g)	ORVR emission reduction at fill pipe (h)	Adjusted excess emission due to ORVR incomp. (i)	VRS return line, HC conc, % (j)	Notes

<u>NOTES</u>

a Refueling emissions = fill pipe displacement + spillage per EPA definition; spillage not addressed in these data
b Fill pipe emissions = fill pipe displacement emissions
c P/V vent emissions = emissions from UST vent pressure/vacuum valve
d Calculated pressure related (PR) fugitive emissions from VRS leaks per CARB calculation method
e Total pressure related emissions = P/V vent emissions + PR fugitives
f Total refueling emissions = total refueling emissions by CARB test method = Fill pipe displacement + P/V vent emissions + calculated PR fugitives (spillage estimated separately or by performance standard of nozzle?)
g Excess emissions due to ORVR incompatibility = total pressure related emissions for ORVR - total pressure related emissions for non-ORVR vehicles. Note: the API report refers to excess emissions of pressure-related fugitives separately from P/V emissions
h ORVR emission reductions at fill pipe = measured fill pipe displacement emissions for non-ORVR vehicles - measured fill pipe displacement emissions for ORVR vehicles
i Total adjusted excess emissions = pressure related excess emissions due to ORVR incompatibility - ORVR emissions reductions achieved at fill pipe
Note: the API report refers to this as "total incompatibility emissions"
j Average hydrocarbon concentration in the VRS return line.
k Weighted average of ORVR with and without recirculation; assumes 75% of ORVR vehicles have recirculation.
m Average of Phase 1 (in-field) tests and SHED tests
n PUFF = puff of emissions that occur when gas cap is removed; measured quantity normalized to gallons dispensed
p Measured values are from test simulation of 40 to 45% ORVR vehicles; calculated emissions factors are extrapolated; divide measured Gilbarco value by 0.45; divide measured Dresser Wayne value by 0.39 [CARB Enhanced Vapor recovery ISOR, February 2000, Appendix D; CARB Enhanced Vapor Recovery Technology Review, October 2002]
NA = Not Applicable
All emission units are lb/1000 gals dispensed or [g/gal] unless otherwise noted.

B. Data Provided by Stakeholders

Several stakeholders provided monitoring and testing data to assist us in understanding: (1) the sources of emissions at GDF, and (2) the impact UST pressure has on emissions at GDF. We received data from multiple States, GDF operators, and equipment vendors. We also received data for vehicle fueling operations at automobile manufacturing facilities. These data included:

- Balance Stage II VRS, with a P/V valve, with no UST add-on APCD;
- Balance Stage II VRS, without a P/V valve, with no UST add-on APCD;
- Vacuum assist Stage II VRS with and without an UST add-on APCD;
- Vacuum assist Stage II VRS with and without an P/V valve; and
- No Stage II VRS, with a P/V valve, and no UST add-on APCD (i.e., Stage I scenario).

We did not receive data for a scenario with:

- No Stage II VRS and no P/V valve; or
- For no Stage II VRS, with a P/V valve, and with an UST add-on APCD.

The data received are summarized below, including the testing scenarios, the test data, and related conclusions. Some data consisted primarily of parameter operating data and some data included emissions testing data as well. Each set of data provided information on one or more of the various emissions points from Stage II operations. Additional information is provided in Appendix A for each data set.

1. California GDF Testing, Site 1

The test was conducted to conclude whether an UST vent add-on APCD (i.e., a processor) would be necessary on a balance Stage II system to be compliant with the EVR UST pressure requirements (CP-201). The operating conditions of the GDF were monitored over a 36-day test period during February and March in California, and fuels with different RVP were in use over the time period. The February winter fuel had a RVP of 13 psi and the March fuel had a RVP of 9 psi. No emissions measurement testing was conducted. The GDF shuts down every night for 6 hours. The gasoline throughput was 41 percent to ORVR-equipped vehicles, and the percentage of ORVR-equipped vehicles was 42 percent.

Stage II balance VRS, with P/V valve, no UST vent add-on APCD.

The system was at negative pressure for the majority of the test period and remains at negative pressure for long periods. The system passed weekly pressure decay tests, indicating the system was vapor tight. There are few to no periods at 0 in. w.c. (significant time at 0 in. w.c. would indicate leaks). Some positive pressure periods were seen during the testing but the frequency, magnitude, and duration were low. During the 36-day testing period, the CARB daily average pressure limit and the daily hourly maximum pressure were exceeded on a few days; however, the 30-day rolling average pressure met the CARB limits. The data are summarized in Table 16. The test demonstrates that the balance system meets the pressure profile requirements of CARB's EVR CP-201, without the use of an UST add-on APCD (i.e., processor). In addition to meeting the CARB EVR pressure requirements, the UST pressure never exceeded 3 in. w.c. during the testing period, so the UST vent never opened. The V/L ratios for each fueling point over the 36-day period ranged from 0.71 to 1.0.

Additional analysis was conducted to compare the UST pressures for the two RVP. The analysis was conducted on a subset of data, specifically for those shut down hours when no fueling is being conducted at the GDF. For the shutdown periods only, the 30-day rolling daily average was 0.35 in. w.c. for RVP of 13 psi and was 0.055 in. w.c. for RVP of 9 psi. The 30-day rolling average hourly maximum pressure was 2.4 in. w.c. for RVP of 13 psi and was 0.51 in. w.c. for RVP of 9 psi.

Table 16. Pressure Data for Balance Stage II VRS Without an UST Add-on APCD

Parameter	Test period over February 1 through March 21, 2005	Exceeded, days	CARB limit	Based on RVP	
				High RVP (13 psi)	Low RVP (9 psi)
All Data [a]					
CARB daily average P, in. w.c.	+0.04	3	+0.25 in. w.c.	NA	NA
30-day rolling average hourly maximum P, in. w.c.	+0.32	2	+1.5 in. w.c.	NA	NA
Average V/L	Ranged from 0.71 to 1.0				
Calculated UST emissions from positive P periods	7 lb HC during testing period; extrapolated annually to 48 lb/yr.				
Subset of data					
For GDF shutdown periods only, daily average P, in. w.c.	NA	NA	NA	+0.35	+0.055
For GDF shutdown periods only, 30-day rolling average hourly maximum P	NA	NA	NA	+2.4	+0.51

[a] Minus data from 13 days (February 16-28) prior to failed leak decay test.

2. California GDF Testing, Site 2

This test was conducted to determine whether the ORVR-compatible vacuum assist Stage II VRS and an UST add-on APCD are EVR compliant. The UST add-on APCD is an expandable bladder that accepts vapor from the UST during positive pressure periods. The operating conditions of the GDF were monitored in January and August 2004. No emissions testing was conducted. The GDF shuts down each night. The percentage of ORVR vehicles is not known, although it should not matter for an ORVR-compatible system. The daily average V/L ratio at the two pumps for the January time period ranged from 0.95 to 1.1 over the test period. A summary of the operating data and possible emissions implications is shown in Table 17.

ORVR-compatible vacuum assist Stage II VRS, with P/V valve, without UST add-on APCD.

Without the add-on APCD (August 11-17 data), the UST pressures ranged from approximately -9 in. w.c. to +3 in. w.c. During operating hours when the GDF was dispensing fuel from the UST, the significant negative UST pressures were maintained. During nighttime hours when the GDF was closed and not operating, there was consistent pressure increase, indicating vapor growth. The pressures during off-hours were often above 0 in. w.c., indicating pressurization of the tank and possible fugitive emissions. The pressures rose to +3 in. w.c. on some nights, indicating P/V valve venting and UST vent emissions and UST fugitive emissions as well.

ORVR-compatible vacuum assist Stage II VRS, with P/V valve, with UST add-on APCD, and with a simulated fugitive leak.

With the add-on APCD and a simulated fugitive leak, pressures ranged from -8 in. w.c. to approximately 0 in. w.c. There were a few momentary spikes in pressure (as high as +4.5 in. w.c.) with return to 0 in. w.c. During overnight hours, there was consistent pressure increase, indicating vapor growth. There are minimal episodes above 0 in. w.c. because the UST is vented to the flexible bladder at +0.15 in. w.c. (If the Clean Air Separator was not in place, significant positive pressures could not be maintained due to the leak that was simulated during this testing scenario.) During operating hours, the UST pressures decreased to negative pressures, however, with the simulated leak, not as much vacuum was pulled on the UST (i.e., the pressures did not appear to be as negative as shown in the "tight" UST data above).

ORVR-compatible vacuum assist Stage II VRS, with P/V valve, and with UST add-on APCD.

With the UST add-on APCD, the pressure ranged from approximately -9 in. w.c. to just above 0 in. w.c. During operating hours when the GDF was dispensing fuel from the UST, the UST pressures decrease and significant negative pressures are maintained. During nighttime hours when the GDF would be closed and not operating, there was consistent pressure increase, indicating vapor growth. However, there were minimal episodes above 0 in. w.c. because the UST vents to the flexible bladder at +0.15 in. w.c.

Table 17. Pressure Data for ORVR-Compatible Vacuum Assist Stage II VRS

Parameter	Without add-on APCD	With add-on APCD and a simulated leak	With add-on APCD
Range	-9 to +3 in. w.c.	-8 to 0 in. w.c.	-9 to 0 in. w.c.
During operating/ fueling hours	Significant negative P	Negative P	Significant negative P
Overnight	Positive P overnight, sometimes > +3 in. w.c.	No positive P because vented to APCD at +0.15 in. w.c. (If the APCD were not in place, significant positive P would not occur due to the fugitive leak; emissions would occur from fugitive leaks rather than at the UST vent.)	No positive P because vented to APCD at +0.15 in. w.c.

Parameter	Without add-on APCD	With add-on APCD and a simulated leak	With add-on APCD
UST emissions	Significant fugitives, Significant vent emissions	No fugitives, No vent emissions (If the APCD were not in place, significant fugitives would occur, however, no vent emissions would be likely.)	No fugitives, No vent emissions

3. California GDF Testing, Site 3

This testing was conducted on a GDF in California with a balance Stage II VRS. The operating conditions of the GDF were monitored during a 7-day period in December. A total of 486 vehicle fuelings occurred and a total of 2,816 gal were dispensed during the test period. The vehicles fueled during the test period were 100 percent ORVR, and the GDF closes for 8 hours each day. The UST pressures ranged from approximately -2.6 in. w.c. to +0.15 in. w.c. over the 7-day period. The UST pressures seemed consistent with typical UST pressures for refueling, with higher pressures during nighttime hours when the GDF was closed (i.e., not dispensing fuel) and with negative pressures during operating hours (dispensing fuel). The UST pressures were less than or equal to 0 in. w.c. for 95 percent of the operating period, and were greater than 0 in. w.c. for 5 percent of the operating time.

The pressure data indicate that the balance Stage II VRS used to fuel ORVR vehicles is not likely to generate excess emissions from the UST due to ORVR refuelings (from incompatibility). Because the UST pressures are negative for the majority of the time, fugitive emissions and UST vent emissions may be minimized.

4. Florida GDF Testing, Site 1

The Florida Department of Environmental Protection (DEP) and we observed testing at a GDF with a vacuum assist Stage II VRS that had an installed add-on APCD on the UST vent. The UST add-on APCD is a membrane system that accepts gasoline vapors during periods of positive UST pressure and recovers and returns the gasoline vapors to the UST. These data are for Florida in February, UST temperature of 74°F, ambient T of 71°F, RVP of fuel of 11.1 psia, V/L ratio of 0.97, and a fueling rate of approximately 8 gal/min; the percentage of ORVR vehicles fueled is not known. The UST vent emissions testing was conducted for an approximately 24-hr period for each testing scenario including both daytime operating hours (i.e., refueling) and during nighttime hours when no refueling operations occurred (i.e., the GDF was closed). The emissions data for all scenarios are shown in Table 18.

Stage II VA VRS, no P/V valve, no UST add-on APCD.

The emissions rate from the UST vent is 3.48 lb/1,000 gal and 2.78 lb/hr.

Stage II VA VRS, with a P/V valve, no UST add-on APCD.

The emissions rate from the UST vent is 1.20 lb/1,000 gal and 0.95 lb/hr. UST pressures during this testing were at +3 in. w.c., so fugitive emissions were likely occurring. The UST system passed the leak decay test; a portable HC analyzer, however, showed that drain valve bucket leaks became prominent at a pressure of +2.7 in. w.c. These emissions data likely represent low values in that fugitive leaks were occurring with the P/V valve in place. An emissions reduction of 59.8 percent from uncontrolled UST vent levels could be calculated, however, addition of the fugitive emissions (not quantified for the testing) that are occurring to this vent emissions value would likely show little to no decrease in emissions rate over the uncontrolled levels shown above (no P/V valve, no UST add-on APCD).

Stage II VA VRS, with a P/V valve, with UST add-on APCD.

The emissions rate from the UST vent is 0.014 lb/1,000 gal and 0.0113 lb/hr. The UST vents to the add-on APCD when the UST pressure reaches +0.5 in. w.c.; at these pressures, there should be little to no fugitive emissions occurring. These data represent an emissions reduction of 99.3 percent from uncontrolled UST vent rates.

Table 18. Stage II VA VRS, with and without P/V Valve, with and without add-on APCD

Source	Uncontrolled System, [a] lbs/1,000 gal	Controlled System, [b] lbs/1,000 gal	Controlled System, [c] lbs/1,000 gal
UST vent emissions	3.48	1.20	0.014

[a] Uncontrolled scenario means: with Stage II VA VRS, no P/V valve, no UST add-on APCD (ORVR unknown).
[b] Controlled scenario means: with Stage II VA VRS, with P/V valve, no UST add-on APCD (ORVR unknown). This emissions data point does not include fugitive emissions that are occurring due to leaks in the UST system.
[c] Controlled scenario means: with Stage II VA VRS, with P/V valve, with UST add-on APCD (ORVR unknown).

5. Missouri GDF Testing, Site 1

The emissions levels from the vehicle refueling fillpipe/nozzle interface, the spillage emissions, and the UST vent breathing and fugitives are shown in Table 19. Uncontrolled emissions levels were determined from AP-42 emissions factors. These data are for ambient T of 75°F and RVP of 11.3 psi. The emissions were determined for two types of nozzles. The emissions testing was conducted in October in Missouri and the bench testing was conducted from June through March. (The fueling rates in gal/min are not available.) During the vehicle refueling testing, 77 vehicles were refueled at pump 9 and 76 vehicles were refueled at pump 10. Vehicle matrix data on the model year vehicle and the make are available. The number of ORVR vehicles is not known.

Table 19. Stage II Balance VRS, with P/V valve, no UST vent add-on APCD

Source	Uncontrolled System (without VRS), lbs/1,000 gal	Controlled Pump 9 Husky 5010 (V Short), lbs/1,000 gal	Controlled Pump 10 Husky 5210 (V Long), lbs/1,000 gal	Efficiency Relative to Uncontrolled System	
				Pump 9 Husky 5010 (V Short)	Pump 10 Husky 5210 (V Long)
Vehicle Fueling	14.6 [AP-42 EF equation]	0.64 [a] [emissions measurement]	0.63 [a] [emissions measurement]	95.6%	95.7%
Spillage/Pseudo-Spillage	0.46	0.083 [measured]	0.10 [measured]	82.0%	78.3%
Breathing (Pressure Related Fugitives from components such as P/V valves and nozzles)	1.00 [AP-42 EF]	0.16 [calculated]	0.16 [calculated]	84.0%	84.0%

[a] A portion of this value was due to evaporation of liquid droplets on the nozzle after completion of each fueling event and really belongs in the spillage/pseudospillage category.

6. Missouri GDF Testing, Site 2

The emissions levels from the vehicle/nozzle interface, the spillage emissions, and the UST vent breathing and fugitive emissions are shown in Table 20. The uncontrolled emissions levels were determined from AP-42 emissions factors. These data are for ambient T of 75°F and RVP of 12.76 psi. The emissions testing was conducted in October and the bench testing was conducted from May through December. During the vehicle refueling testing, a total of 205 vehicles were refueled. Approximately 5 of these were ORVR vehicles (which reflected the actual ORVR percentage of the vehicle fleet at that time, 2.4 percent). The fueling rate in gal/min is not available. Vehicle matrix data on the model year vehicle and the make are available.

Table 20. Stage II Balance VRS, with P/V valve, no UST vent add-on APCD

Source	Uncontrolled System (without VRS), Lbs/1,000 gal	Balance VRS, lbs/1,000 gal	Efficiency Relative to Uncontrolled System
Vehicle Fueling	14.6 [AP-42 EF equation]	0.79 [emissions measurement]	95.2%
Spillage/Pseudo-Spillage	0.46	0.02 [measured]	97.8%
Breathing (Pressure Related Fugitives from components such as P/V valves and nozzles)	1.00 [AP-42 EF]	0.06 [calculated]	94.0%

7. Missouri Automobile Manufacturer GDF Testing, Site 3

The emissions levels from the vehicle fueling fillpipe/nozzle interface, the spillage emissions, and the UST vent breathing and fugitives are shown in Table 21. Emissions testing was conducted to measure the uncontrolled emissions levels for vehicle fueling; the testing was conducted in March with ambient T of 72°F and filling rate of 6 to 9 gal/min (assumed RVP of 11.99 psi). The uncontrolled spillage and breathing losses were determined from AP-42 emissions factors and CARB EFs. The controlled emissions levels for vehicle fueling were determined by emissions testing in March with chilled gasoline at 50°F and a filling rate of 6 gal/min (assumed RVP of 11.99 psi). The testing for continuous pressure and temperature was conducted from September through December, and the bench testing was conducted in February, September, and December. All of the vehicles were ORVR, with a single canister design. (Some data are also available for dual canister ORVR at this site but are not shown here.)

In addition to the emissions testing, T and P operating data for the UST are available for a 103-day period and a summary of the data is shown in Table 22. Typical weekday pressures show increasing pressures, indicating vapor growth, for overnight periods and negative pressures during daytime fueling operations. Typical weekend day pressures showed positive pressures for day and night periods. The UST pressures were greater than 0 in. w.c. for 29.6 percent of the test period (pressure-related fugitives are likely occurring) and were greater than +3.0 in. w.c. for 4.2 percent of the testing period (UST vent emissions are likely occurring). A leak was fixed on day 72 of the test. Another analysis of the pressure data was conducted for the time period before and after the leak. The tank maintains negative pressures for longer periods after the leak is fixed (48 percent of the time) than before (19 percent). In addition to maintaining negative pressures, the UST will also "better" maintain positive pressures after the leak is fixed; UST vent emissions are more likely to occur in a tight system, in place of UST fugitive emissions that occur in leaking systems. Because the UST at automobile manufacturing facilities have longer vapor growth periods, the UST emissions from these operations may be higher than would typically be seen at a traditional GDF.

Table 21. No Stage II VRS, with a P/V valve, no UST vent add-on APCD

Source	Uncontrolled System [a] [in MY2001/2002 mockup tanks] lbs/1,000 gal	Controlled [b] MY2003 - mockup, lbs/1,000 gal	Efficiency Relative to Uncontrolled System
Vehicle Fueling	17.6 [emissions measurement]	0.0779 [emissions measurement]	99.6%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.48 [measured]	36.0%
Breathing (Pressure Related Fugitives) - UST emissions - fugitives	1.0 [modified AP-42 equation]	0.24 [calculated based on P, T, time]	76.0%

[a] Uncontrolled scenario means: No chilling, no ORVR, no Stage II VRS, w/ P/V valve [some vapor return from a s fueling area balance nozzle, but this has a small impact because small gasoline throughput].
[b] Controlled scenario means: with Chilling, with ORVR single, and No Stage II VRS.

Table 22. Analysis of Frequency Plots for UST Pressure for All Data and Before/After Fixing the Leak

Pressure ranges, in. w.c.	All data		Before leak is fixed		After leak is fixed	
	minutes	%	minutes	%	minutes	%
< -8.0	40,809	27.9%	19,680	19.2%	21,129	48.3%
-8.0 < P < 0.0	62,137	42.5%	50,166	48.9%	11,971	27.4%
<0.0	102,946	70.4%	69,846	68.1%	33,100	75.7%
>0.0	43,265	29.6%	32,651	31.9%	10,614	24.3%
>3.5	6,249	4.27%	4,184	4.08%	2,065	4.72%

8. Missouri Automobile Manufacturing GDF, Site 4

The emissions levels from the vehicle fueling fillpipe/nozzle interface, the spillage emissions, and the UST vent breathing and fugitives are shown in Table 23. Emissions testing was conducted to measure the uncontrolled emissions levels for vehicle fueling; the testing was conducted in March with ambient T of 72°F and filling rate of 8 gal/min (assumed RVP of 11.99 psi). The uncontrolled spillage and breathing losses were determined from AP-42 emissions factors and CARB EFs. The controlled emissions levels for vehicle fueling were determined by emissions testing in March with chilled gasoline at 43°F and with a filling rate of 8 gal/min (assumed RVP of 11.99 psi). The testing for continuous pressure and temperature was conducted in October and November, and the bench testing was conducted in August, September, and December. All of the (controlled) assembly line vehicles and the uncontrolled mockup tanks were ORVR (dual), and the controlled mockups for the MY2004 were ORVR (single).

Table 23. No Stage II VRS, with a P/V valve, no UST vent add-on APCD

Source	Uncontrolled System [a] MY2003 mockup tanks lbs/1,000 gal	Controlled MY2003 [b] assembly line, dual canister, lbs/1,000 gal	Efficiency Relative to Uncontrolled System	Controlled MY2004 [b] mockup tanks, single canister, lbs/1,000 gal	Efficiency Relative to Uncontrolled System
Vehicle Fueling	13.5 [emissions measurement]	0.0118 [emissions measurement]	99.9%	0.0033 [emissions measurement]	greater than 99.9%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.063 [measured]	91.6%	same	same
Breathing (Pressure Related Fugitives) - UST emissions - fugitives	2.09 [modified AP-42 EF]	0.267 [calculation based on P, T, time]	87.2%	same	Same

[a] Uncontrolled scenario means: No chilling of gasoline, no ORVR, no Stage II VRS, and with P/V valve.
[b] Controlled scenario means: With chilling of gasoline, with ORVR, No Stage II VRS, with P/V valve, and with purge puff nozzle.

UST Operating Data for No Stage II VRS and with P/V valve.

Some typical UST operating pressure data are shown in Table 24. The pressure data show a pattern of high vacuum during production operations on weekdays (i.e., fueling) and higher pressures close to or at the cracking pressure of the P/V valves during off times (overnight and weekends). Because the UST at automobile manufacturing facilities have longer vapor growth period, the UST emissions from these operations may be higher than would typically be seen at a traditional GDF.

Table 24. Summary of Weekday and Weekend UST Vent Pressures (No Stage II VRS, with P/V valve)

Pressure, psi	Friday, 11/08		Saturday, 11/09		Sunday, 11/10		Monday, 11/11		Tuesday, 11/12		Wednesday, 11/13		Thursday, 11/14	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Minimum	-9.29	-10.62	-9.12	-10.48	1.26	1.19	-9.16	-10.72	-9.25	-10.65	-9.23	-10.58	NA	NA
Maximum	3.37	3.30	3.40	3.35	3.32	3.22	3.36	3.34	3.39	3.38	3.63	3.58	3.59	3.51
Average	-6.10	-6.87	1.80	1.62	2.58	2.49	-5.27	-5.90	-6.59	-7.33	-5.81	-6.43	-15.44	-11.17
Pressure, psi	**Friday, 11/15**		**Saturday, 11/16**		**Sunday, 11/17**		**Monday, 11/18**							
	N	**S**	**N**	**S**	**N**	**S**	**N**	**S**						
Minimum	-9.06	-10.47	1.60	1.52	2.27	2.26	-9.29	-10.77						
Maximum	3.38	3.35	3.12	3.06	3.04	3.03	3.06	3.03						
Average	1.58	1.44	2.64	2.59	2.79	2.76	-5.08	-5.77						

Note: Data are provided for pressure gauges at both the north and south ends of the UST.

9. New Hampshire GDF Data

The NH DES monitored approximately 300 GDF in New Hampshire to determine the extent of groundwater pollution with MTBE. The GDF that were monitored included a number of different control types, including balance and vacuum assist Stage II VRS, and some GDF without Stage II VRS controls. The groundwater monitoring data show that a number of the GDF have detectable levels of MTBE and a number have exceeded the groundwater limit. With the MTBE limit for groundwater at 13 ppb, approximately 88 GDF exceeded the limit. Of these 88 GDF, 51 are confirmed to be vacuum assist Stage II VRS that are not ORVR compatible. The last MTBE concentration readings for those GDF that exceeded the limit ranged from 18 to 1,110,000 ppb.

10. Multi-State GDF Data

Testing for multiple GDF with Stage II VRS controls was conducted in 17 States over a 15-month period. Testing included pressure decay tests (static pressure performance test), dynamic backpressure tests, and A/L ratio testing. A total of 7,514 pressure decay tests were conducted over this time period in the 17 States. Of these pressure decay tests, approximately 19 percent failed, and the failure rate from State to State ranged from 0 percent (only 2 GDF were tested) to 29 percent. These failures occurred despite retesting following maintenance attempts by the test technician to repair tank fittings, dispenser fittings, and hanging hardware while onsite when a GDF failed an initial try.

A number of dynamic backpressure tests were conducted, with 3,974 tests on the gasoline (wet) side and 3,916 on the vapor (dry) side. These tests check for any blockage in the gasoline or vapor piping or hoses. Overall, approximately 6.5 percent of the wet backpressure tests were failures (ranging from 0 to 33 percent from State to State) and 3.4 percent of the dry backpressure tests were failures (ranges from 0 to 25 percent).

There were 4,313 A/L ratio tests summarized in the data. Approximately 27 percent of the tests were failures; these tests are considered to be failures if even one fueling point at the GDF fails and cannot be repaired by the technician or if a fueling point is out of order when the test is conducted. All fueling points must be working properly to pass the test.

A summary of the testing and the failure rates by States is provided in Table 25. Information on the frequency requirements for specific tests is also provided. There is much variability in the failure rate from State to State and also from test type within a single State.

Table 25. Stage II VRS Testing and Failure Rates by State

State	PD Test Pressure, in. w.c.	Pressure decay tests			Backpressure tests			Backpressure tests			A/L ratio tests			Test Frequency
		Tests	Fails [a]	Fail, %	WetB Tests	WetB Fails [b]	Fail ,%	DryB Tests	DryB Fails [b]	Fail ,%	Tests	Fails [c]	Fail ,%	
CT	**10**	180	34	19	143	5	4	143	3	2	54	22	41	Every 3 years (changed from every 5 years on 7/26/04, A/L not required before this date)
DC	**2**	60	6	10	46	1	2	46	–	–	70	30	43	Annual (Vac-assist), 5 years balance
DE	**10**	115	14	12	50	4	8	49	–	–	106	33	31	Annual all tests
FL	**2**	92	8	9	60	2	3	60	2	3	51	2	4	PD & A/L Annual, blockage every 2 years in Miami-Dade and every 5 years in Broward
MA	**10**	1,268	115	9	678	18	3	680	9	1	1,029	248	24	PD & A/L annual for all systems, wet/dry blockage every 3 years for all systems
MD	**2**	723	142	20	71	8	11	71	5	7	621	211	34	PD & A/L annual for all systems, dry blockage annual for balance, wet blockage every 5 years for all systems
ME	**10**	28	5	18	3	1	33	3	–	–	24	7	29	PD & A/L Annual for vac-assist, blockage every 5 years, PD and Blockage every 5 years for balance
NC	**10**	2	–	–	2	–	–	2	–	–	–	–	–	PD & Blockage every 5 years
NH	**10**	67	8	12	56	1	2	56	1	2	44	15	34	Every 3 years all tests
NJ	**2**	2,496	672	27	1,533	113	7	1,532	52	3	606	153	25	PD & A/L annual for all systems, wet/dry blockage every 3 years for all systems (PD changed from every 5 years to annual last year)
NY	**10**	914	223	24	731	64	9	732	35	5	279	93	33	PD & B Every 5 years (No A/L requirement)
OH	**2**	131	8	6	64	–	–	4	1	25	157	27	17	PD & A/L annual for all systems, wet/dry blockage every 5 years for all systems
PA	**2**	1,039	128	12	378	29	8	379	20	5	1,019	251	25	PD & A/L Annual for vac-assist, blockage every 5 years, PD and Blockage every 5 years for balance
RI	**10**	155	16	10	76	5	7	76	1	1	157	51	33	PD & A/L annual for all systems, wet blockage every 3 years for all systems
SC		2	–	–	–	–	–	–	–	–	–	–	–	No requirements
VA	**2**	231	67	29	82	8	10	82	6	7	95	33	35	PD & Blockage every 5 years for all systems (A/L at discretion of agency)

State	PD Test Pressure, in. w.c.	Pressure decay tests			Backpressure tests			Backpressure tests			A/L ratio tests			Test Frequency
		Tests	Fails [a]	Fail, %	WetB Tests	WetB Fails [b]	Fail ,%	DryB Tests	DryB Fails [b]	Fail ,%	Tests	Fails [c]	Fail ,%	
VT	**10**	11	–	–	1	–	–	1	–	–	1	–	–	PD & A/L every 5 years for all systems, wet/dry blockage for every 5 years for balance only
Total		7,514	1,446	19.2%	3,974	259	6.52%	3,916	135	3.45%	4,313	1,176	27.3%	
				Avg			Avg			Avg			Avg	

[a] Pressure decay failures are considered failures after all attempts have been made by the technician to repair.
[b] Blockage failures are underground blockage failures.
[c] A/L failures are considered failures if even one fueling point at the site fails and cannot be repaired.The only time A/L is considered a pass is when all fueling points are working properly at the time of the test.

11. Vermont GDF Data

Testing was conducted at 32 GDF to determine how well in-use GDF systems maintain compliance with performance standards and the level of effort required to bring GDF back into compliance. Nineteen percent of GDF were balance and 81 percent were various types of VA VRS. No recent maintenance had been conducted at these facilities. Testing included (1) pressure decay tests, (2) A/L ratio test for VA VRS, and (3) vacuum line integrity test for GDF with a central vacuum pump. Testing was conducted on an "as is" basis, i.e., without any maintenance being conducted prior to testing. The technicians also tracked the amount of effort to bring each GDF into compliance. The conclusions from these data are that a significant number of GDF will fail pressure decay testing without ongoing maintenance. Another conclusion is that the majority of GDF do meet the A/L ratio requirements.

Pressure decay tests.

A total of 90 USTs, 128 gasoline dispensers, and 360 gasoline nozzles were included in the testing. Fill caps and Stage I poppet valves were the equipment components involved in failure of the pressure decay test; the balance nozzles contributed to the failure at all of the balance VRS GDF. Twelve percent of the fill caps, 27 percent of Stage I poppet valves, and 23 percent of balance nozzles were found to be leaking. Data on the pressure decay tests is provided in Tables 26 through 29.

Table 26. Initial Pressure Decay Test Results

Subset of GDF	No. of GDF (percentage)	No. Pass (percentage)	No. Fail (percentage)
All stations	31 (100%)	10 (32%)	21 (68%)
VA	25 (81%)	10 (40%)	15 (60%)
Balance	6 (19%)	0 (0%)	6 (100%)

Table 27. Margin by Which Pressure Decay Test Failed

Pass/Fail description	Percent of total stations
Pass – Within Allowed Leak Rate	32
Fail – Up to 10% Above Allowed Leak Rate	26
Fail – Between 10% and 50% Above Allowed Leak Rate	13
Fail – Greater than 50% Above Allowed Leak Rate	29

Table 28. Equipment Problems that Contributed to Pressure Decay Test Failure

Part	Percent of Failing Stations Where Component Was a Factor [a]
Fill Cap	41
Stage I Poppet Valves	41
Fill Adaptor	32
Spill Bucket Drain Valve	27
Nozzle [b]	27
Breakaway	14
In-Tank Monitor	5
Submersible Pump	5

[a] At most GDF, more than one component contributed to failure, therefore, percentages do not add to 100 percent.
[b] Nozzles were a contributing factor only at balance stations.

Table 29. Parts Found Leaking During Pressure Decay Tests

Part	Number Leaking	% Leaking, Out of Total Number Tested
Fill Cap	11	12
Stage I Poppet Valve	15	27
Fill Adaptor	9	10
Spill Bucket Drain Valve	12	not determined
Balance System Nozzle	13	23
Breakaway	3	<1
In-Tank Monitor	3	not determined
Submersible Pump	1	1

Vacuum Line Integrity Test.

Vacuum line integrity testing was performed at two GDF with VA VRS that had a central vacuum source. Both GDF passed this test on the initial attempt.

A/L Ratios.

A/L ratio tests were performed at 26 VA VRS GDF and involved testing of 298 nozzles. The majority of nozzles passed the A/L ratio testing. Most nozzles that failed did so with a small margin. Information on the A/L ratio testing is provided in Table 30.

Table 30. A/L Ratio Testing Results

Status	Percent of Nozzles			
	WayneVac	Gilbarco Vapor Vac	Healy	Franklin Intellivac
Within Allowable Range	85	94	92	100
Fail– Within 10% of Allowable Range	11	4	4	0
Fail– Between 10% and 50% of Allowable Range	2	2	4	0
Fail– Greater than 50% of Allowable Range	2	0	0	0

Number of GDF Tested: WayneVac = 15 (186 nozzles); Gilbarco VaporVac = 8 (48 nozzles); Healy = 2 (56 nozzles); Franklin = 1 (8 nozzles).

Required Effort to Attain Compliance.

Following test failures, the testing technician conducted repairs, adjusted equipment, and replaced broken or worn components. For more than 50 percent of the components, minor maintenance such as tightening was sufficient to stop leaks. At 6 of 21 GDF, tightening of parts or other adjustments was sufficient to pass the pressure decay test; at 15 of 21 GDF, replacement of one or more parts was required.

For the A/L ratio failures, adjustment of the vacuum motor or replacement of nozzles resolved most problems.

Overall, replacement parts at 19 GDF cost $6,315 ($332/GDF).

12. EPA's Initial In-Use Evaporative Testing of ORVR Vehicles

Two-day evaporative testing was conducted on a total of 32 ORVR vehicles of various ages. The odometer readings ranged from 6,800 to 190,000 miles, with an average of 45,000 miles per vehicle. Of the 32 vehicles testing, 28 passed the evaporative testing, indicating an 88 percent pass rate. While these evaporative system tests do not provide information specifically on the control efficiency of ORVR canisters, these tests do provide data indicating that most ORVR systems are operating correctly.

13. EPA's IUVP

The latest EPA data from the IUVP includes testing on a total of 151 ORVR-equipped vehicles, using FTPs for the outlet of the ORVR canister. Overall, 9.3 percent of the ORVR-equipped vehicles (14 out of 151) had canister emissions greater than the 0.2 g/gal limit. An analysis of the data with respect to high mileage versus low mileage vehicles was also conducted. Of the high-mileage vehicles, 13 percent (6 out of 47) had emissions greater than the 0.2 g/gal limit. Of the low-mileage vehicles, 7.7 percent (8 out of 104) had emissions greater than the 0.2 g/gal limit. These results are presented in Table 31.

Table 31. EPA IUVP Test Results

Test Result	Overall		Low Mileage		High Mileage	
	Number	Percentage	Number	Percentage	Number	Percentage
< 0.2 g/gal	137	91%	96	92%	41	87%
> 0.2 g/gal	14	9.3%	8	7.7%	6	13%
Total	151	100%	104	100%	47	100

B. Other Data Found within Literature

1. WSPA – UST vent emissions

This study measured VOC emissions from the UST vent and determined the effect of tank capacity and P/V valves on emissions levels. Conclusions drawn (by the authors of the study) from this testing indicated that the UST vent emissions are not directly correlated to the UST capacity, the product throughput, or the ambient T and P. It was also concluded from these emissions data that working losses compared to breathing losses are a small part of total UST vent emissions.

Stage II balance VRS, without a P/V valve, no UST vent add-on APCD.

The emissions level from the UST vent is 0.083 lb/1,000 gal. The ambient T, RVP of the fuel, and the fueling rate are not known. There were no ORVR vehicles refueled during the testing (conducted prior to ORVR implementation).

Stage II balance VRS, with P/V valve, no UST vent add-on APCD.

The emissions level from the UST vent is 0.024 lb/1,000 gal. (Same scenario discussed in the previous paragraph.)

2. ORS Pilot Study

This pilot study was conducted to evaluate optical remote sensing (ORS) technology for determining emissions factors. The study was conducted over a 3-day period at a retail gasoline outlet (RGO) with no Stage II VRS and without P/V valves. Both open-path Fourier transform infrared (OP-FTIR) and open-path ultraviolet (OP-UV) systems were used to determine gasoline vapors, benzene, and toluene and these values were compared to the AP-42 emissions factors. A vehicle refueling emissions factor and a total emissions factor (including fugitive and vehicle refueling emissions from ground level and vent pipes from elevated releases) were measured and calculated and are shown in Table 32.

The study showed that both OP-FTIR and OP-UV systems detected emissions from vehicle fueling, UST vents, and fugitive emissions. In comparing the emissions to the AP-42 emissions factors, the OP-FTIR determined vehicle refueling emissions factors were higher. The study suggested that the results may be site-specific and conclusions may not be applicable to other RGO facilities.

Table 32. Optical Remote Sensing at an RGO with No Stage II VRS and No P/V Valve

Source	Measured Emissions Factor	Emissions Factor Based on AP-42 Equation
Vehicle Fueling, no Stage II VRS, OP-FTIR (F1)	0.16% ± 0.05%, mass percent [a]	0.11% (using generic T and RVP) 0.12% ± 0.02% (using UST T for dispensed fuel T and using ambient T for vehicle tank fuel)
Vehicle Fueling, no Stage II VRS, OP-FTIR (F2)	0.15% ± 0.03%, mass percent [a]	0.11% (using generic T and RVP) 0.12% ± 0.02% (using UST T for dispensed fuel T and using ambient T for vehicle tank fuel)
Average Total Emissions Factor, OP-FTIR (F1)	0.32% [a]	–
Average Total Emissions Factor, OP-FTIR (F2)	0.35% [a]	–

[a] Compares average mass of vapors emitted (kg emitted) to the average mass of gasoline dispensed (kg dispensed).

C. Planned Testing

1. Florida GDF Testing, Site 2

The Florida Department of Environmental Protection (Florida DEP) is planning testing at a station with no Stage II VRS. The Florida DEP contact indicates that this testing is to occur in the Fall of 2005. The station has installed ARID's Permeator system in lieu of Stage II VRS and has requested a variance for 24 months or until Stage II VRS is no longer required, whichever is earlier. EPA may observe some of the testing and obtain additional data to address some of the Stage II VRS issues.

2. Hertz Testing, Rental Car Facilities

Hertz believes that because their vehicle fleet is almost entirely comprised of vehicles with ORVR equipment and because maintaining Stage II VRS is redundant, removal of Stage II VRS at their facilities would not result in an increase in VOC emissions. To demonstrate this, Hertz is considering testing of emissions from the fillpipe and UST vent using the CARB TP-201.2 test protocol. During the testing, Hertz will also collect data on UST system leak tightness and/or tank pressure. Hertz is considering testing at a vacuum assist Stage II VRS station without an UST add-on APCD, at a vapor balance Stage II VRS station without an UST add-on APCD, and at a station with no Stage II VRS. Data from these tests would address some of the current data gaps.

3. New Hampshire GDF Testing

[*Editorial note – the New Hampshire testing described in this section has been canceled due to scheduling and funding issues.*]

The NH DES, the UNH, GVR, and EPA plan to conduct testing at a GDF in New Hampshire beginning in January and continuing through April 2006. The GDF has a vacuum assist Stage II VRS in place and will have an ISD system installed at the site. There are 3 gasoline UST and one diesel UST at the facility. Testing will be conducted for two scenarios.

The first (baseline) will be testing of the Stage II VRS currently in place, and the second scenario (follow-up) will involve conversion to an ORVR-compatible Stage II VRS by installing the Healy EVR Phase II system. The GDF site is subject to the NH DES Groundwater Management Permit (GMP) program to monitor petroleum discharges that are believed to have occurred at the site. The facility is required to monitor three times per year for a number of specific VOCs and static water elevations at eight on-site and two off-site monitoring wells. MTBE and TAME have been the major contaminants at the site. ORS systems will be used to measure emissions from vehicle refueling, UST vents, and fugitives. The objectives of the emissions testing include:

- Obtaining OP-FTIR measurements for aliphatic compounds, such as methanol, ethanol, MTBE, and other HAP;
- Obtaining UV-DOAS measurements for benzene, toluene, ethylene, and xylenes (BTEX) compounds;
- Calculating emissions fluxes downwind from major hot spots;
- Identifying major hot spots by generating surface concentration maps in the horizontal plane; and
- Obtaining more sensitive measurements of aromatic HC across identified hot spots.

4. Arizona GDF Testing

In collaboration with the Salt River Pima Maricopa Indian Community, we conducted ORS testing at two GDF in Arizona in October 2005 to measure emissions from vehicle refueling, UST vents, and fugitives.. One GDF has no Stage II VRS and the other has a vacuum assist Stage II VRS. The objectives of these emissions tests are the same as those mentioned above for the New Hampshire testing. Results are being summarized.

VII. NESCAUM Widespread Use Study

As previously discussed in this paper, there are four possible definitions being considered for defining widespread use of ORVR. Definition (a) (percentage of ORVR-equipped vehicles) is based on vehicle registration data, projections of that data into the future, and the phase-in schedule for ORVR. Definition (b) (percentage of VMT by ORVR-equipped vehicles) is based on all of the data inputs for definition (a) plus the VMT data by class of vehicle. Definition (c) (VOC emissions with ORVR controls equal VOC emissions with Stage II VRS only) requires comparison of calculated vehicle refueling emissions based on two different refueling control measures. This definition requires the data inputs for definitions (a) and (b) along with data on ambient temperature, RVP, rule effectiveness, rule penetration, and the percentage of GDF with vacuum assist Stage II VRS (to determine incompatibility excess emissions). Definition (d) (gasoline dispensed to ORVR-equipped vehicles) requires data on the volume of gasoline sold in addition to the data inputs needed for definition (b).

The EPA used data provided by NESCAUM from three states (Massachusetts, New Hampshire, and Vermont) to calculate widespread use for each potential definition. The algorithms are based on MOBILE6 data/equations. This section summarizes the calculation results for determining the widespread use date for each potential widespread use definition.

A. Methodology for Determining Widespread Use

Algorithms used for calculating widespread use are based on MOBILE6 equations, with the addition of an IEE factor for ORVR-equipped vehicles refueling at GDF equipped with vacuum assist Stage II VRS.[59] An IEE factor of 0.86 lb/1,000 gal (based on CARB's findings) was used for calculation purposes. The algorithms calculated VOC emissions for a summer day in a given calendar year (CY) for all gasoline vehicle types under the following control scenarios:

1. Emissions from Stage II VRS only, without ORVR,
2. Emissions from ORVR only, without Stage II VRS,
3. Emissions from compatible Stage II VRS and ORVR, and
4. Emissions from incompatible Stage II VRS and ORVR.

Equations based on MOBILE6 were also used to calculate the percentage of VMT from ORVR-equipped vehicles in a given CY and to calculate the percentage of gasoline dispensed to ORVR-equipped vehicles in a given CY.

MOBILE6 refueling emissions factors have two components. The first component is for vapor displacement and the second is for spillage. The uncontrolled vapor displacement emissions factor and spillage emissions factor for vehicle refueling are used in all calculation scenarios. The uncontrolled vapor displacement emissions factor is area-specific in the sense it accounts for ambient temperature and gasoline volatility or Reid Vapor Pressure (RVP), which are inputs to the MOBILE6 model. An uncontrolled spillage emissions factor of 0.31 grams per gallon is used in all calculations [MOBILE6 applies a 50 percent control level to spillage for ORVR]; this value is consistent with the value presented in AP-42 (Chapter 5.2 Transportation and Marketing of Petroleum Liquids). Algorithm equations are presented in Appendix B - NESCAUM Widespread Use Study Supporting Documentation, along with a description of each equation. Appendix B also contains the calculation spreadsheets.

B. NESCAUM Provided Data

NESCAUM provided EPA with data from three states to aid in analysis and comparison of the widespread use dates determined for each potential widespread use definition. NESCAUM was asked to supply the following data for each state:

- Stage II VRS In-use Control Efficiency (CE);
- Ambient Temperature Data (used to calculate refueling emissions);
- In-use RVP of the gasoline used during the summer ozone season, and whether the gasoline was RFG;
- Total gasoline usage, gallons/yr for the most recent available CYs and for those years that the states have projected data;

[59] API commissioned Tech Environmental to develop a spreadsheet to reproduce data from the MOBILE6 that includes IEE from ORVR-equipped vehicles and vacuum assist Stage II VRS.

- Percentage of GDFs equipped with balance Stage II VRS, and percentage of GDFs equipped with vacuum assist Stage II VRS, and percentage of GDFs equipped with balance Stage II VRS and Stage I (indicate the percentage of Stage I GDFs not equipped with P/V valves);
- Percentage of GDFs equipped with Stage I, but not equipped with Stage II, and the percentage of Stage I GDFs not equipped with P/V valves;
- Expected percentages of balance and vacuum assist for new VRS installations (i.e., x percent of new VRS installations will be balance systems; y percent of new VRS installations will be vacuum assist);
- Vehicle distribution data by vehicle type and age;
- Vehicle mileage accumulation data;
- Vehicle miles traveled (VMT) data;
- Diesel sales fraction data;
- Vehicle fuel economy data;
- Alternatively-Fueled Vehicle (AFV) penetration data; and
- Anti-Tampering Program data.

If the state was unable to provide area specific data, EPA used MOBILE6 default values, which are based on national averages. Table 33 summarizes the data collected from each state and indicates which MOBILE6 default values were used in the algorithms for determining widespread use.

Table 33. Data Provided by NESCAUM

Requested Data	**Provided Data Or MOBILE6 Defaults Used**		
	Massachusetts	**New Hampshire**	**Vermont**
Stage II VRS CE	✓	✓	✓
Ambient Temperature Data	✓	✓	✓
In-use RVP of the gasoline used during the summer ozone season, and indicate if the gasoline is RFG	✓	✓	✓
Total gasoline usage, gallons/yr for the most recent available CYs and for those years that the states have projected data	✓	✓	✓
Percentage of GDFs equipped with balance Stage II VRS	✓	✓	✓
Percentage of GDFs equipped with vacuum assist Stage II VRS	✓	✓	✓
Percentage of GDFs not equipped with Stage II VRS, but equipped with Stage I. Also indicate the percentage of Stage I GDFs not equipped with P/V valves	✓	✓	✓

Requested Data	Provided Data Or MOBILE6 Defaults Used		
	Massachusetts	New Hampshire	Vermont
Percentage of GDFs equipped with balance Stage II VRS and Stage I. Also indicated the percentage of Stage I GDFs not equipped with P/V valves	✓	✓	✓
Vehicle distribution data by vehicle type and age	✓	✓	Defaults
Vehicle mileage accumulation data	Defaults	Defaults	Defaults
Vehicle miles traveled (VMT) for the most recent calendar year and any years where projected data are available	✓	✓	✓
VMT fractional mix (represents the fraction of total highway VMT accumulated by each vehicle type)	Defaults	✓	Defaults
Diesel sales fraction data	✓	Defaults	Defaults
Vehicle fuel economy data	Defaults	Defaults	Defaults
Anti-Tampering Program data	✓	✓	✓

✓ Denotes that data provided by the State was used in the analysis.

C. Results of Widespread Use Analysis

A widespread use date for definitions (a), (b), (c), and (d) were determined for each state. A variation of definition (c) was also considered in the analysis of widespread use dates. API suggested that definition (c) needed to be modified to clearly identify the date at which there would be no emissions increase as a result of removing Stage II VRS.[60] Specifically, the modified definition (c), referred to as definition (c2), is when the total VOC emissions from ORVR-equipped vehicles are equal to or less than the total VOC emissions from Stage II VRS and ORVR, including IEE. The input values for key parameters (except vehicle mix) provided by the three states and used for the analysis are summarized in Table 34.

Table 34. Values for Key Parameters

Parameter	MA	NH	VT
Stage II VRS in-use Control Efficiency, %	84	68.6	62.4
Minimum Ambient Temperature, °F	60.9 [a]	62 [b]	59.9 [a]
Maximum Ambient Temperature, °F	79.4 [a]	92 [b]	81.2 [a]
RVP, psi	6.8 (RFG)	6.8 (RFG)	8.5
Percent of VRS that are Balance, %	41	20.4	10
Percent of VRS that are Vacuum Assist, %	59	79.6	90

[a] Average summer day.
[b] Probably minimum, maximum (not average).

[60] Memorandum from T. Tamura, STI, to P. Searles, API. March 3, 2005. Onboard refueling vapor recovery (ORVR) systems – proposed definitions of “widespread use.”

Table 35 summarizes the results of the analysis. Based on the assumptions for this analysis and applying the emissions-based calculations [definitions (c) and (c2)], widespread use occurs within the 7-yr window of 2008 to 2015. Using the definitions based on the percentage of VMT by ORVR-equipped vehicles and the percentage of fuel dispensed to ORVR-equipped vehicles [definitions (b) and (d)] and the criterion of 85 to 90 percent, widespread use occurs within the 5-year window of 2011 to 2016.

Table 35. Summary of Algorithm Analysis

Definition	Description	MA WSU Date	NH WSU Date	VT WSU Date
(a)	85% of fleet with ORVR			2015
	90% of fleet with ORVR			2017
	95% of fleet with ORVR			2023
(b)	85% of VMT from ORVR-equipped vehicles	2011	2012	2013
	90% of VMT from ORVR-equipped vehicles	2012	2013	2015
	95% of VMT from ORVR-equipped vehicles	2015	2016	2019
(c)	Emissions from ORVR only are equal to emissions from Stage II only	2010	2008	2008
(c2)	Emissions from ORVR-equipped vehicles are equal to or less than the total emissions from Stage II VRS and ORVR, including IEE	2013	2013	2015
(d)	85% of gasoline dispensed to ORVR-equipped vehicles	2011	2012	2013
	90% of gasoline dispensed to ORVR-equipped vehicles	2013	2014	2016
	95% of gasoline dispensed to ORVR-equipped vehicles	2016	2018	2021

As previously mentioned, if Stage II VRS is removed when the ORVR only emissions are equivalent to the Stage II VRS emissions [definition (c)], an increase in emissions from the level achieved with both ORVR and Stage II VRS controls will occur. The results from this analysis indicate that for the year widespread use is achieved this increase would be:

State	Year	Increase, tpsd
MA	2010	2.0
NH	2008	1.0
VT	2008	0.6

As the penetration of ORVR-equipped vehicles increases, this difference in emissions between ORVR only and ORVR with Stage II and IEE decreases rapidly with each ensuing year, as indicated in Table 36.

Table 36. Difference in Emissions Between ORVR only and ORVR with Stage II VRS plus IEE

Emissions, (tons per summer day)			
Year	**MA**	**NH**	**VT**
2008		0.97[a]	0.64[a]
2009		0.72	0.49
2010	1.96[a]	0.47	0.36
2011	1.00	0.25	0.25
2012	0.24	0.10	0.15
2013	-0.38 [b]	-0.06 [b]	0.08
2014			0.01
2015		-	-0.05 [b]

[a] Def (c): ORVR = SII
[b] Def (c2): ORVR = SII+ORVR+IEE

D. Algorithm Analysis Issues

The in-use CE used in determining widespread use for definition (c) has an impact on how soon widespread use is reached. A higher in-use CE will result in a later widespread use date, while a lower in-use CE results in an earlier widespread use date. The impact of the in-use CE is understandable because a low in-use CE represents a Stage II VRS that is not operating as efficiently and effectively as the systems designed CE; therefore, as ORVR-equipped vehicles become more prominent in the vehicle fleet, it takes less time for ORVR technology to be more effective at reducing emissions. A high in-use CE for Stage II VRS delays the widespread use date because ORVR technology only becomes more effective at reducing emissions when the vehicle fleet is mostly comprised of ORVR-equipped vehicles.

The IEE factor used in determining a widespread use date for definition (c2) impacts how soon the widespread use date occurs. The larger the IEE factor, the sooner the widespread use date will approach. Definition (c2) takes into account that there is an additional level of control achieved by Stage II VRS beyond the control level defined by definition (c) (i.e., when the ORVR control level is equivalent to the Stage II VRS control level), but this additional level of control is offset by IEE. As ORVR-equipped vehicles become more prominent in the fleet, the IEE increases; eventually the emissions from ORVR only are less than the emissions from combined Stage II VRS and ORVR, including IEE. For these analyses an IEE factor of 0.86 lb/1000 gal was used (based on CARB data for a VA system with a certified A/L ratio of 1.0 to 1.2). This emissions factor was used for all VA systems in these analyses and no attempt was made to adjust the factor for systems with lower A/L ratios nor for volatility of the fuel (Reid vapor pressure). Using a smaller IEE factor would result in a later date for widespread use defined by (c2). Because applying a smaller IEE factor would result in less IEE, the difference in total emissions between ORVR only and ORVR with stage II VRS plus IEE would increase (i.e., the emissions summarized in Table 36 would increase). IEE factors lower than the 0.86 lb/1000 gal value used in these analyses have been reported for systems with lower A/L ratios [specifically: by CARB (for Dresser Wayne VA system) and by API (for Miniboot); See Section VI]

E. Recommendations

As discussed previously, EPA stated support for definition (c), however after examining the results from determining widespread use for definitions (c) and (c2), we recommend definition (c2). Definition (c) is less ideal than definition (c2) because it does not take into account the short-term increase in emissions from the removal of Stage II VRS. As ORVR-equipped vehicles become more prominent in the fleet, the emissions increase from Stage II removal decreases and eventually the emissions from ORVR only are less than the emissions from combined Stage II VRS and ORVR, including IEE. Definition (c2) is complicated and is largely impacted by the IEE factor used in algorithm analysis. EPA believes that additional emissions monitoring needs to be conducted to better understand IEE. As discussed in Section V.D., CARB and the WSPA plan to conduct some emissions testing to better define IEE; however, when their testing will occur is unclear. Hertz is planning to conduct some emissions testing that will include UST vent emissions and tank pressure tracking. In addition, Hertz will be conducting testing to demonstrate that withdrawing Stage II vacuum assist VRS will not adversely impact VOC emissions from their GDFs. Because most of their vehicles are ORVR-equipped and the Stage II VRS are vacuum assist, their test data will provide IEE data. NH DES, University of New Hampshire (UNH), Gilbarco/Veeder Root (GVR), and EFPAG are conducting an emissions monitoring project that will also provide more IEE data. We believe that these emissions tests will enable EPA to better quantify the IEE and indicate what IEE factor to use in determining widespread use.

EPA recommends that States use the same methodologies as presented in this section to calculate a widespread use date. States are advised to wait until EPA has had time to examine the IEE data collected from upcoming testing before calculating widespread use dates. Once EPA has examined the IEE data, EPA will provide guidance on what IEE factor to use in widespread use calculations.

VIII. Recommendations

A summary of our recommendations from the previous sections are as follows:

- OPSG not dictate a policy on vacuum-assist versus balance for Stage II VRS.
- OPSG continue to urge OMS to produce data for ORVR in-use long-term control efficiency.
- We continue to conduct testing to determine the IEE and forward the data results to OPSG.
- OPSG consider definition (c2) as the best option for determining widespread use.
- Regarding phase out of Stage II VRS, OPSG: (1) develop guidance on the decommissioning of Stage II VRS; (2) allow waivers for new GDF and conduct a cost study to determine when new GDF are not required to install Stage II VRS; and (3) develop guidance on other control measures, control efficiencies, and costs.

- OPSG recommend P/V valves for all UST vents nationwide for additional HAP control.
- Regarding phase out in the OTR: (1) same recommendations as above for Stage II VRS in other States; (2) OPSG provide the mechanism to phase out section 184(b)(2) requirements for Stage II VRS by updating or amending the Stage II Comparability Study, or other acceptable means.
- OPSG develop guidance for awarding SIP credits to GDF owners/operators who provide additional control for the three categories including, (1) new GDF; (2) GDF that remove Stage II VRS; and (3) other large-emitting GDF.
- OPSG consider adopting some components of CARB's EVR.
- OPSG recommend use of ISD and increased inspections.
- Provided adequate funding is available, we update emissions factors based on emissions measurement data.
- OPSG draft and release memorandum indicating our acceptance of waivers for Rental Car Facilities and Automobile Manufacturers.
- OPSG consider additional control measures that focus on alleviating UST pressurization and thus reducing MTBE groundwater contamination.
- We continue to conduct testing to determine the magnitude of UST emissions (both vent and fugitive) and provide the data results to OPSG.

Appendix A

Brief Summaries of Data Provided by Stakeholders

Previous Data Collected by EPA

SUMMARY OF EXCESS EMISSION DATA

This summary presents the key data and conclusions from several studies conducted to evaluate excess emissions created from the refueling of Onboard Refueling Vapor Recovery (ORVR) equipped cars at Gasoline Dispensing Facilities (GDF) using vapor recovery systems (VRS). For each data source: (1) the tests conducted are described, (2) key results and conclusions presented in the data sources are summarized, and (3) a table of the data is presented. The table is organized to identify the actual measurements conducted and results reported in the study.

GENERAL NOTES

EPA defines refueling emissions as the evaporative loss emissions during refueling, as well as emissions from spillage. For the purposes of this summary, spillage emissions are not addressed and reference to "refueling emissions" does not include spillage.

Emissions may occur (and may be measured or calculated) at numerous points within the system. CARB's VRS certification test method, TP-201.2, addresses making measurements or calculating emissions from several points in the system. The measurement points are:

1. Emissions at nozzle/vehicle interface ("fill pipe" emissions)
2. VOC's returned through the vapor passage of the hose
3. Emissions from the UST P/V valve
4. Emissions from the assist processor (not applicable in these studies), and
5. Calculated pressure-related fugitives based on UST tank pressure measurements

The emissions data generally are reported as lb VOC/1000 gallons dispensed. Note that in the actual reports both lb VOC/1000 gallons dispensed and g VOC/gal dispensed were used; this often got confusing as the authors switched back and forth. The figures from the reports that are presented along with this summary typically use g VOC /gallons dispensed, whereas the data in the summary table is presented in lb/1000 gallons. 1 lb/1000 gallons = 0.454 g/gallon (roughly, there are 2 lb/1000 gallon per g/gallon).

SOURCES

[1] CARB: Preliminary Draft Test Report, "Total Hydrocarbon Emissions from Two Phase II Vacuum Assist Vapor Recovery Systems During Baseline Operation and Simulated Refueling of Onboard Refueling Vapor Recovery (ORVR) Equipped Vehicles", June 1999

- Tests conducted in August/September 1998 at two facilities with Vacuum Assist(VA) VRS. to quantify "excess emissions" from vapor growth
- At time of tests, these two types of systems represented 80% of VA systems in CA, and dispense 55% of gasoline purchased
- VRS emissions were determined from direct measurement of UST pressure/ vacuum (P/V) valve emissions and calculation of fugitive emissions based on UST pressure readings

- CARB did not measure or attempt to quantify the emissions at the nozzle/fill pipe interface ("fillpipe emissions") during the study
- Testing had two phases: 1) "baseline" normal operations and 2) simulated ORVR **(mix of 40% ORVR vehicles)**. Because ORVR vehicles were not prevalent when tests were done, the refueling of ORVR was simulated by modifying the dispensers to ingest ambient air.

Key Results:

- Negligible emissions emitted from the P/V valve when P/V valve in operation; fugitives were from other unknown locations (e.g. leaks)
- Excess emissions did occur (calculated pressure related fugitives) when refueling with the simulated ORVR scenario. See table 1 for details. Ultimately, CARB used these data to develop an average excess emissions factor of 0.86 lb/1000gal when refueling ORVR equipped vehicles with VA VRS.

[2] API: ORVR Compatibility Study for the Gilbarco Vaporvac VRS, February 2004; Phase 1

- ORVR compatibility study at a GDF in California.
- The fuel was summertime reformulated federal gasoline (RVP 7.0)
- The vapor recovery system was vacuum assisted (Gilbarco).
- Used CARB Stage 2 certification test procedure TP201.2. Figure 2-1 identifies the measurement points. The measurement points are:
  1) Emissions at nozzle/vehicle interface ("fill pipe" emissions);
  2) VOC's returned through the vapor passage of the hose;
  3) Emissions from the UST P/V valve;
  4) Emissions from the assist processor (not applicable in these studies), and
  5) Calculated pressure related fugitives based on UST tank pressure measurements.
- Test 1: 100 car matrix, standard VA nozzles
- Test 2: 100 car matrix, nozzles with "miniboots," to limit influx of ambient air

Key Results:

- Overall pressure related emissions:
  - Test 1 (standard nozzle): 1.38 lb/1,000 gal
  - Test 2 (miniboot): 0.494 lb/1,000 gal.
  - Therefore, Miniboot reduces pressure related emissions by 0.886 lb/1000 gal (64 percent)
- Could not differentiate (quantify) the effects of ORVR vs non-ORVR vehicles on UST pressures and UST vent emissions due to interferences from vehicles simultaneously refueling at other pumps connected to tanks
- Emissions from the fill pipe were measured. ORVR vehicles reduce emissions from the nozzle/fillpipe interface by 0.31 lb/1,000 gal. Therefore, it is concluded that the CARB "ORVR excess emission factor" due to vapor growth (0.86 lb/1,000 gal) should be offset accordingly; i.e., total excess emissions are 0.86

lb/1,000 gal - 0.31 lb/1,000 gal or 0.55 lb/1,000 gal.

[3] API: ORVR Compatibility Study for the Gilbarco Vaporvac VRS, February 2004, Phase 2 – Outside

- Outdoor tests using 3000 gallon UST containing 1000 gallons in a laboratory setting
- RVP: 7.8 summer grade oxygenated
- Six refueling tests on 3 vehicles (two with ORVR and one without ORVR)
- Measured UST fugitives from P/V vent & pressure related fugitives (the system was first demonstrated to be leak free; then a fugitive leak rate was controlled using a calibrated needle valve)
- Compared fugitives measured while refueling ORVR & non-ORVR vehicles to determine incompatibility excess emissions
- Compared pressure related fugitives actually measured to those predicted by CARB calculations

Key Results:
For standard nozzle:

- Pressure related excess emissions were calculated to be 0.72 lb/1000 gal.
- Fill pipe emissions for ORVR equipped vehicles were 0.39 lb/1000 gal less than for non-ORVR vehicles (91% reduction)
- Adjusted ("net") ORVR excess emissions were 0.33 lb/1000 gal. [i.e., pressure related excess emissions minus the savings at the fill pipe = 0.72-0.39]
- If using these corrections on data generated from MOBILE6, the correct excess emission factor to use is 0.42 lb/1000 gal (not 0.33 lb/1000 gal) because MOBILE 6 already accounts for some of the fill pipe reductions achieved by ORVR equipped vehicles by using a 98% control efficiency for ORVR rather than the 95% efficiency for VRS.

For miniboot:

- Pressure related excess emissions were calculated to be zero (-0.008) lb/1000 gal.
- Fill pipe emissions for ORVR equipped vehicles were less than for non-ORVR vehicles
- Adjusted ("net") ORVR excess emissions were -0.39 lb/1000 gal; i.e., a decrease in emissions [zero pressure related excess emissions minus the savings at the fill pipe = a reduction of 0.39 lb/1000 gal].

[4] API: ORVR Compatibility Study for the Gilbarco Vaporvac VRS, February 2004, Phase 2 – SHED

- Conducted in Sealed Housing for Evaporative Emissions (SHED)
- Thirty-six refueling tests using procedures similar to the federal ORVR certification test;
- Three vehicles (two ORVR, one non-ORVR)
- First checked (validated) ORVR performance (i.e., baseline certification)
- Investigated impact of:
    - RVP 7.1 & 7.8;

- Temperature: three summertime temperature scenarios (one vapor growth and two vapor shrinkage scenarios) by varying the temperature of the fuel dispensed and vehicle tank)
- A/L ratios (standard nozzle & miniboot);
- Type of ORVR equipment (recirculation or not)

<u>Key Results</u>:

- Fill pipe emissions for ORVR and non-ORVR vehicles fall within the range of values measured in the Phase 1 and Phase 2 - outdoor tests.
- Fill pipe emissions for ORVR equipped vehicles were 0.46 lb/1000 gal less than for non-ORVR vehicles
- For ORVR equipped vehicles, fill pipe emissions are insensitive to changes in RVP, delta T, and A/L ratio; there is a positive correlation of fill-pipe emissions with vehicle tank temperature
- For non-ORVR vehicles, there is a positive correlation of fill-pipe emissions with RVP, a negative correlation of fill-pipe emissions with A/L ratio, and a negative correlation of fill-pipe emissions with delta T, as assumed in MOBILE 6
    - fill-pipe emissions for the miniboot (A/L =0.95) were greater than (about double) the fill pipe emissions with the standard nozzle (A/L =1.15)
    - the emissions are greater for the vapor growth scenario (temperature of fuel in vehicle tank is less than temperature of fuel being dispensed)
- "Puff" losses (the puff of emissions when the gas cap is removed) are the same order of magnitude as fill-pipe emissions for both ORVR and non-ORVR equipped vehicles

SUMMARY OF EXCESS EMISSION DATA

All emission units are lb/1000 gals dispensed or [g/gal] unless otherwise noted

Data Source	**Unit Type/ Test conditions**	**Fill Pipe Emissions (a) (b)**	**P/V Vent Emission (c)**	**Calculated Pressure Related Fugitives (leaks) (d)**	**Total Pressure Related emissions (e = c+d)**	**Total Refueling emissions (f =b+c+d)**	**Excess Emission due to ORVR Incomp. (g)**	**ORVR Emission reduction at fill pipe (h)**	**Adjusted Excess Emission due to ORVR Incomp. (i)**	**VRS Return line, HC Conc. % (j)**	**Note**
CARB [1] Scenario 1	Gilbarco VA Baseline:	Not measured	Negligible		0.396			Not measured			
	Gilbarco VA ORVR:				0.782		**0.386**				
CARB [1] Scenario 2	Dresser Wayne Baseline:	Not measured	Negligible.		0.028						
	Dresser Wayne ORVR:				0.0524		**0.0244**	Not measured			
CARB [1] Scenario 3	Dresser Wayne (without P/V valve) Baseline:	Not measured	Negligible	0.026	0.026						
	Dresser Wayne (without P/V valve) ORVR:			0.289	0.289		**0.263**	Not measured			
CARB							**0.86**				Calculated from Scenarios 1 thru 3

Data Source	Unit Type/ Test conditions	Fill Pipe Emissions (a) (b)	P/V Vent Emission (c)	Calculated Pressure Related Fugitives (leaks) (d)	Total Pressure Related emissions (e = c+d)	Total Refueling emissions (f =b+c+d)	Excess Emission due to ORVR Incomp. (g)	ORVR Emission reduction at fill pipe (h)	Adjusted Excess Emission due to ORVR Incomp. (i)	VRS Return line, HC Conc. % (j)	Note
API [2] Test 1	Gilbarco VA Standard nozzle (OPW 11VA1); non-ORVR	0.42	0.823	0.557	1.38					32 %	
	Gilbarco VA Standard nozzle (OPW 11VA1); ORVR vehicles	0.11					Not measured	**0.31 (73% less than non-ORVR)**		11%	
API [2] Test 2	Gilbarco VA With “miniboot” (OPW 12VW); non-ORVR	0.42	0.008	0.484	0.494					approx 40%	**Miniboot reduces pressure related fugitives 0.886 lb/1000 gal (64% reduction)**
	Gilbarco VA With “miniboot” (OPW 12VW); ORVR vehicles	0.11					Not measured	**0.31 (73% less than non-ORVR)**		approx 17%	

Data Source	Unit Type/ Test conditions	Fill Pipe Emissions (a) (b)	P/V Vent Emission (c)	Calculated Pressure Related Fugitives (leaks) (d)	Total Pressure Related emissions (e = c+d)	Total Refueling emissions (f =b+c+d)	Excess Emission due to ORVR Incomp. (g)	ORVR Emission reduction at fill pipe (h)	Adjusted Excess Emission due to ORVR Incomp. (i)	VRS Return line, HC Conc. % (j)	Note
API[3]	Outdoor test 5; Standard nozzle non-ORVR	**1.53** (check)	0	(Measured) 0.022	(Measured) 0.022		NA			33.2	check run number table 6-4
	Outdoor test 1; Standard nozzle ORVR vehicle with recirc.	**0.024**	0	(Measured) 0.918	(Measured) 0.918		0.896			3.0	CARB: 0.86
	Outdoor test 3; Standard nozzle ORVR vehicle without recirc.	**0.026** (check)	0	(Measured) 0.229	(Measured) 0.229		0.207			0.6	check run number table 6-4
	Standard nozzle ORVR vehicle, wgt. average (calculated)	0.025			0.745 (k)		**0.72 (k)**	**0.39 (m)** (91% less than non-ORVR)	**0.33**	2.4 (RTI)	**Note: fill-pipe reductions calculated for these tests = 1.505**
API[3]	Outdoor test 6; Miniboot; non-ORVR	**2.11**	0	(Measured) 0.011	(Measured) 0.011		NA			38.8	
	Outdoor test 2; Miniboot; ORVR vehicle with recirc.	**0.002**	0	(Measured) 0.004	(Measured) 0.004		- 0.007			5.4	
	Outdoor test 4; Miniboot; ORVR vehicle without recirc.	not available	0	(Measured) 0.002	(Measured) 0.002		- 0.009			7.6	
	Miniboot; ORVR vehicle, wgt average (calculated)				0.003 (k)		**-0.008 (k)**	**0.39 (m)** (91% less than non-ORVR)	**-0.39 i.e., zero**	6.0 (RTI)	**Note: fill-pipe reductions calculated for these tests = 2.1**

Data Source	Unit Type/ Test conditions	Fill Pipe Emissions (a) (b)	P/V Vent Emission (c)	Calculated Pressure Related Fugitives (leaks) (d)	Total Pressure Related emissions (e = c+d)	Total Refueling emissions (f =b+c+d)	Excess Emission due to ORVR Incomp. (g)	ORVR Emission reduction at fill pipe (h)	Adjusted Excess Emission due to ORVR Incomp. (i)	VRS Return line, HC Conc. % (j)	Note
API[4]	SHED Standard nozzle Non - ORVR	0.32									
	SHED Standard nozzle ORVR with recirc.	0.057									
	SHED Standard nozzle ORVR without recirc	0.007									
	SHED Standard nozzle ORVR Vehicle Wgt Avg. (calc.)	0.045						**0.275**			
API[4]	SHED Mini-boot Non - ORVR	0.69									
	SHED Mini-boot ORVR with recirc	0.054									
	SHED Mini-boot ORVR without recirc	0.007									
	SHED Mini-boot ORVR Vehicle Wgt Avg. (calc)	0.041						**0.649**			Average for Standard & miniboot = **0.46** **(91% less than non-ORVR)**

Data Source	Unit Type/ Test conditions	Fill Pipe Emissions (a) (b)	P/V Vent Emission (c)	Calculated Pressure Related Fugitives (leaks) (d)	Total Pressure Related emissions (e = c+d)	Total Refueling emissions (f =b+c+d)	Excess Emission due to ORVR Incomp. (g)	ORVR Emission reduction at fill pipe (h)	Adjusted Excess Emission due to ORVR Incomp. (i)	VRS Return line, HC Conc. % (j)	Note
API [4]	SHED Vehicle 3 Non - ORVR	PUFF (n) 0.321									
	SHED Vehicle 1 ORVR with recirc	PUFF (n) 0.030									
	SHED Vehicle 2 ORVR without recirc	PUFF (n) 0..007									
API [4]	Vehicle 1: ORVR Certification	0.017 [0.008]									
API[4]	Vehicle 2: ORVR Certification	0.002 [0.001]									
	EPA Standard for ORVR	0.44 [0.20] (Includes spillage)									
ARID [5]	Non-ORVR and ORVR autos	[0.0458] for non-ORVR; [0.0092] for ORVR	Not Reported (?)	Not Reported (?)	Not Reported (?) Or 0.042?, based on what Roy did for the API [2] results?	Not Reported (?)	0.042 (Roy put this parameter in the "Pressure Releated Fugitives" column, when dealing with API [2]	0.0805 [0.0366]	-0.0385(?) (May be wrong, if the "0.042" belongs in the "Pressure related fugitives" column	35.40% for non-ORVR; 5.65% for ORVR	

NOTES

(a) Refueling emissions = fill pipe displacement + spillage per EPA definition; spillage not addressed in these data
(b) Fill pipe emissions = fill pipe displacement emissions
(c) P/V vent emissions = emissions from UST vent pressure /vacuum valve
(d) Calculated pressure related (PR) fugitive emissions from VRS leaks per CARB calculation method
(e) Total pressure related emissions = P/V vent emissions + PR fugitives
(f) Total refueling emissions = total refueling emissions by CARB test method = Fill pipe displacement + P/V vent emissions + calculated PR fugitives (spillage estimated separately or by performance standard of nozzle?)
(g) Excess emissions due to ORVR incompatibility = total pressure related emissions for ORVR - total pressure related emissions for non-ORVR vehicles ; Note: the API report refers to excess emissions of pressure-related fugitives separately from P/V emissions
(h) ORVR emission reductions at fill pipe = measured fill pipe displacement emissions for non-ORVR vehicles - measured fill pipe displacement emissions for ORVR vehicles
(i) Total adjusted excess emissions = pressure related excess emissions due to ORVR incompatibility - ORVR emissions reductions achieved at fill pipe
Note: the API report refers to this as "total incompatibility emissions"
(j) Average hydrocarbon concentration in the VRS return line.
(k) Weighted average of ORVR with and without recirculation; assumes 75% of ORVR vehicles have recirculation.
(m) Average of Phase 1 (in-field) tests and SHED tests
(n) PUFF = puff of emissions that occur when gas cap is removed; measured quantity normalized to gallons dispensed
NA = Not Applicable

Source Company/Organization (include Title and date):
Phase II Balance System Test Report, Lincoln Test Site. Husky Corporation, Franklin Fueling Systems. June 2005. (Data from February 1 to March 21, 2005). [Submitted by Husky Corporation]

Test Scenario (Describe):
The GDF tested is a balance Stage II VRS. The test was conducted to conclude whether an UST vent add-on APCD (i.e., a processor) would be necessary on the balance system to be compliant with the EVR UST pressure requirements (CP-201). The test studied the effects of the GDF that shut down each night for 6 hours while operating with high RVP winter fuel and with lower RVP fuel. A total of 121,000 gal was dispensed over the testing time period. An ISD system was in place. Redundant monitoring was in place. The ISD collected data on system pressure, ullage data, and the nozzle fuel and vapor (V/L ratio), and CARB collected data on system pressure, barometric pressure, RVP, Static pressure decay test, Dynamic back pressure test, liquid extraction functionality by hose drainage, and ORVR penetration percentage.

Based on tracking ORVR activity over a 13-hour period, 41 percent of gasoline throughput went to ORVR vehicles (1,540 gal/3,745 gal). So, the balance VRS collected vapors for 59 percent of the fuel dispensed, and ORVR controlled the vehicle refueling vapors for 41 percent of the fuel. For comparison purposes, the percentage of ORVR vehicles was 42 percent (149/354).

Emissions Testing:
None.

Operating Data:
Testing was conducted from February 1 through March 21, 2005. Winter fuel (high RVP) was used during the time period February 1 through 28; lower RVP fuel was used during March 1 through 21.

Results and Conclusions Reported:
Pressure decay tests were conducted weekly. The system passed these tests, however, on February 22 the pressure decay test failed; without modification or maintenance, the tank then passed the pressure decay test on February 28. The data from February 16 through February 28 was suspect and was excluded from the test and analysis.

Pressures and temperatures were monitored continuously. These data indicate both (1) that the system is leak free and (2) the amount of emissions that would be sent to a processor if one were in place (i.e., any positive pressure greater than 0 in. w.c.). [Note that no vapor was actually vented from the UST because the P/V valve was in place and would not open unless pressure reached 3 in. w.c.; it did not over the 36-day period.] The system remains at significant negative pressure for long periods (exceeding 8 hours) and this would also indicate the system is tight (in addition to the pressure decay tests above). There were 3 days when the pressure flat-lined or remained at 0 in. w.c. for a length of time, indicating a possible leak. Each of these events was explained and/or corrected. The amount of emissions that would be sent to a processor was calculated from the total time when UST pressures were above 0 in. w.c. The UST fugitive and vent emissions were calculated to be 7.7 lb of HC and this was extrapolated to an annual basis of 48 lb/yr that would be controlled by a processor (if one were in place).

During the 36-day testing period, the CARB daily average pressure was exceeded on 3 days and the 30-day average pressure was 0.04 in. w.c. (compared to the allowed 0.25 in. w.c.) The daily hourly maximum pressure was exceeded on 2 days, and the 30-day average hourly maximum pressure was 0.32 in. w.c. (compared to 1.5 in. w.c.). The test demonstrates that the balance system meets the pressure profile requirements of CARB's EVR CP-201, without the use of a processor.

A comparison of the pressures resulting from the high and low RVP fuels was also conducted. For shutdown periods (early morning hours when pressures will be highest), the daily average pressure dropped from -0.04 in. w.c. to -0.45 in. w.c. with the lower RVP fuel. Additional analysis was conducted to compare the UST pressures for the two RVP. The analysis was conducted on a subset of data, specifically for those shut down hours when no fueling is being conducted at the GDF. For the shutdown periods only, the 30-day rolling daily average was 0.35 in. w.c. for RVP of 13 psi and was 0.055 in. w.c for RVP of 9 psi. The 30-day rolling average hourly maximum pressure was 2.4 in. w.c. for RVP of 13 psi and was 0.51 in. w.c. for RVP of 9 psi. A summary table for each RVP is provided.

The V/L ratios were also measured for each of the 12 fueling points. The daily averages ranged from 0.34 to1.66 across the fueling points (the sensors at 2 of the fueling points failed and are not included). The average V/L ratios over the 36-day period for each fueling point ranged from 0.71 to 1.0.

Comments:
The pressures experienced by the balance system are generally low and the system does not experience vapor releases. These systems appear to be vapor tight because significant negative, and occasional positive, pressures are maintained in the tank over long periods (several hours and longer) and few to no periods are shown at 0 in. w.c. (if there were, this would indicate leaks). For the majority of time, the UST tank is at negative pressure. The negative pressures reduce the potential for UST fugitives emissions and UST venting emissions. Positive pressure periods were seen during the study but the frequency, magnitude, and duration are low. Emissions from the positive pressure periods were estimated to be 48 lb/yr.

Daily Summary of Pressure Data for Friday, March 11, 2005

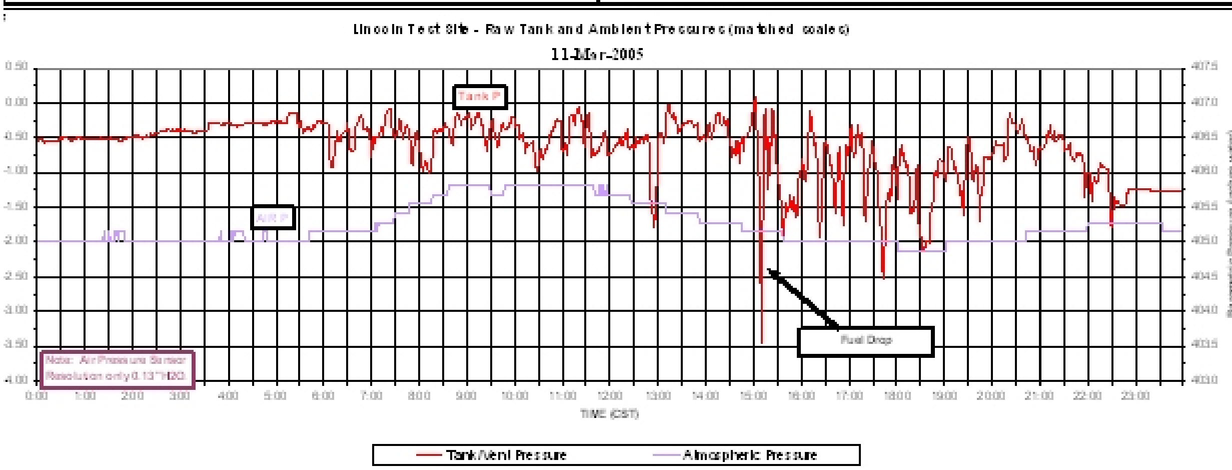
Lincoln Test Site - QA/QC DAILY SUMMARY

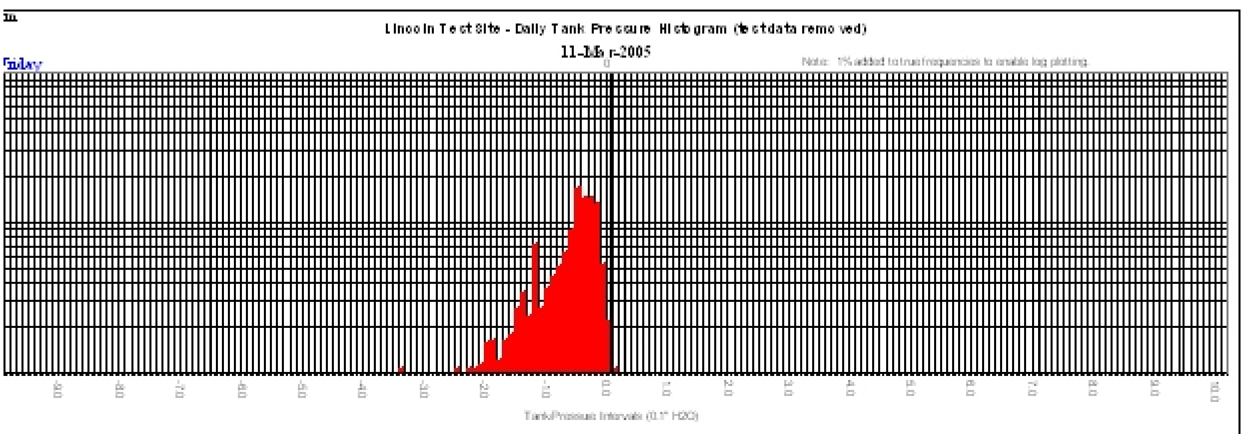
DATE: Friday 11-Mar-2005

Includes All Data			Test Data Removed			Fuel Drop & Test Data Removed			BP
arithmetic tank P	CARB 1 min vals	CARB Max runHR	arithmetic tank P	CARB 1 min vals	CARB Max runHR	arithmetic tank P	CARB 1 min vals	CARB Max runHR	inches H2O
0.10	0.10	0.002	0.10	0.10	0.002	-0.03	0.00	0.000	405.82
-3.44	0.00	0.00	-3.44	0.00	0.00	-2.52	0.00	0.00	404.87
-0.652	0.000	0.000	-0.652	0.000	0.000	-0.650	0.000	0.000	405.24
0.42	0.00	0.00	0.42	0.00	0.00	0.412	0.00	0.00	0.29
1440	1440	1440	1440	1440	1440	1412	1412	1440	1440
100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	98.1%	98.1%	100.0%	100.0%

Day Averages of Tank Pressure ("H2O)	
-0.652	(Arithmetic day AVERAGE for ALL tank Pressure data)
0.000	(CARB day AVERAGE for all Tank Pressure Data)
0.002	(MAX 1 hr running CARB Average - all data)
-0.652	(Arithmetic day AVERAGE with Test Data Removed)
0.000	(CARB day AVERAGE with Test Data Removed)
0.002	(MAX 1 hr CARB Average with Test Data Removed)
-0.650	(Arithmetic day AVE w Fuel Drop & Test Data Removed)
0.000	(CARB day AVE with Fuel Drop & Test Data Removed)
0.000	(MAX 1hr CARB AVE with Fuel & Test Data Removed)

* Franklin Ullage input data were adjusted to synchronize with CARB pressure data.
* Product delivered was approx 6,809 gallons.
* System pressure data edited 1500-1527 LST for Fuel Drop affected data.
* Believe data shown in PST zone but not certain.





Daily Summary of Pressure Data for Saturday, March 12, 2005

Lincoln Test Site - QA/QC DAILY SUMMARY

DATE: Saturday 12-Mar-2005

	Includes All Data			Test Data Removed			Fuel Drop & Test Data Removed			BP
	arithmetic tank P	CARB 1min vals	CARB Max run HR	arithmetic tank P	CARB 1min vals	CARB Max run HR	arithmetic tank P	CARB 1min vals	CARB Max run HR	inches H2O
MAX	0.03	0.03	0.001	0.03	0.03	0.001	0.03	0.03	0.001	405.49
MIN	-1.79	0.00	0.00	-1.79	0.00	0.00	-1.79	0.00	0.00	404.19
AVG	-0.794	0.000	0.000	-0.794	0.000	0.000	-0.794	0.000	0.000	404.94
stdev	0.53	0.00	0.00	0.53	0.00	0.00	0.530	0.00	0.00	0.44
count	1440	1440	1440	1440	1440	1440	1440	1440	1440	1440
% val	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%	100.0%

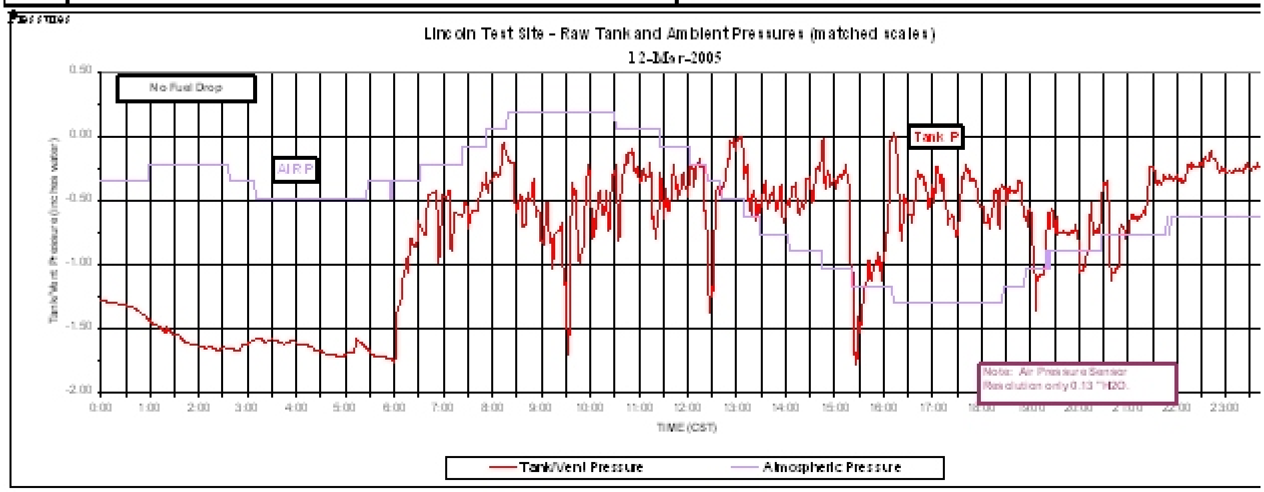
Day Averages of Tank Pressure ("H2O)	
-0.794	(Arithmetic day AVERAGE for ALL tank Pres
0.000	(CARB day AVERAGE for all Tank Pressure I
0.001	(MAX 1 hr running CARB Average - all data)
-0.794	(Arithmetic day AVERAGE with Test Data Re
0.000	(CARB day AVERAGE with Test Data Remo
0.001	(MAX 1 hr CARB Average with Test Data Re
-0.794	(Arithmetic day AVE w Fuel Drop & Test Data
0.000	(CARB day AVE with Fuel Drop & Test Data
0.001	(MAX 1 hr CARB AVE with Fuel & Test Data

* Franklin Ullage input data were adjusted to synchronize with CARB pressure data.

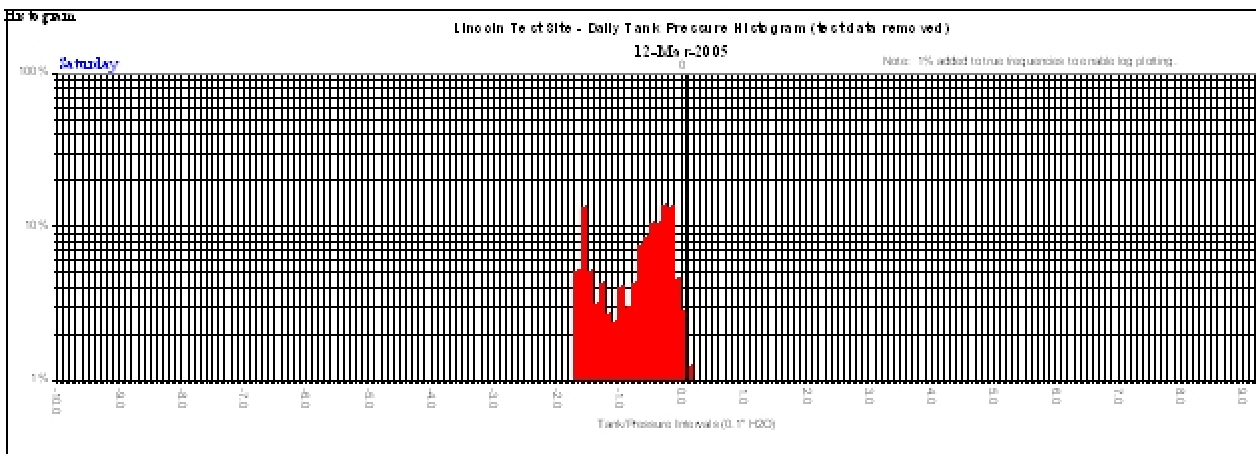
* No bulk delivery of fuel this day.

* Believe data shown in PSI zone but not certain.

Pressures



Histogram



Daily Average Nighttime (2300 to 0500) System Pressures with High RVP Fuel (~13 psi).

Lincoln Test Site - QA/QC DAILY SUMMARY

DATE: 2/1/2005-2/15/2005

Time Sorted 2300-0500 only

	Includes All Data			Test Data Removed			Fuel Drop & Test Data Removed			BP		System		
	arithmetic tankP	CARB 1min vals	CARB Max runHR	arithmetic tankP	CARB 1min vals	CARB Max runHR	arithmetic tankP	CARB 1min vals	CARB Max runHR	inches H2O	Air Temp degF	Pressure Slope	tankP + slope	tankP - slope
MAX	2.51	2.51	**2.371**	2.51	2.51	**2.371**	2.51	2.51	**2.371**	408.82	59.16	0.204	0.204	-0.001
MIN	-5.86	0.00	0.00	-5.86	0.00	0.00	-4.92	0.00	0.00	402.97	39.09	-0.199	0.001	-0.199
AVG	**-0.010**	**0.369**	0.361	**-0.040**	**0.346**	0.347	**-0.028**	**0.347**	0.347	**406.16**	**47.87**	**0.002**	**0.007**	**-0.006**
stdev	1.12	0.59	0.55	1.10	0.57	0.54	1.088	0.57	0.54	1.57	4.43	0.013	0.011	
count	*5399*	*5399*	*5340*	*5299*	*5299*	*5340*	*5274*	*5274*	*5340*	*5399*	*5399*	*5256*	*3136*	*1788*
% val	*100.00%*	*100.0%*	*98.9%*	*98.1%*	*98.1%*	*98.9%*	*97.7%*	*97.7%*	*98.9%*	*100.0%*	*100.0%*	*97.4%*	*58.1%*	*34.0%*

Day Averages of Tank Pressure ("H2O)	
-0.010	(Arithmetic AVERAGE for CLOSED tank Pressure data)
0.369	(CARB AVERAGE for CLOSED Tank Pressure Data)
2.371	(MAX 1 hr running CARB Average - ALL CLOSED data)
-0.040	(Arithmetic AVERAGE with Test Data Removed)
0.346	(CARB AVERAGE with Test Data Removed)
2.371	(MAX 1 hr CARB Average with Test Data Removed)
-0.028	(Arithmetic AVE w Fuel Drop & Test Data Removed)
0.347	(CARB AVE with Fuel Drop & Test Data Removed)
2.371	(MAX 1hr CARB AVE with Fuel & Test Data Removed)

Categorical Frequencies (- test data)	
tankP < 0" =	53.48%
tankP = 0" =	0.11%
tankP > 0" =	46.40%
tankP > 0.25" =	31.18%
tankP > 0.5" =	25.61%
tankP > 1.5" =	6.45%
tankP > 2.5" =	0.02%

Daily Average Nighttime (2300 – 0500) System Pressures with Low RVP Fuel (~9 psi).

Lincoln Test Site - QA/QC DAILY SUMMARY

DATE: 3/9/2005 (2300) -3/21/2005

Time Sequenced 2300-0500 only

	Includes All Data			Test Data Removed			Fuel Drop & Test Data Removed			BP		System		
	arithmetic tankP	CARB 1min vals	CARB Max runHR	arithmetic tankP	CARB 1min vals	CARB Max runHR	arithmetic tankP	CARB 1min vals	CARB Max runHR	inches H2O	Air Temp degF	Pressure Slope	tankP + slope	tankP - slope
MAX	2.23	2.23	1.473	0.54	0.54	0.512	0.54	0.54	0.512	407.32	64.72	0.316	0.316	-0.001
MIN	-4.72	0.00	0.00	-4.72	0.00	0.00	-1.72	0.00	0.00	401.61	42.29	-0.402	0.001	-0.402
AVG	**-0.414**	**0.083**	0.076	**-0.449**	**0.055**	0.055	**-0.438**	**0.055**	0.055	**405.18**	**54.65**	**0.001**	**0.009**	**-0.002**
stdev	0.66	0.26	0.19	0.60	0.12	0.12	0.577	0.13	0.12	1.43	3.88	0.015	0.013	
count	*4375*	*4375*	*4375*	*4308*	*4308*	*4375*	*4281*	*4281*	*4375*	*4375*	*4375*	*4265*	*2161*	*1867*
% val	*100.00%*	*100.0%*	*100.0%*	*98.5%*	*98.5%*	*100.0%*	*97.9%*	*97.9%*	*100.0%*	*100.0%*	*100.0%*	*97.5%*	*49.4%*	*43.8%*

Day Averages of Tank Pressure ("H2O)	
-0.414	(Arithmetic AVERAGE for CLOSED tank Pressure data)
0.083	(CARB AVERAGE for CLOSED Tank Pressure Data)
1.473	(MAX 1 hr running CARB Average - ALL CLOSED data)
-0.449	(Arithmetic AVERAGE with Test Data Removed)
0.055	(CARB AVERAGE with Test Data Removed)
0.512	(MAX 1 hr CARB Average with Test Data Removed)
-0.438	(Arithmetic AVE w Fuel Drop & Test Data Removed)
0.055	(CARB AVE with Fuel Drop & Test Data Removed)
0.512	(MAX 1hr CARB AVE with Fuel & Test Data Removed)

Categorical Frequencies (- test data)	
tankP < 0" =	76.14%
tankP = 0" =	0.28%
tankP > 0" =	23.58%
tankP > 0.25" =	11.54%
tankP > 0.5" =	1.02%
tankP > 1.5" =	0.00%
tankP > 2.5" =	0.00%

Source Company/Organization (include Title and date):
UST pressure monitoring data at a GDF in Sacramento, CA. January and August 2004.
[Submitted by Healy, Inc.]

Test Scenario (Describe):
The GDF has a Healy vacuum assist Enhanced Vapor Recovery (EVR) Stage II VRS and a Clean Air Separator on the UST; this system is ORVR compatible. An ISD system is also installed.

Emissions Testing:
None.

Operating Data:
UST pressure measurements were shown with and without the Clean Air Separator operating. Pressure data are shown for:

(1) summer fuel in August (August 11-17) without the Clean Air Separator operating,
(2) for summer fuel in August (August 25-31) with the Clean Air Separator operating with a simulated fugitive leak, and
(3) for winter fuel in January (December 31-January 20) with the Clean Air Separator operating.

The Clean Air Separator is a tank with an expandable bladder that accepts vapor from the UST and reduces UST vent emissions and UST fugitive emissions that result from positive pressures. When UST pressures exceed +0.15 in. w.c., the UST vents to the flexible bladder where the vapor is contained. The conversion of a vacuum assist Stage II VRS to an ORVR compatible Stage II VRS includes replacing the vacuum source (pump), hose assembly, and the nozzle.

Results and Conclusions Reported:
Without the UST Clean Air Separator in place (August 11-17 data), the pressures range from approximately -9 in. w.c. to +3 in. w.c. During operating hours when the GDF was dispensing fuel from the UST, the UST pressures decreased and significant negative pressures were maintained. During nighttime hours when the GDF would be closed and not operating, there was consistent pressure increase, indicating vapor growth. The pressures during off-hours were often above 0 in. w.c., indicating pressurization of the tank and possible fugitive emissions. The pressures rose to +3 in. w.c. on some nights, indicating P/V valve venting and UST vent emissions and UST fugitive emissions as well.

The August 25-31 pressure data graphs with the UST Clean Air Separator and with a simulated fugitive leak show pressures range from -8 in. w.c. to approximately 0 in. w.c. There were a few momentary spikes in pressure (as high as +4.5 in. w.c.) with return to 0 in. w.c. During off-hours, there was consistent pressure increase, indicating vapor growth. There are minimal episodes above 0 in. w.c. because the UST is vented to the flexible bladder at +0.15 in. w.c. (If the Clean Air Separator was not in place, significant positive pressures would not be maintained due to the leak that was simulated during this testing scenario.) During operating hours, the UST pressures decrease to significant negative pressures, however, with the simulated leak, not as much vacuum is pulled on the UST (i.e., the pressures do not appear to be as negative as shown in the "tight" UST data above).

With the UST add-on APCD in place (January data), the pressure ranges from approximately -9 in. w.c. to just above 0 in. w.c. During operating hours when the GDF was dispensing fuel from the UST, the UST pressures decrease and significant negative pressures are maintained. During nighttime hours when the GDF would be closed and not operating, there was consistent pressure increase, indicating vapor growth. However, there are minimal episodes above 0 in. w.c. because the UST vents to the flexible bladder at +0.15 in. w.c. There are a few momentary spikes in pressure with immediate return to 0 in. w.c. The daily average V/L ratio at the two pumps for the January time period ranged from 0.95 to 1.1 over this time period.

Comments:
Based on these data, the Healy EVR system with the Clean Air Separator on the UST does limit positive pressure periods in the UST, reducing the potential for fugitive emissions and reducing UST venting periods that occur when the pressure rises to +3 in. w.c. or greater. Significant negative pressures are maintained during operating (i.e., dispensing) hours.

IV0700
JAN 25, 2004 12:43 AM

102931-135868
8900 POCKET RD.
SACRAMENTO, CA 95831
80347398005001

ISD DAILY REPORT DETAILS

EVR TYPE: VACUUM ASSIST
ISD TYPE: 01.00
VAPOR PROCESSOR TYPE: NO VAPOR PROCESSOR

OVERALL STATUS :PASS
EVR VAPOR CONTAINMENT :PASS
ISD MONITOR UP-TIME : 99%
EVR/ISD PASS TIME :100%

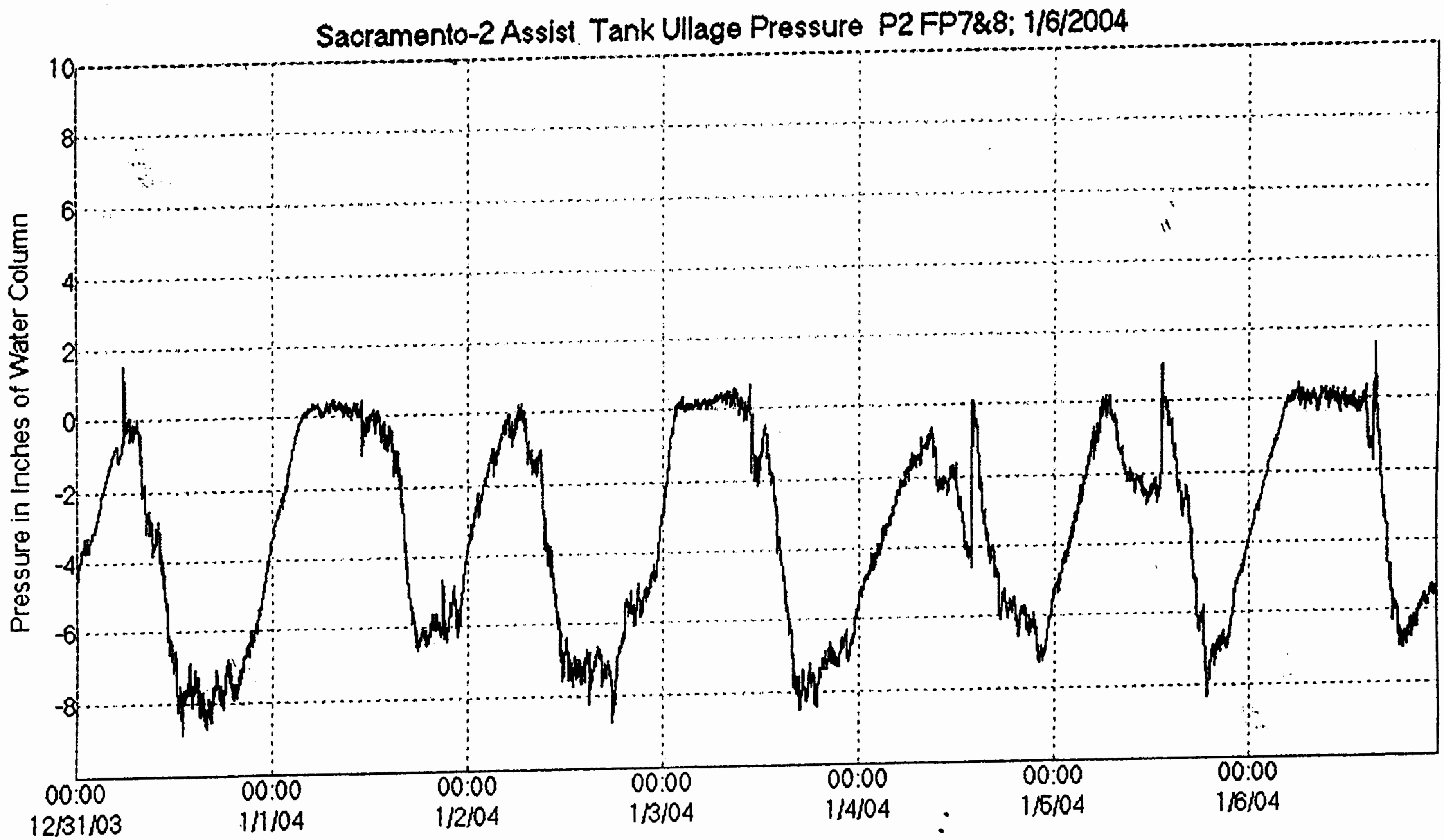
EVR VAPOR COLLECTION :PASS

STAGE I TRANSFERS: 18 of 18 PASS

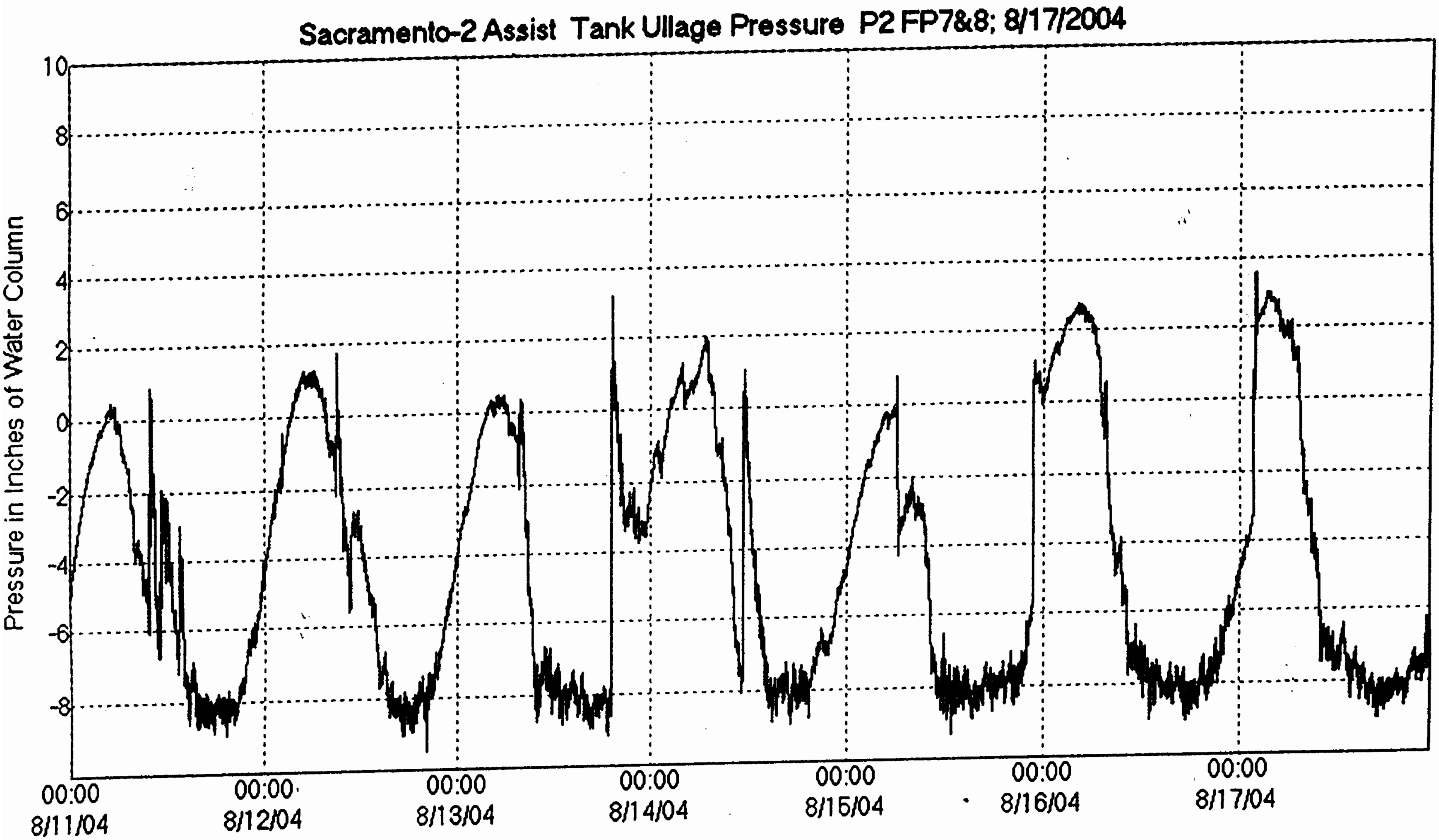
Status Codes: (W)Warn (F)Fail (D)Degradation Fail (G)Gross Fail
(ISD-W)ISD Self-Test Warning (ISD-F)ISD Self-Test Fail (N)No Test

	ISD	ISD	---CONTAINMENT TESTS---					STAGE	---COLLECTION TESTS-DAILY AVERAGE HOSE V/L RATIO----											
	EVR	%UP	GROSS	DGRD	MAX	MIN	LEAK	I	FP1	FP2	FP3	FP4	FP5	FP6	FP7	FP8	FP9	FP10	FP11	FP12
DATE	STATUS	TIME	95%	75%	"WC	"WC	CFH	XFR	BLEND	BLEND	BLEND	BLEND	BLEND	BLEND	BLEND	BLEND	BLEND	BLEND	BLEND	BLEND
12/31	PASS	100%	0.1	-0.4	1.4	-5.0	0	PASS	1.07	1.10	1.09	1.12	1.09	1.00	0.97	1.06	1.08	1.06	1.08	1.10
01/01	PASS	100%	0.2	-0.4	0.5	-5.0	0	PASS	1.06	1.16	1.09	1.12	1.03	1.00	0.95	1.07	1.08	1.09	1.16	1.06
01/02	PASS	100%	0.2	-0.4	0.2	-5.0	0		1.08	1.14	1.09	1.11	0.99	1.01	1.00	1.09	1.12	1.07	1.11	1.08
01/03	PASS	100%	0.3	-0.5	0.5	-5.0	0	PASS	1.06	1.14	1.07	1.07	1.05	1.00	1.03	1.07	1.11	1.07	1.11	1.07
01/04	PASS	100%	0.3	-0.5	0.1	-5.0	0	PASS	1.06	1.14	0.96	1.06	1.02	1.05	0.99	1.09	1.10	1.06	1.08	1.06
01/05	PASS	100%	0.2	-0.5	1.0	-5.0	0	PASS	1.10	1.14	1.07	1.06	1.05	1.03	1.04	1.08	1.05	1.10	1.17	1.06
01/06	PASS	100%	0.2	-0.4	1.5	-5.0	0	PASS	1.04	1.07	1.03	1.06	1.03	1.06	1.06	1.08	1.07	1.10	1.08	1.08
01/07	PASS	100%	0.2	-0.4	-0.5	-5.0	0	PASS	1.02	1.10	1.05	1.06	1.05	1.02	1.03	1.06	1.07	1.11	1.10	1.06
01/08	PASS	100%	0.2	-0.5	1.0	-5.0	0	PASS	1.06	1.10	1.05	1.07	1.02	1.02	1.02	1.06	1.09	1.09	1.14	1.06
01/09	PASS	100%	0.2	-0.6	0.6	-5.0	0	PASS	1.06	1.12	1.08	1.10	1.09	1.03	0.99	1.10	1.06	1.12	1.11	1.04
01/10	PASS	100%	-0.0	-0.6	1.6	-5.0	0	PASS	1.04	1.13	1.05	1.01	1.01	0.99	1.00	1.09	1.07	1.12	1.08	1.05
01/11	PASS	100%	0.1	-0.5	0.2	-5.0	0		1.07	1.12	1.06	1.02	1.00	1.00	1.05	1.10	1.11	1.07	1.11	1.06
01/12	PASS	100%	0.1	-0.6	5.0	-5.0	1	PASS	1.06	1.13	1.07	1.02	1.08	1.02	1.03	1.04	1.10	1.13	1.11	1.05
01/13	PASS	100%	0.1	-0.6	0.8	-5.0	2	PASS	1.05	1.12	1.08	1.02	1.08	0.99	0.94	1.08	1.11	1.11	1.11	1.06
01/14	PASS	99%	-2.3	-3.6	-1.5	-5.0	0	PASS	1.06	1.01	1.07	0.94	1.07	1.01	1.07	1.10	1.06	1.10	1.12	1.07
01/15	PASS	100%	-0.3	-2.2	0.7	-5.0	0	PASS	1.06	1.05	1.04	0.94	1.09	1.03	1.03	1.09	1.08	1.10	1.08	1.04
01/16	PASS	100%	-0.4	-2.0	1.2	-5.0	0	PASS	1.05	1.09	1.07	1.06	1.09	1.00	1.04	1.09	1.05	1.10	1.04	1.04
01/17	PASS	100%	-0.6	-2.1	-0.7	-5.0	0		1.07	1.16	1.05	1.10	1.07	1.02	1.05	1.09	1.10	1.12	1.15	1.07
01/18	PASS	100%	-0.0	-1.6	1.9	-3.9	1	PASS	1.05	1.11	1.08	1.08	1.07	1.00	1.07	1.08	1.08	1.14	1.11	1.04
01/19	PASS	100%	-0.0	-1.5	0.0	-5.0	3	PASS	1.09	1.15	1.09	1.09	1.11	1.00	1.04	1.09	1.10	1.12	1.10	1.05
01/20	PASS	100%	-0.1	-1.7	-0.8	-5.0	2	PASS	1.04	1.12	1.05	1.03	1.09	0.99	1.04	1.10	1.13	1.13	1.02	1.09

WINTER FUEL WITH CLEAN AIR SEPARATOR ON

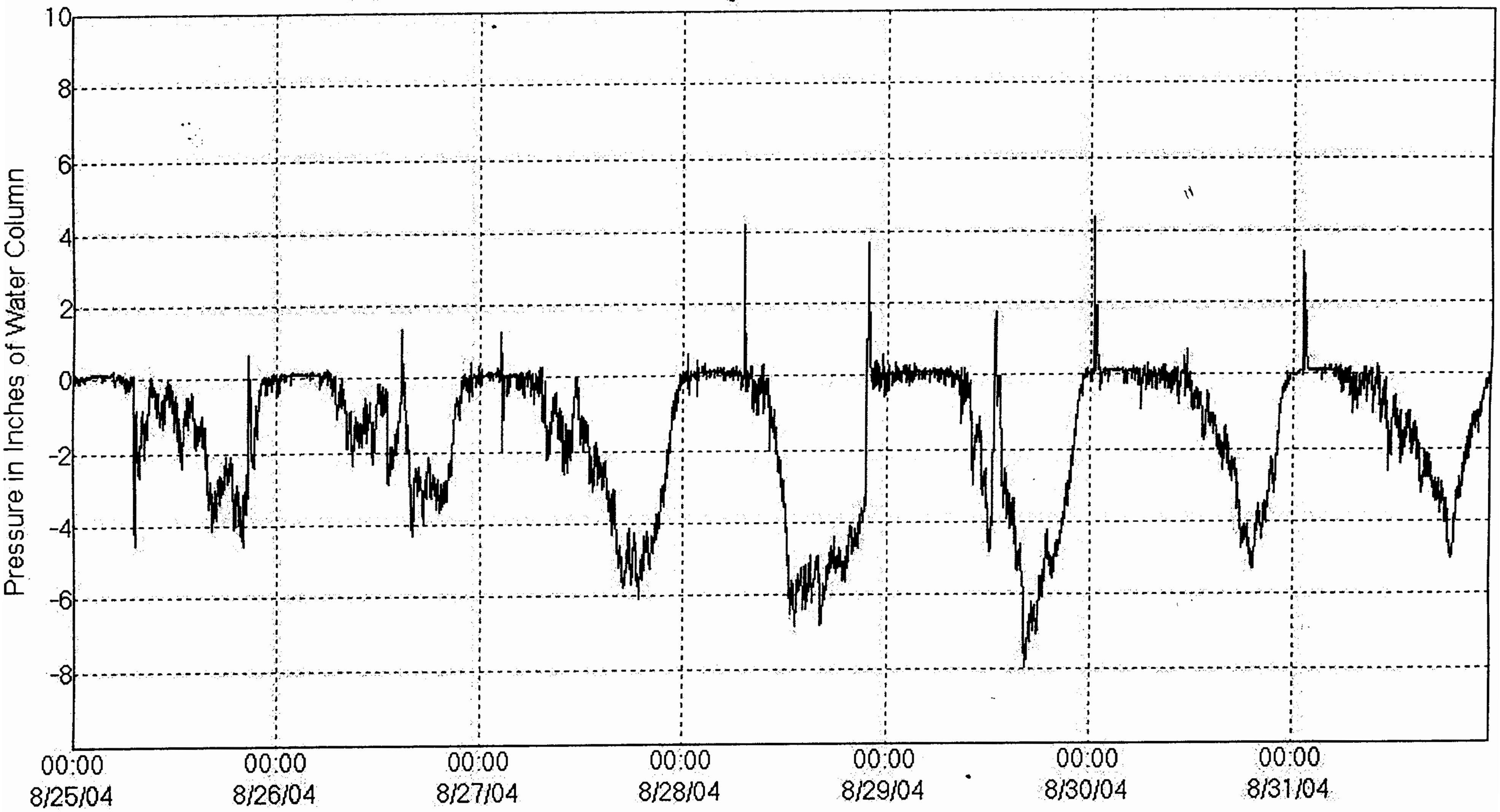


SUMMER FUEL WITH CLEAN AIR SEPARATOR OFF



SUMMER FUEL WITH SIMULATED FUGITIVE LEAK, CLEAN AIR SEPARATOR ON

Sacramento-2 Assist Tank Ullage Pressure P2 FP7&8; 8/31/2004



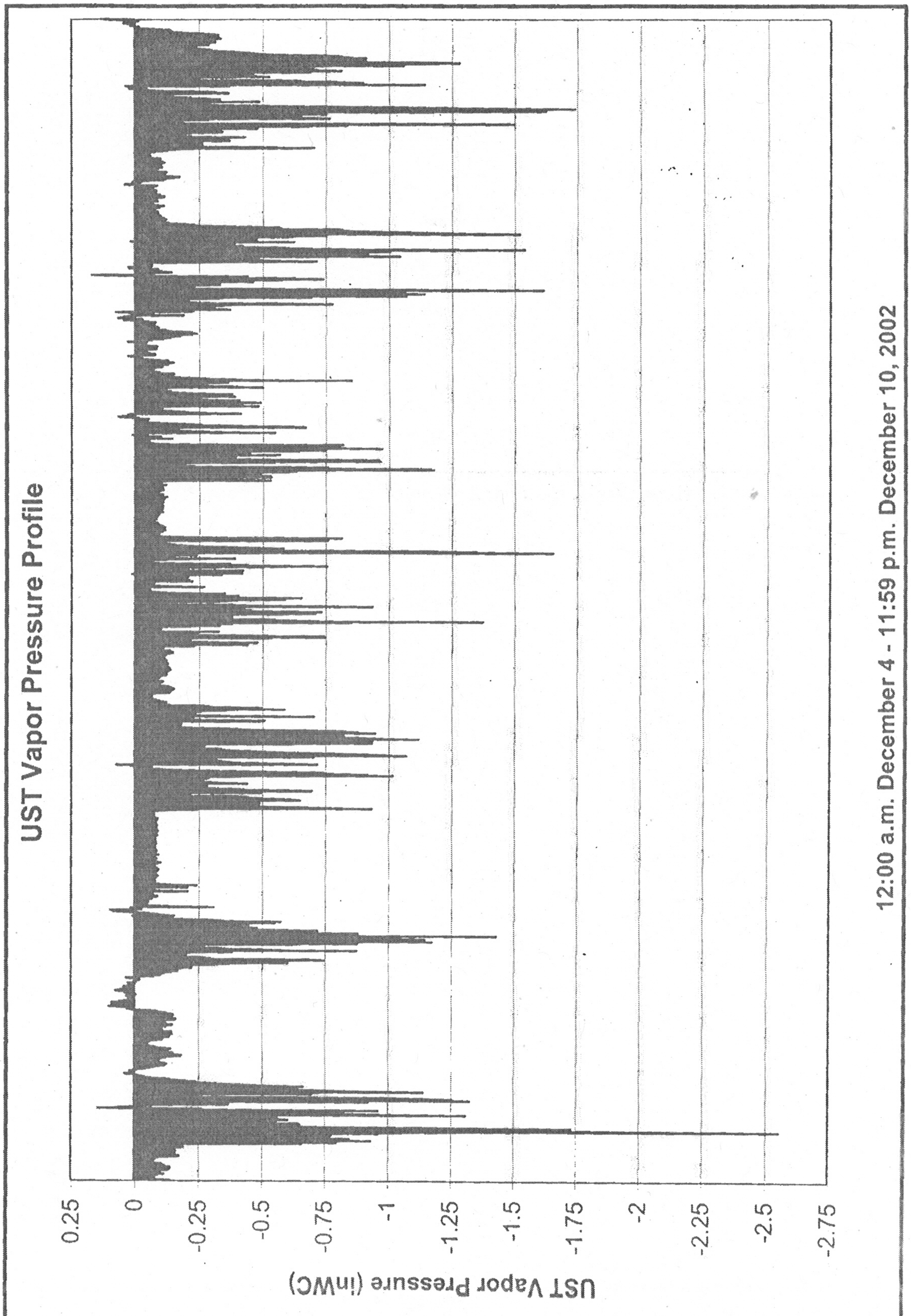
Source Company/Organization:
Summary of the Evaluation for Phase II Balance Type Vapor Recovery Systems Interacting with On-Board Refueling Vapor Recovery (ORVR) Equipped Vehicles. Data collected in December 2002. [Submitted by EMCO Wheaton Retail]

Test Scenario:
The GDF has a balance Stage II VRS. Pressure measurements of the UST were taken from December 4-10 in California. The vehicles refueled at the facility were 100 percent ORVR. The GDF closes for 8 hours per day.

Results and Conclusions Reported:
The pressures in the UST ranged from -2.6 iwc to +0.15 iwc over a 7-day period. A total of 486 vehicle fuelings were conducted and a total of 2,816 gal were dispensed. The pressures seemed consistent with typical UST pressures for refueling with higher pressure during nighttime hours when the GDF was closed and not dispensing fuel and with negative pressures during operating hours when the GDF is dispensing fuel (although the dates and times were not specifically delineated on the graph). The UST pressures were less than or equal to 0 iwc for 95 percent of the operating time and was greater than 0 iwc and less than +0.25 for 5 percent of the operating time.

The pressure data indicate that the balance Stage II VRS used to fuel ORVR vehicles will not generate excess emissions from the UST due to ORVR refuelings. Because the UST pressures are negative most of the time with a small amount of time at positive pressures, fugitive emissions and UST vent emissions are minimized.

Comments:
None.



UST Vapor Pressure Profile
UST Vapor Pressure (inWC)
0.25
0
-0.25
-0.5
-0.75
-1
-1.25
-1.5
-1.75
-2
-2.25
-2.5
-2.75
12:00 a.m. December 4 - 11:59 p.m. December 10, 2002

Source Company/Organization:
Test Report for the Arid Technologies Vapor Recovery Unit Installed at the Costco Gasoline Station, Lantana, Florida. Testing conducted in February 2005. The draft report is undated (appears to be circa March 2005).

Test Scenario:
Emissions testing was conducted at the Costco retail gasoline station to demonstrate the capture efficiency of an UST add-on APCD on the UST and to compare the UST vent stack emissions when the add-on APCD is operating (on) and not operating (off). The GDF has a vacuum assist Stage II VRS. The add-on APCD is Arid Technologies Inc. vapor control unit called the PERMEATOR.® This device is used to control VOC emissions from the UST vent during gasoline dispensing operations. The PERMEATOR® is a membrane system that allows gasoline vapors to pass through and back to the UST; air is prevented from permeating the membrane and is vented to the atmosphere.

The test period was continuous and lasted approximately 72 hours. Sampling was conducted at the outlet vent of the USTs when the add-on APCD was not operating. Sampling was conducted at three locations on the add-on APCD while it was operating. Testing was conducted with and without the P/V valves in place; these conditions are referred to in the test report as "Vent Off" and "Vent On," respectively. The number of ORVR vehicles fueled at the facility during the testing periods is not known.

Operating Data:
A graph of UST pressure data for periods with and without the add-on APCD (and with the P/V in place) is provided. While the add-on APCD was operating, the UST pressure is maintained at approximately 0.5 in. w.c with the majority of measurements ranging from 0.3 to 0.9 in. w.c. Venting to the add-on APCD occurs when pressures within the tank reach approximately 0.5 in. w.c. While the add-on APCD is operating, the P/V valve never opens because the UST does not reach sufficient pressure, so there are no UST vent emissions. In addition, because pressurization above approximately +0.5 in. w.c. does not occur, UST fugitive emissions may also decrease. When the add-on APCD is not operating, the pressures are typically at approximately 3.3 in. w.c. The UST pressure will increase to approximately 3 in. w.c. and then the P/V valve will open to release the pressure and gasoline vapors to the atmosphere. UST vent emissions are occurring in addition to UST fugitive emissions.

Results and Conclusions Reported:
Test results were as shown in the table below.

Emissions Testing Results for UST Vent Add-on APCD.

Test Conditions	**APCD off without P/V valve**	**APCD off with P/V valve**	**APCD on with P/V valve**
Test Date	February 14-15, 2005	February 16-17, 2005	February 15-16, 2005
Gasoline Loaded, gal	19,186	18,908	19,121
Average Inlet Concentration, % C_3	NA	NA	38.52
Average Outlet Concentration, % C_3	39.79	41.58	0.72
Average Hydrocarbon Emission, lbs/1000 gal	**3.48**	**1.20 ***	**0.014**
Hydrocarbon Emission Rate, lb/24hr	66.84	22.75 *	0.27
Hydrocarbon Removal Efficiency, % (mass basis)	NA	65.5% *	99.3%
Ambient T, °F	71°F	71°F	71°F
UST temperature, °F	74°F	74°F	74°F
RVP, psia	11.1	11.1	11.1
V/L ratio **	0.97	0.97	0.97
Fueling rate, gal/min	8	8	8
Percent ORVR vehicles fueled, %	Not known	Not known	Not known

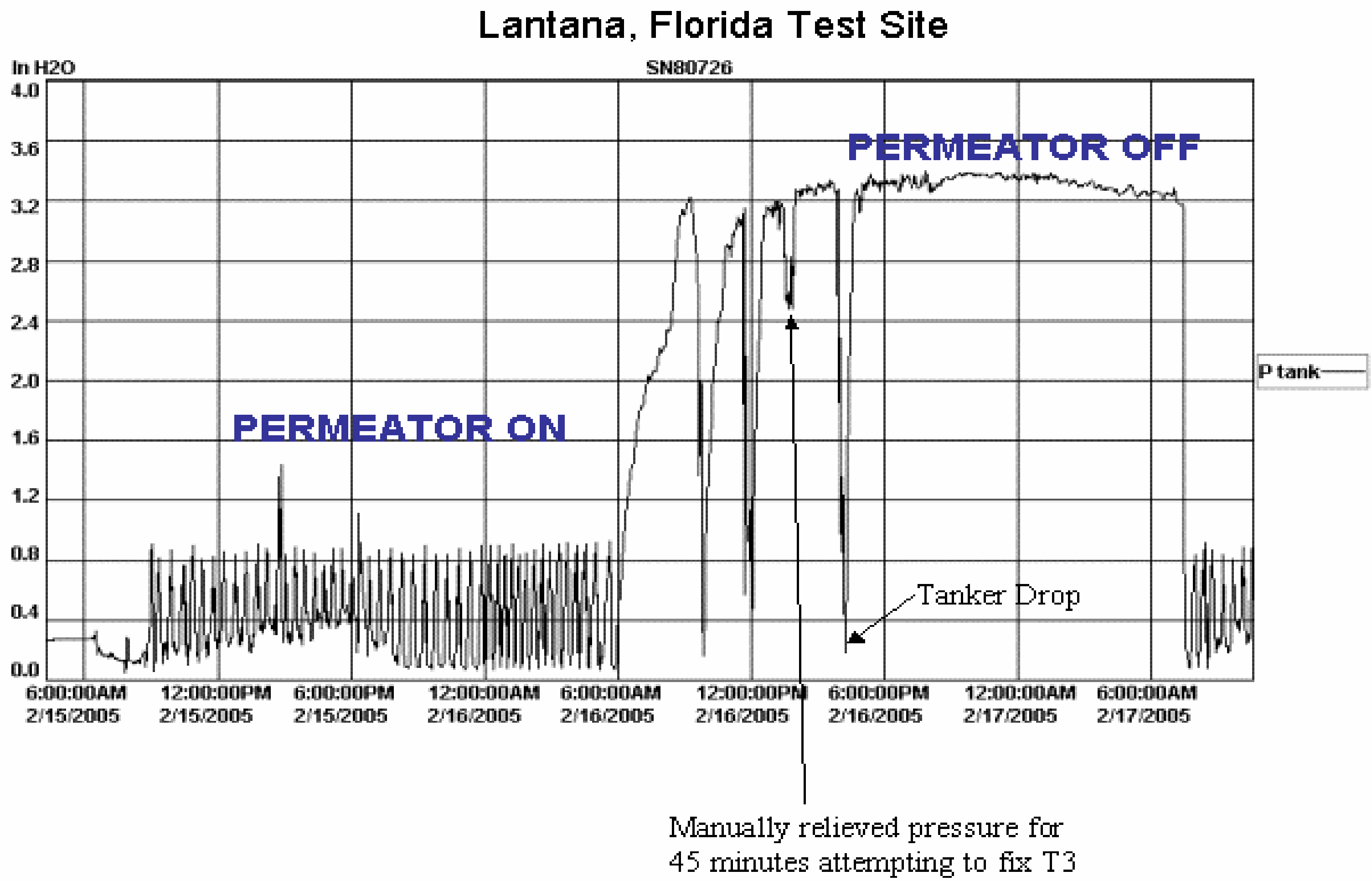
* Due to a leak, fugitive emissions were released to the atmosphere during UST pressurization periods; the amount of fugitive emissions (i.e., gasoline vapors) released are not quantifiable.

** The V/L ratio was calculated based on an average for regular gasoline only, at fueling points 7 through 12 while the GDF was closed and on fueling points 1 through 6 while the GDF was open. The majority of gasoline pumped during the test was regular fuel.

Comments:

The testing demonstrates that the P/V valve may reduce UST vent emissions. When P/V valves were not in place, emissions were 3.48 lbs/1,000 gal (66.84 lb/24hr). When the P/V valve was in place, emissions were reduced to 1.20 lbs/1,000 gal (22.75 lb/24hr); while the UST vent emissions may have been reduced, there were fugitive emissions occurring due to UST system leaks during this test due to vapor growth and pressurization of the tank. The amount of fugitive emissions, (i.e., gasoline vapor leaks) were not quantified but would likely show similar emissions levels to the uncontrolled scenario for the UST vent emissions (no P/V valve, with no add-on APCD).

The testing demonstrates that the UST add-on APCD, the PERMEATOR® membrane system, was effective in separating gasoline vapor from air and returning the vapor to the UST, thereby reducing UST vent emissions to the atmosphere. With the add-on APCD operating, UST vent emissions were reduced to 0.014 lb/1,000 gal (0.27 lb/24hr); the calculated control efficiency (mass basis) was 99.3 percent. The Permeator system also limits positive pressures in the UST, reducing the potential for fugitive emissions and reducing UST venting periods that occur when pressure rises to +3 in. w.c. or greater.


Lantana, Florida Test Site
SN80726
In H2O
4.0
3.6
3.2
2.8
2.4
2.0
1.6
1.2
0.8
0.4
0.0
6:00:00AM 2/15/2005
12:00:00PM 2/15/2005
6:00:00PM 2/15/2005
12:00:00AM 2/16/2005
6:00:00AM 2/16/2005
12:00:00PM 2/16/2005
6:00:00PM 2/16/2005
12:00:00AM 2/17/2005
6:00:00AM 2/17/2005
PERMEATOR ON
PERMEATOR OFF
Tanker Drop
P tank
Manually relieved pressure for
45 minutes attempting to fix T3

Source Company/Organization (include Title and date):
Husky MO/PETP Testing Final Report, Citgo Express Mart, Festus, Missouri. July 1997 through March 1998. Prepared by Environmental Solutions, Inc., for the Missouri Department of Natural Resources (MDNR). [Submitted by RSA]

Test Scenario (Describe):
The Citgo Express Mart uses a balance Stage II VRS with P/V valves on the UST vents. There are 3 USTs manifolded together. During the test period, two Husky nozzles were tested. Husky nozzle model 5210, V long was tested with an 109-vehicle matrix, while Husky nozzle model 5010, V short was tested with an 107-vehicle matrix.

Emissions Testing Data:
The following MO/PETP tests were conducted:

- Bench Testing (MO/TP-201.2B) - requires bench testing of nozzles, P/V valves, drain valves for transition flow, and leak rates
- Dynamic Pressure (Back Pressure) Testing (MO/TP-201.4)
- Static Pressure (Leak Decay) Testing (MO/TP-201.3)
- Liquid Removal Test (MO/TP-201.6)
- Stage I Efficiency Test (MO/TP-201.1)
- Stage II Efficiency Test (MO/TP-201.2)
- Spillage and Pseudo-Spillage (MO/TP-201.2C)

The liquid removal test had not been previously performed in Missouri. This test proved to be difficult and questions regarding the validity and applicability of some of the test procedures came to light. The State agency felt that the test problems were not significant to the overall test program, and the agency decided to rewrite the test method.

Operating Data:
Continuous T and P data were taken for a 180-day period as part of the testing; these data include T and P of the UST, ambient temperatures, barometric pressure but were not provided as part of the report.

Results and Conclusions Reported:
Test results are summarized in the table below. The balance Stage II VRS at the Citgo Express Mart passed the overall efficiency at 97 percent (the overall efficiency for Missouri is based on the Stage I, vehicle refueling, spillage, and UST emissions). Both Husky nozzles were recommended for approval to be used with other approved balance VRS.

Table 1 - Summary of Stage I and Stage II Test Results

Source	Uncontrolled System (without VRS) lbs/1,000 gal	Pump 9 Husky 5010 (V Short), lbs/1,000 gal	Pump 10 Husky 5210 (V Long), lbs/1,000 gal	Efficiency Relative to Uncontrolled System	
				Pump 9 Husky 5010, (V Short)	Pump 10 Husky 5210, (V Long)
Loading (Stage I)	13.6 [AP-42 EF equation]	0.0 [measured]	0.0 [measured]	100%	100%
Vehicle Fueling	14.6 [AP-42 EF equation)	0.64 [a] [emissions measurement]	0.63 [a] [emissions measurement]	95.6%	95.7%
Spillage/Pseudo-Spillage	0.46	0.083 [measured]	0.10 [measured]	82.0%	78.3%
Breathing (Pressure Related Fugitives from components such as P/V valves and nozzles)	1.00 [AP-42 EF]	0.16 [calculated]	0.16 [calculated]	84.0%	84.0%
TOTAL	**29.7**	**0.88**	**0.89**	**97.0%**	**97.0%**

[a] A portion of this value was due to evaporation of liquid droplets on the nozzle after completion of each fueling event and really belongs in the spillage/pseudospillage category.

Comment:
The summary did not specify if any of the vehicles tested were ORVR-equipped. RSA indicated that there were possibly 3 or 4 ORVR-equipped vehicles tested during the test program.

Notes on Specific Emissions Factors:
The vehicle fueling EF may be typical of other GDF with balance Stage II VRS, with similar RVP, (percent ORVR is not known).
The UST vent and fugitive EF may be typical of other GDFs with balance Stage II VRS, with P/V valve, with similar RVP (percent ORVR is not known).
The spillage EF may be typical of other GDF with similar nozzles.

Source Company/Organization:
OPW MO/PETP Testing Final Report, Mobil Mart, St. Louis, Missouri, May 1998 through December 1998. Prepared by Environmental Solutions, Inc., for the Missouri Department of Natural Resources (MDNR). [Submitted by RSA]

Test Scenario:
The Mobil Mart uses a balance Stage II VRS with P/V valves on the UST vents. There are 4 USTS all manifolded together. A total of 205 vehicles were tested; 5 of these were ORVR vehicles, and this percentage is representative of the actual fleet (2.4%).

Emission Testing:
The following MO/PETP tests were conducted:

- Bench Testing (MO/TP-201.2B) - requires bench testing of nozzles, P/V valves, drain valves for transition flow, and leak rates
- Dynamic Pressure (Back Pressure) Testing (MO/TP-201.4)
- Static Pressure (Leak Decay) Testing (MO/TP-201.3)
- Stage I Efficiency Test (MO/TP-201.1)
- Stage II Efficiency Test (MO/TP-201.2)
- Spillage and Pseudo-Spillage (MO/TP-201.2C)

Operating Data:
Continuous T and P data were taken for a 180-day period as part of the testing; these data include T and P of the UST, ambient temperatures, barometric pressure but were not provided as part of the report.

Results and Conclusions Reported:
Test results are shown in the table below:

Summary of Stage I and Stage II Test Results

Source	Uncontrolled System (without VRS) lbs/1,000 gal	Balance VRS lbs/1,000 gal	Efficiency Relative to Uncontrolled System
Loading (Stage I)	16.5 [AP-42 EF equation]	0.0 [measured]	100%
Vehicle Fueling	14.6 [AP-42 EF equation]	0.79 [emissions measurement]	94.6%
Spillage/Pseudo-Spillage	0.46	0.02 [measured]	97.8%
Breathing (Pressure Related Fugitives from components such as P/V valves and nozzles)	1.00 [CARB EF]	0.06 [measured]	94.0%
TOTAL	**32.6**	**0.87**	**97.3%**

Comments:
Notes on Specific Emissions Factors:
The vehicle fueling EF may be typical of other GDF with balance Stage II VRS, with similar RVP, percent ORVR.
The UST vent and fugitive EF may be typical of other GDFs with balance Stage II VRS, with P/V valve, with similar RVP, percent ORVR.
The spillage EF may be typical of other GDF with similar nozzles.

As an additional analysis, RSA went back to the original test data and considered the impact of ORVR on Stage II balance systems. RSA noticed a reduction in the average emissions factor when both ORVR and Stage II balance systems were used at the same time. It is not clear whether the emissions factor given is for vehicle refueling only or represents an overall average emissions factor. The table below shows the data.

Impact of ORVR on a Stage II Balance VRS

Model Year	1998	1998	1999
ORVR-equipped	No	Yes	Yes
Number of ORVR-equipped Vehicles	11	5	6
Average Emissions Factor, lb/1,000 gal	0.302	0.050	0.042
Std Deviation of Emissions Factor	0.621	0.045	0.046
Average Vapor Recovery Efficiency, %	98.1	99.7	99.7
Std Deviation of Vapor Recovery Efficiency, %	3.99	0.29	0.29

Source Company/Organization (include Title and date):
DaimlerChrysler Corporation St. Louis Assembly Plant - South, MOPETP Testing Final Report, January 2001 through February 2002. Remote Sensing Air, Inc. for Missouri Department of Natural Resources. May 28, 2004. [Sent by RSA]

MO/PETP Testing Report for DaimlerChrysler Corporation St. Louis Assembly Plant - South, Final Report. URS Corporation for Daimler Chrysler Corporation. January 30, 2003. [Sent by AAM]

Addendum to the MO/PETP Testing Report for DaimlerChrysler Corporation St. Louis Assembly Plant - South, Final Report, for the Single Canister On-Board Refueling Vapor Recovery System MO-PETP Testing Conducted on February 8, 2003. URS Corporation for Daimler Chrysler Corporation. October 16, 2003. [Sent by AAM]

Approval Letter 2004-03 for DaimlerChrysler St. Louis South Assembly Plant. From R. Randolph, MDNR, to T. Tecklenburg, DaimlerChrysler Corporation. [Sent by AAM]

Test Scenario (Describe):
All vehicles from the production area are ORVR, i.e., fuel 100 percent ORVR vehicles. The GDF has a different configuration than traditional. There are two fueling areas, with no return of vapors from the assembly line fueling area to the UST, i.e., no Stage II VRS, and a satellite fueling area, with a balance vapor recovery nozzle that returns vapors to the UST. Fueling at the satellite fueling area is restricted to ORVR vehicles and fueling on weekends is to be limited. The satellite fueling area has a throughput of approximately 1.4 percent, i.e., minimal impact. There are three 20,000 gal USTs located in a tank farm. Gasoline is chilled prior to fueling. The three vent pipes from the USTs are [vapor] manifolded to one vent with a P/V valve. For fueling emissions testing, emissions were collected using a sleeve around the nozzle interface to collect emissions escaping from this area; the emissions from the ORVR canister vent were collected in a second sleeve. (The plant had a Hasstech processor/incinerator as the main vapor recovery control prior to production of all ORVR vehicles but MDNR has since allowed the facility to remove it; the Hasstech incinerator controlled vehicle fueling emissions.) The State agency allowed the facility to remove Stage II VRS for MY2001, i.e., in 2000. Some emissions information is based on calculations.

Emissions Testing Data:
The following MO/PETP tests were conducted:

- Bench Testing (Modified MO/TP-201.2B) - requires bench testing of nozzles, P/V valves, drain valves for transition flow, and leak rates
- Static Pressure (Leak Decay) Testing (MO/TP-201.3)
- Stage I Efficiency Test (MO/TP-201.1)
- Continuous monitoring of storage tanks
- Stage II Efficiency Test (Modified MO/TP-201.2), both dual and single canister ORVR testing
- Spillage and Pseudo-Spillage (MO/TP-201.2C)

Operating Data:
Continuous T and P data of the USTs are available for September 9 through December 20, 2001, for a total of 103 days. Data are available for 146,302 minutes out of 148,320 possible minutes, or 98.6 percent of the time period. The data available for all 103 days are shown in an attached table along with the daily average pressures and the minimum and maximum 1-min P value for each day. Pressures for a typical weekday are shown in an attached graph for Wednesday October 17; pressures for a typical weekend day, when the facility is closed for 2 days, are shown in an attached graph for Sunday October 21. The weekday graph shows increasing pressures (due to vapor growth) overnight and negative pressures during the day while fueling operations are occurring. The average P for the weekday was -3.09 in. w.c. (minimum 1-min P of -7.69 and maximum 1-min P of +1.67 in. w.c.). The weekend day graph shows continued vapor growth and positive pressure for the entire day; the average P for the day was +2.45 in. w.c. (minimum 1-min P of +1.68 and maximum 1-min P of +2.99 in. w.c.).

<u>Frequency plot of all P data</u>. A graph showing the frequency of pressure for the 103 day period is also provided. The pressure is greater than 0 in. w.c. for 43,265 minutes, or 29.6 percent of the time; pressure related fugitive emissions are likely to be occurring during these time periods. The pressure is greater than 3 in. w.c for 6,249 minutes, or 4.2 percent of the time period; UST vent emissions are likely occurring during these period when the P/V valve opens. Because the facility fixed a leak on November 19, the frequency plots are shown for the time period before and after the leak.

<u>Frequency plot for P data before and after a leak is fixed</u>. September 9 through November 19. A frequency plot for the time period before the leak was fixed, from September 9 through November 19, is provided. A frequency plot for the period after the leak was fixed, November 20 through December 20, is also provided. The "before" time periods show that the UST remains at the most negative pressures for approximately half of that following the leak fix (19 percent vs. 48 percent), i.e., with the leak fix, the tank can maintain negative pressures better. In addition, the UST in general will maintain positive pressures for longer periods (4.72 percent) than before the leak fix (4.08 percent); UST vent and fugitive emissions occur during positive pressure periods. For a vapor tight UST, the positive pressures are maintained and UST emissions occur from the UST vent. For a leaking UST, positive pressures are not maintained as long because fugitive leaks are occurring.

The total pressure related fugitive and UST vent emissions were calculated to be 281.3 lb over the 103 day time period; with a fuel throughput of 885,450 gal, the emissions factor for UST fugitives and vent emissions is 0.32 lb/1,000 gal. [This value is slightly higher than the value reported by the facility in the test report, however, no explanation as to why is given.]

Analysis of Frequency Plots for UST Pressure for All Data and Before and After the Fixing Leak

Pressure ranges, in. w.c.	All data		Before leak is fixed		After leak is fixed	
	minutes	%	minutes	%	minutes	%
< -8.0	40,809	27.9%	19,680	19.2%	21,129	48.3%
-8.0 < P < 0.0	62,137	42.5%	50,166	48.9%	11,971	27.4%
<0.0	102,946	70.4%	69,846	68.1%	33,100	75.7%
>0.0	43,265	29.6%	32,651	31.9%	10,614	24.3%
>3.5	6,249	4.27%	4,184	4.08%	2,065	4.72%

Results and Conclusions Reported:

Summary of Emissions Factors and Efficiency Determinations for both Stage I and Stage II (single canister ORVR). **[This is the type or canister currently used; single canister is used on MY2003 and later.]**

Source	Uncontrolled System [in MY2001/2002 mockup tanks] lbs/1,000 gal	Controlled MY2003 - mockup, lbs/1,000 gal	Efficiency Relative to Uncontrolled System
Loading (Stage I)	13.5 [AP-42 EF eqn]	0.13 [measured]	99.0%
Vehicle Fueling	17.56 [emissions measurement]	0.0779 [emissions measurement]	99.6%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.48 [measured]	36.0%
Breathing (Pressure Related Fugitives) - UST em - fugitives	1.0 [modified AP-42 EF]	0.24 [calculated based on P, T, time]	76.0%
TOTAL	**32.87**	**0.93**	**97.2%**

Uncontrolled: No chilling, no ORVR, no Stage II VRS, w/ P/V valve [some vapor return from satellite fueling balance nozzle, but small impact because less gasoline throughput].
Controlled: w/ Chilling, w/ORVR single, No Stage II VRS, w/ P/V valve.
[The controlled breathing emissions estimated from the data are 0.32 lb/1,000 gal, which does the value shown here as provided by the facility in the test report.]

Summary of Emissions Factors and Efficiency Determinations for <u>Stage II alone</u> (single canister ORVR).

Source	**Uncontrolled System [in MY2001/2002 mockup tanks] lbs/1,000 gal**	**Controlled MY2003 - mockup, lbs/1,000 gal**	**Efficiency Relative to Uncontrolled System**
Vehicle Fueling	17.56 [emissions measurement]	0.0779 [emissions measurement]	99.6%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.48 [measured]	36.0%
Breathing (Pressure Related Fugitives) - UST em - fugitives	1.0 [modified AP-42 EF]	0.24 [calculated based on P, T, time]	76.0%
TOTAL	**19.31**	**0.7979**	**95.87%**

Uncontrolled: No chilling, no ORVR, no Stage II VRS, w/ P/V valve [some vapor return from satellite fueling balance nozzle, but small impact because less gasoline throughput].
Controlled: w/ Chilling, w/ORVR single, No Stage II VRS.
[The controlled breathing emissions estimated from the data are 0.32 lb/1,000 gal, which does the value shown here as provided by the facility in the test report.]

Summary of Emissions Factors and Efficiency Determinations for <u>both</u> Stage I and Stage II (dual canister ORVR). **[Dual canisters are no longer in use after MY2002.]**

Source	**Uncontrolled System [MY2001/2002 mockup tanks] lbs/1,000 gal**	**Controlled MY2001/2002, lbs/1,000 gal**	**Efficiency Relative to Uncontrolled System**
Loading (Stage I)	13.5 [AP-42 eqn 3-1]	0.13	99.0%
Vehicle Fueling	17.56 [emissions measurement]	0.014 [emissions measurement]	99.9%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.48 [measured]	36.0%
Breathing (Pressure Related Fugitives) - UST em - fugitives	1.0 [modified AP-42 eqn]	0.24 [<u>calc</u> based on P, T, time]	76.0%
TOTAL	**32.87**	**0.86**	**97.4%**

Uncontrolled: No chilling, no ORVR, no Stage II VRS, w/ P/V valve [some vapor return from satellite fueling balance nozzle, but small impact because less gasoline throughput].
Controlled: w/ Chilling, No Stage II VRS, w/ORVR dual.
[The controlled breathing emissions estimated from the data are 0.32 lb/1,000 gal, which does the value shown here as provided by the facility in the test report.]

Summary of Emissions Factors and Efficiency Determinations for Stage II alone (dual canister ORVR).

Source	Uncontrolled System [in MY2001/2002 mockup tanks] lbs/1,000 gal	Controlled MY2001/2002, lbs/1,000 gal	Efficiency Relative to Uncontrolled System
Vehicle Fueling	17.56 [emissions measurement]	0.014 [emissions measurement]	99.9%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.48 [measured]	36.0%
Breathing (Pressure Related Fugitives) - UST em - fugitives	1.0 [modified AP-42 eqn]	0.24 [calc based on P, T, time]	76.0%
TOTAL	**19.31**	**0.734**	**96.2%**

Uncontrolled: No chilling, no ORVR, no Stage II VRS, w/ P/V valve [some vapor return from satellite fueling balance nozzle, but small impact because low gasoline throughput].
Controlled: w/ Chilling, No Stage II VRS, w/ORVR dual.

Comments:
Because the leak decay test is conducted during off-production hours when there is continual pressurizing of the tank with vapor growth, the growth may mask a leak greater than the allowed amount. MO DNER recommended that it might be more productive to require continuous monitoring for one month every 5 years rather than the leak decay test.

The operating data for the UST pressures show that the system is at positive pressure (i.e., greater than 0.0 in. w.c.) for 720 hours out of the 103 day period, or 29 percent of the time. Because gasoline dispensing stops for longer periods over weekends in addition to overnight periods, these USTs likely operate at positive pressure for a higher percentage of time than would likely be seen at traditional uncontrolled GDF. These periods at pressures greater than 0.0 in. w.c. are when UST fugitive and vent emissions occur.

Chilling of the gasoline suppresses vaporization and therefore emissions, so vehicle fueling emissions are lower than they would be otherwise at ambient conditions. Chilling of gasoline is a unique operating condition that is used at several, but not all, facilities nationwide; chilling may not be representative of automobile manufacturers nationwide.

The green tank effect, i.e., no gasoline vapors present prior to fueling, may affect the vehicle fueling emissions, likely affects the refueling emissions levels. AAM has indicated that refueling emissions would be lower with the green tank effect, however, one State agency indicated that the emissions may be higher, particularly for the immediate splash into the vehicle tank, then the emissions would be similar to refueling emissions for the remainder of the fueling event. At any rate, these data may not be representative of traditional refueling at GDF.

The emissions levels from the UST tank are essentially similar to an uncontrolled UST (i.e, no Stage II VRS) with a P/V valve and may be representative of traditional refueling at GDF, with one noted difference. One difference in the UST emissions would be that the facility typically fuels on Monday through Friday and shut downs over the weekend (i.e., no fueling operations for a 2-day period), causing an extended vapor growth period and more UST fugitive and vent emissions. A traditional GDF would be open 7 days per week without an extended shut down or vapor growth period. The emissions levels for UST emissions shown in this report may actually be higher than UST emissions from a traditional GDF.

<u>Notes on Specific Emissions Factors</u>:
Uncontrolled vehicle fueling EFs with ambient T fuel may be affected by the green tank effect.
Vehicle fueling EFs with ORVR-control with ambient temperature fuel may be affected by the green tank effect.
Vehicle fueling EFs with ORVR-control and with chilled gasoline may be lower because of the lower vapor pressure of the gasoline and may be affected by the green tank effect.
Vehicle fueling EFs with chilled gasoline may be lower because of the lower vapor pressure of the gasoline and may be affected by the green tank effect.
Uncontrolled UST vent and fugitives EF with P/V valve may be similar to other uncontrolled tanks (i.e., non-Stage II VRS) with one noted difference, increased UST emissions related to the longer shut down periods of the facility.

Daily Average Tank Pressures from September 9 to December 20, 2001

Date	CountOfTP_"WC	Percent Complete	AvgOfTP_"WC	MinOfTP_"WC	MaxOfTP_"WC
9/9/2001	1439	99.93%	1.21	0.033	3.046
9/10/2001	1440	100.00%	-6.42	-9.62	0.375
9/11/2001	1440	100.00%	-2.62	-9.59	3.296
9/12/2001	1440	100.00%	-5.37	-9.69	3.025
9/13/2001	1440	100.00%	-5.91	-9.81	3.785
9/14/2001	316	21.94%	-2.06	-7.69	2.69
9/15/2001	1440	100.00%	-5.03	-8.98	3.506
9/16/2001	1440	100.00%	1.09	-7.01	3.104
9/17/2001	1440	100.00%	-4.10	-9.49	3.171
9/18/2001	1440	100.00%	-5.34	-9.44	3.83
9/19/2001	1440	100.00%	-6.66	-9.25	1.19
9/20/2001	1440	100.00%	-6.59	-9.65	0.939
9/21/2001	1440	100.00%	-4.60	-9.2	0.874
9/22/2001	1440	100.00%	-3.02	-9.26	2.909
9/23/2001	1440	100.00%	2.27	0.428	3.199
9/24/2001	1440	100.00%	-5.08	-9.59	0.424
9/25/2001	1440	100.00%	-5.75	-9.57	3.7
9/26/2001	1440	100.00%	-5.33	-9.91	4.451
9/27/2001	1440	100.00%	-4.58	-9.59	2.578
9/28/2001	1440	100.00%	-5.79	-9.52	0.968
9/29/2001	1440	100.00%	1.44	-6.571	3.115
9/30/2001	1440	100.00%	-0.57	-9.77	2.98
10/1/2001	1440	100.00%	-4.10	-8.67	0.727
10/2/2001	1439	99.93%	-5.91	-9.43	0.229
10/3/2001	1440	100.00%	-3.75	-9.42	1.61
10/4/2001	1440	100.00%	-4.00	-8.97	0.433
10/5/2001	1440	100.00%	-4.03	-9.05	1.44
10/6/2001	1440	100.00%	1.95	-5.371	3.29
10/7/2001	1440	100.00%	2.83	2.491	3.141
10/8/2001	1440	100.00%	-0.43	-8.77	2.813
10/9/2001	1440	100.00%	-3.09	-8.03	1.205
10/10/2001	1440	100.00%	-2.72	-6.986	2.324
10/11/2001	1440	100.00%	-2.55	-7.23	1.681
10/12/2001	1440	100.00%	-1.99	-4.023	1.561
10/13/2001	1440	100.00%	-5.24	-9.19	2.985
10/14/2001	1440	100.00%	-0.26	-8.83	1.772
10/15/2001	1440	100.00%	-4.23	-9.21	0.497
10/16/2001	1440	100.00%	-3.39	-7.67	2.471
10/17/2001	1440	100.00%	-3.09	-7.69	1.669
10/18/2001	1440	100.00%	-4.03	-9.19	0.453
10/19/2001	1440	100.00%	-4.76	-9.79	3.46
10/20/2001	1440	100.00%	1.92	-4.306	3.106
10/21/2001	1440	100.00%	2.45	1.679	2.993
10/22/2001	1440	100.00%	-4.64	-9.65	2.851
10/23/2001	1440	100.00%	-5.02	-9.03	2.332
10/24/2001	1440	100.00%	-4.76	-9.8	1.642
10/25/2001	1440	100.00%	-5.54	-9.99	1.795
10/26/2001	1440	100.00%	-4.35	-9.91	4.733
10/27/2001	1440	100.00%	-1.45	-6.871	3.198
10/28/2001	1439	99.93%	1.38	-2.688	3.123
10/29/2001	1440	100.00%	-3.62	-9.83	2.911
10/30/2001	1440	100.00%	-4.48	-9.8	3.434
10/31/2001	1440	100.00%	-4.52	-9.66	3.557
11/1/2001	1440	100.00%	-6.30	-10.05	2.944
11/2/2001	1440	100.00%	-7.69	-9.89	0.008
11/3/2001	1440	100.00%	-3.53	-9.48	2.109

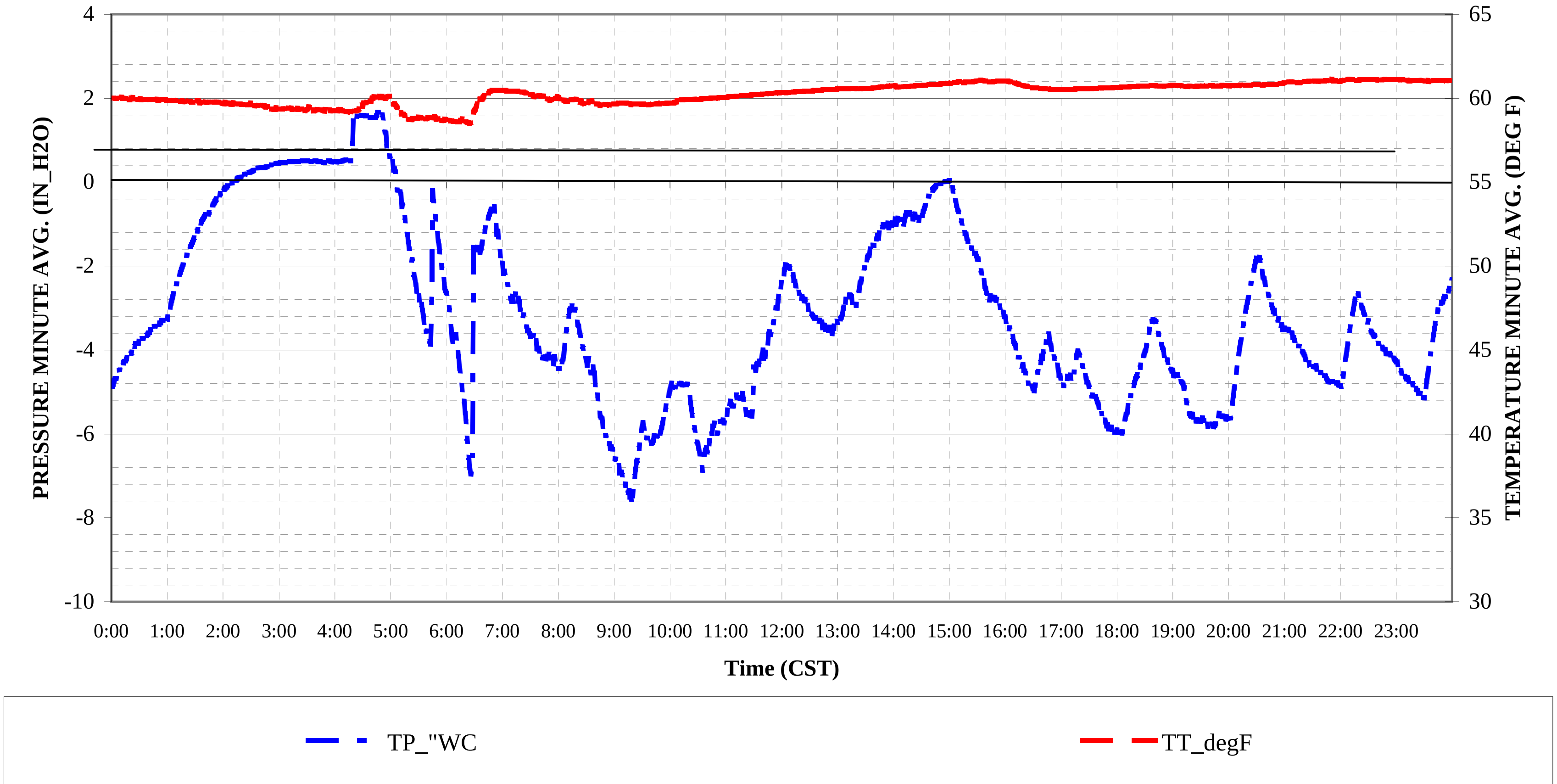
Date	CountOfTP_"WC	Percent Complete	AvgOfTP_"WC	MinOfTP_"WC	MaxOfTP_"WC
11/4/2001	1440	100.00%	1.89	-2.764	4.815
11/5/2001	1440	100.00%	-4.49	-9.76	3.041
11/6/2001	1440	100.00%	-6.42	-9.78	2.735
11/7/2001	1440	100.00%	-6.50	-9.84	1.469
11/8/2001	1440	100.00%	-7.19	-9.91	1.726
11/9/2001	1440	100.00%	-5.96	-9.68	3.789
11/10/2001	1440	100.00%	1.00	-8.75	4.117
11/11/2001	1440	100.00%	2.42	0.864	3.269
11/12/2001	1440	100.00%	-4.27	-9.7	3.091
11/13/2001	1440	100.00%	-6.56	-9.88	4.457
11/14/2001	1440	100.00%	-7.07	-10.06	0.809
11/15/2001	1440	100.00%	-6.75	-10.03	0.649
11/16/2001	1440	100.00%	0.83	-9.59	3.387
11/17/2001	1440	100.00%	2.64	2.155	2.918
11/18/2001	1438	99.86%	2.50	-9.7	3.037
11/19/2001	1440	100.00%	-5.06	-9.84	2.845
11/20/2001	1440	100.00%	-6.43	-9.9	3.504
11/21/2001	1440	100.00%	-5.73	-9.91	18.52
11/22/2001	1440	100.00%	0.71	-9.94	3.416
11/23/2001	1440	100.00%	2.74	2.013	3.069
11/24/2001	1440	100.00%	1.99	0.175	5.802
11/25/2001	1440	100.00%	-1.58	-3.004	0.174
11/26/2001	1440	100.00%	-6.03	-9.81	0.644
11/27/2001	1440	100.00%	-7.62	-9.87	5.501
11/28/2001	1440	100.00%	-7.55	-9.88	3.706
11/29/2001	1440	100.00%	-7.55	-9.85	12.81
11/30/2001	1440	100.00%	-7.95	-9.87	0.979
12/1/2001	1440	100.00%	-7.98	-9.95	4.411
12/2/2001	1440	100.00%	0.79	-9.79	3.359
12/3/2001	1440	100.00%	-5.61	-9.9	3.033
12/4/2001	1440	100.00%	-7.86	-10.01	-0.486
12/5/2001	1440	100.00%	-7.91	-10	0.007
12/6/2001	1440	100.00%	-7.89	-9.94	1.46
12/7/2001	1440	100.00%	-8.17	-9.97	-0.538
12/8/2001	1440	100.00%	-6.65	-9.9	1.207
12/9/2001	1440	100.00%	-1.27	-9.37	3.225
12/10/2001	1440	100.00%	-5.59	-9.95	3.033
12/11/2001	1440	100.00%	-7.82	-9.99	0.071
12/12/2001	1440	100.00%	-8.45	-9.98	-2.843
12/13/2001	1440	100.00%	-8.30	-9.96	-3.341
12/14/2001	551	38.26%	-7.29	-9.96	1.042
12/15/2001	1440	100.00%	1.27	-9.85	3.268
12/16/2001	1440	100.00%	2.92	1.843	3.099
12/17/2001	1440	100.00%	-5.53	-9.93	3.097
12/18/2001	1440	100.00%	-8.14	-9.96	-2.528
12/19/2001	1440	100.00%	-8.01	-9.99	-0.316
12/20/2001	1440	100.00%	-6.71	-10.01	3.989

103 days total during time period

148,320 total minutes during time period	146,302	minutes available data	98.64%
2,472 total hours during the time period	2,438	hours available data	98.64%

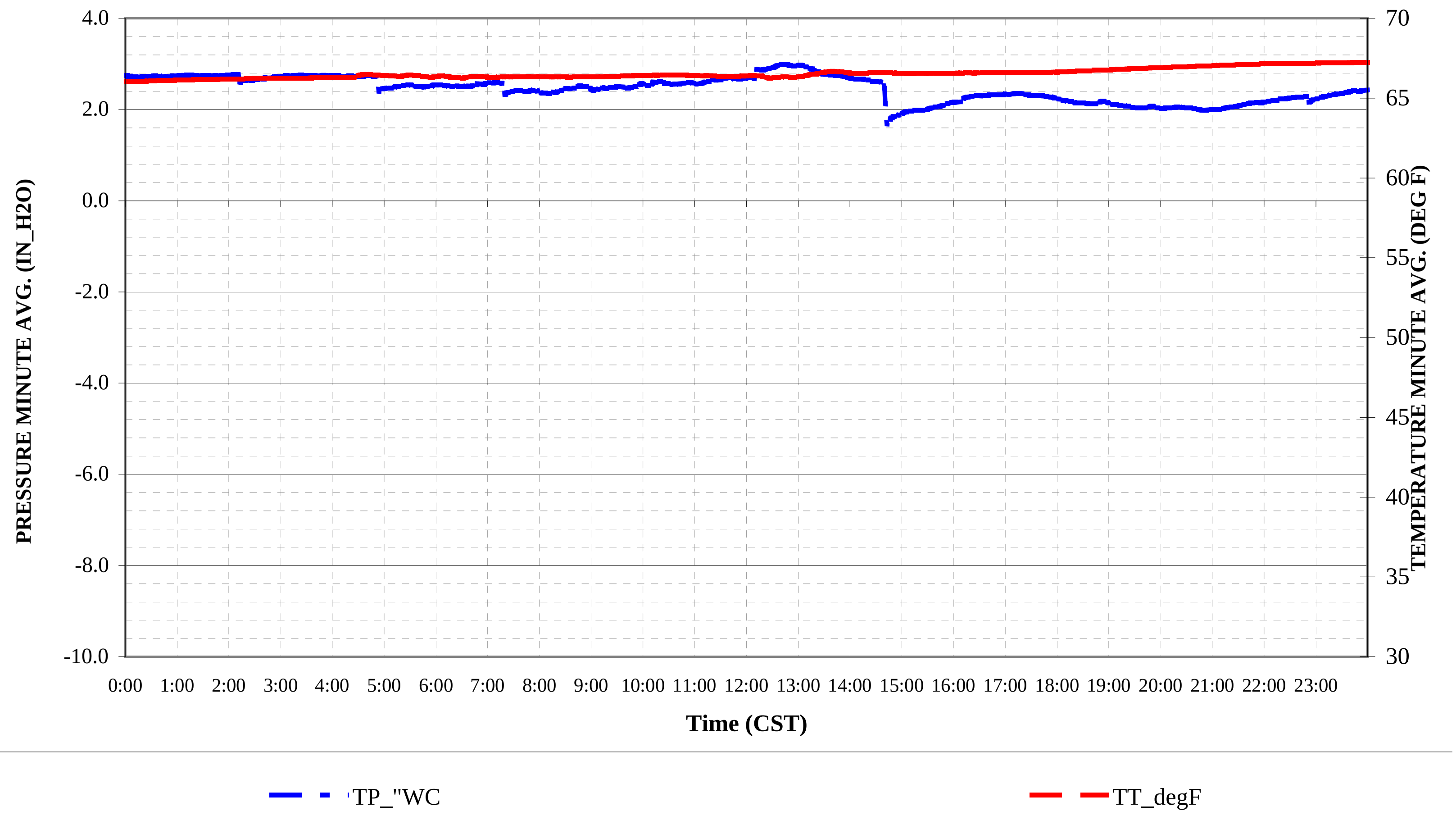
Daimler Chrysler MOPETP

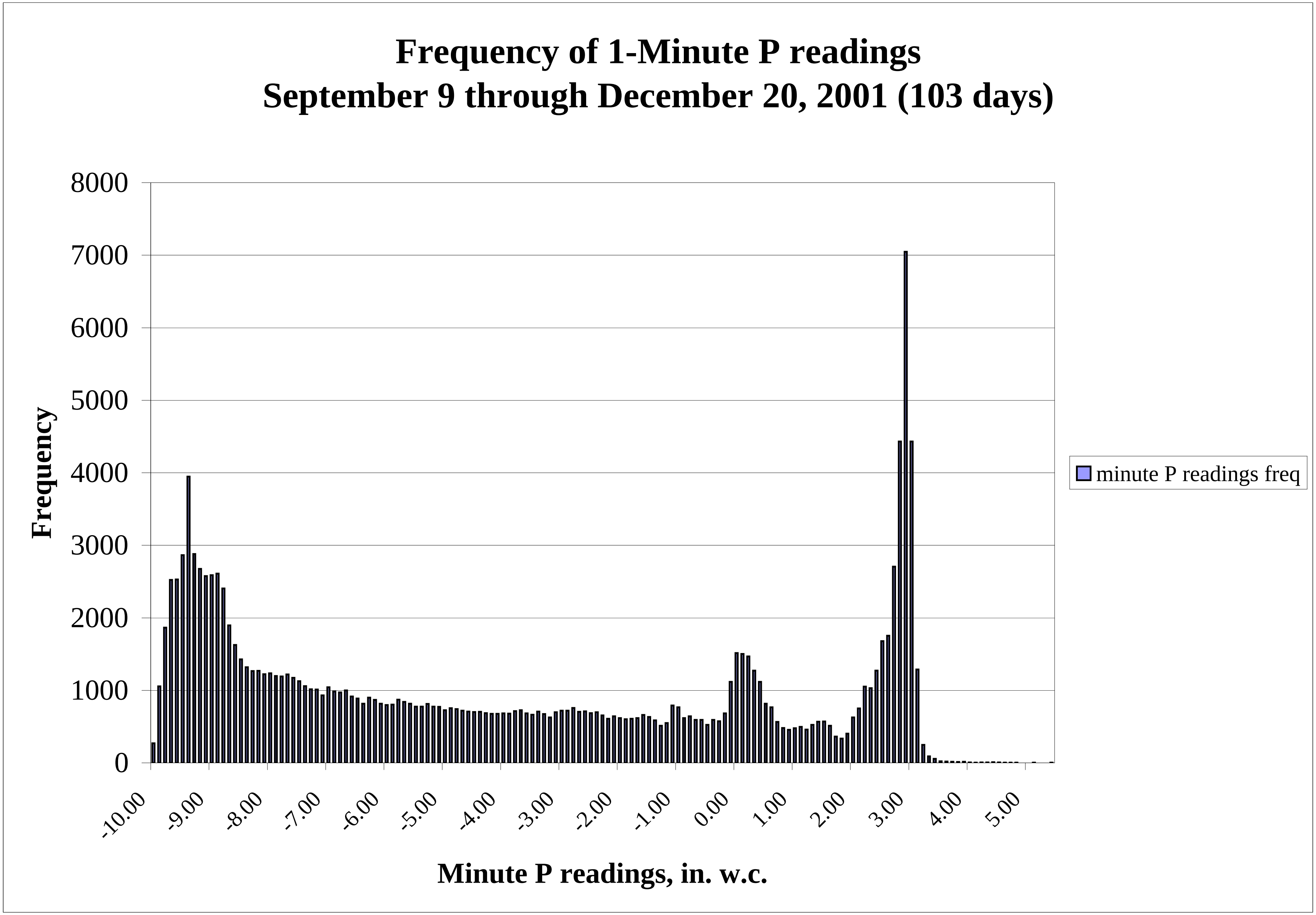
Wednesday October 17, 2001



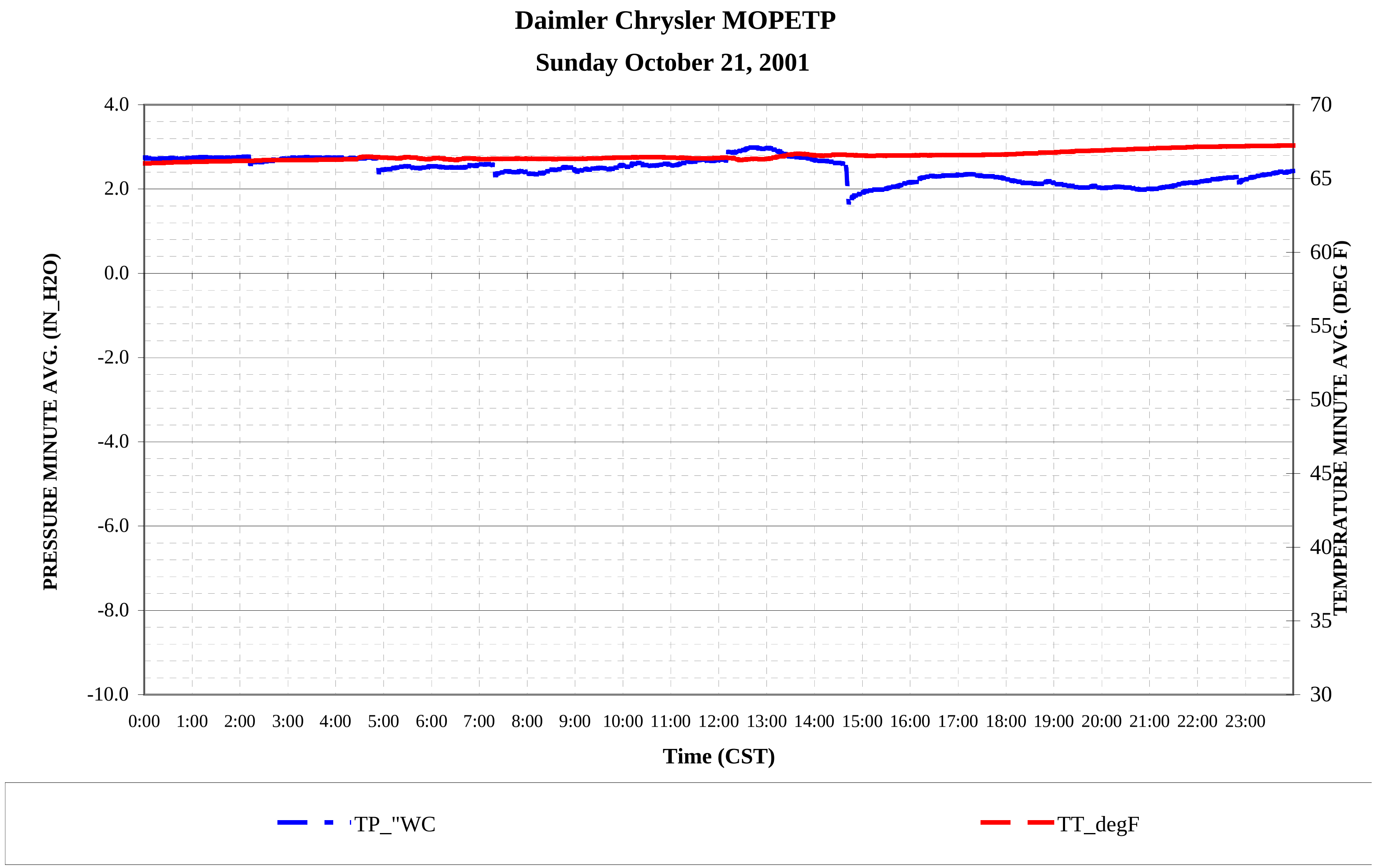
Daimler Chrysler MOPETP

Sunday October 21, 2001

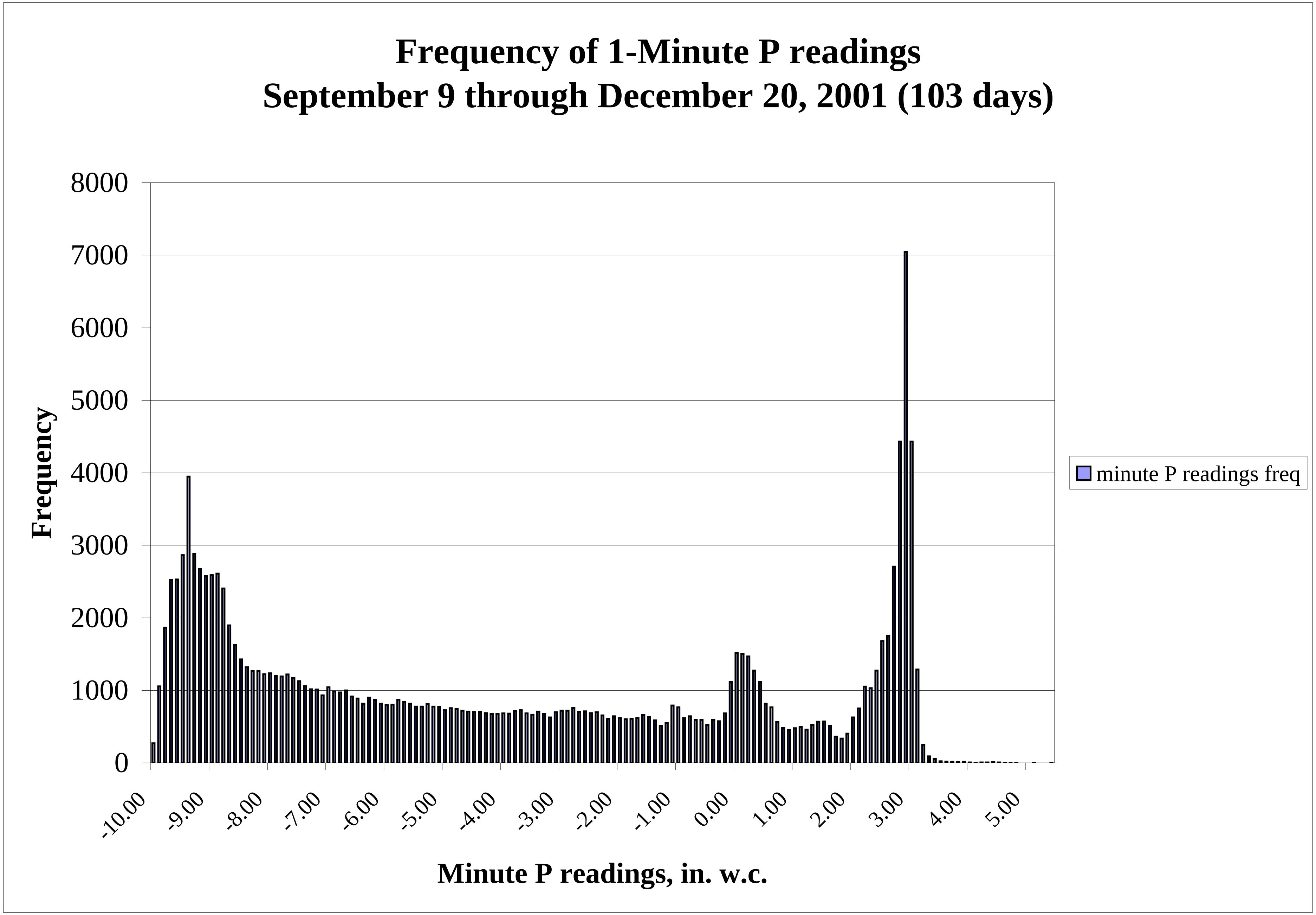




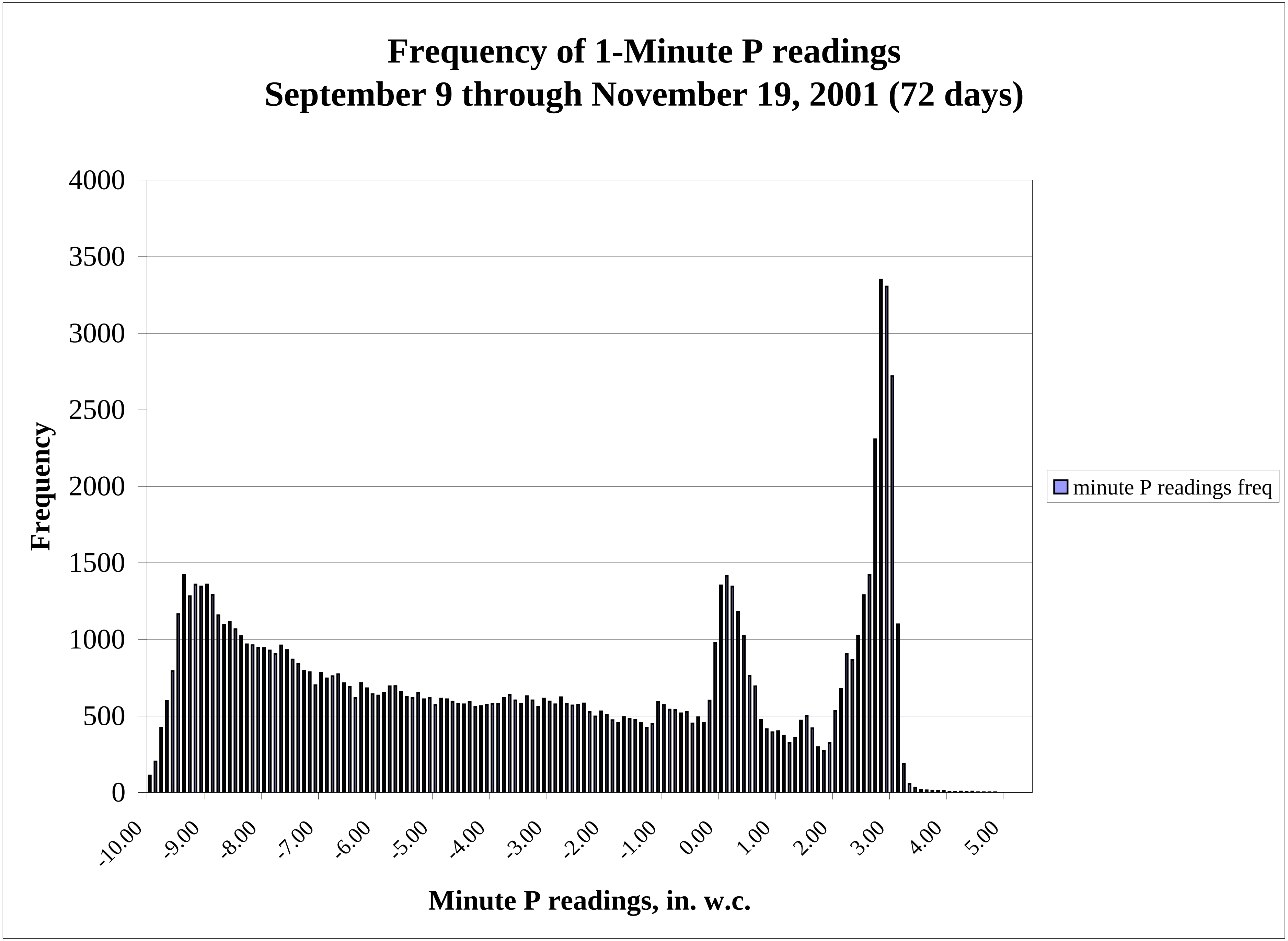
These data are for an uncontrolled UST with no vapor returned to the tank; there is a P/V valve on the UST vent.
A total of 10 minutes with pressure greater than +5.5 in. w.c. occurred over the 103 day period and are not shown in this graph.



Daimler Chrysler MOPETP
Sunday October 21, 2001
PRESSURE MINUTE AVG. (IN_H2O)
4.0
2.0
0.0
-2.0
-4.0
-6.0
-8.0
-10.0
TEMPERATURE MINUTE AVG. (DEG F)
70
65
60
55
50
45
40
35
30
0:00 1:00 2:00 3:00 4:00 5:00 6:00 7:00 8:00 9:00 10:00 11:00 12:00 13:00 14:00 15:00 16:00 17:00 18:00 19:00 20:00 21:00 22:00 23:00
Time (CST)
TP_"WC
TT_degF

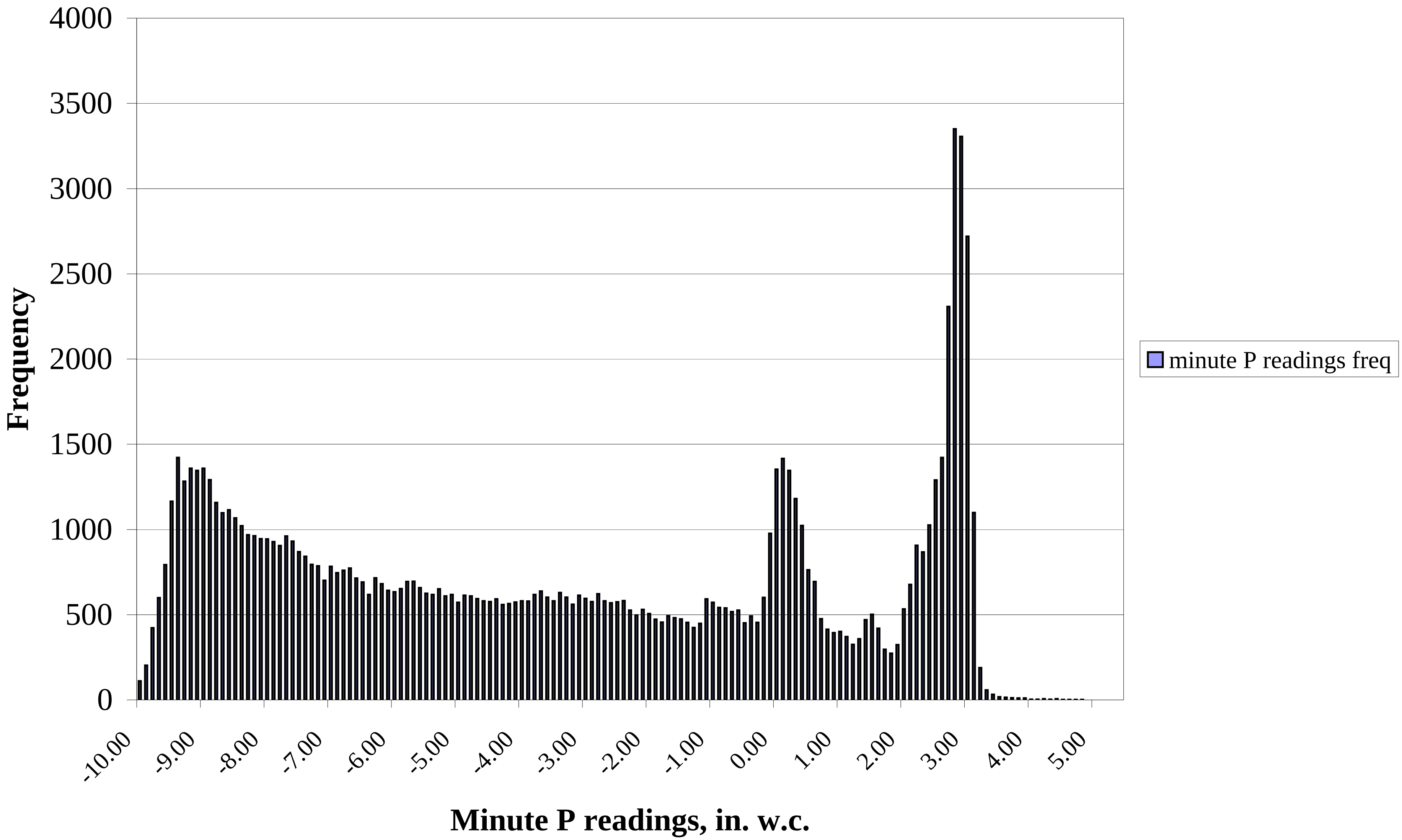


These data are for an uncontrolled UST with no vapor returned to the tank; there is a P/V valve on the UST vent.
A total of 10 minutes with pressure greater than +5.5 in. w.c. occurred over the 103 day period and are not shown in this graph.

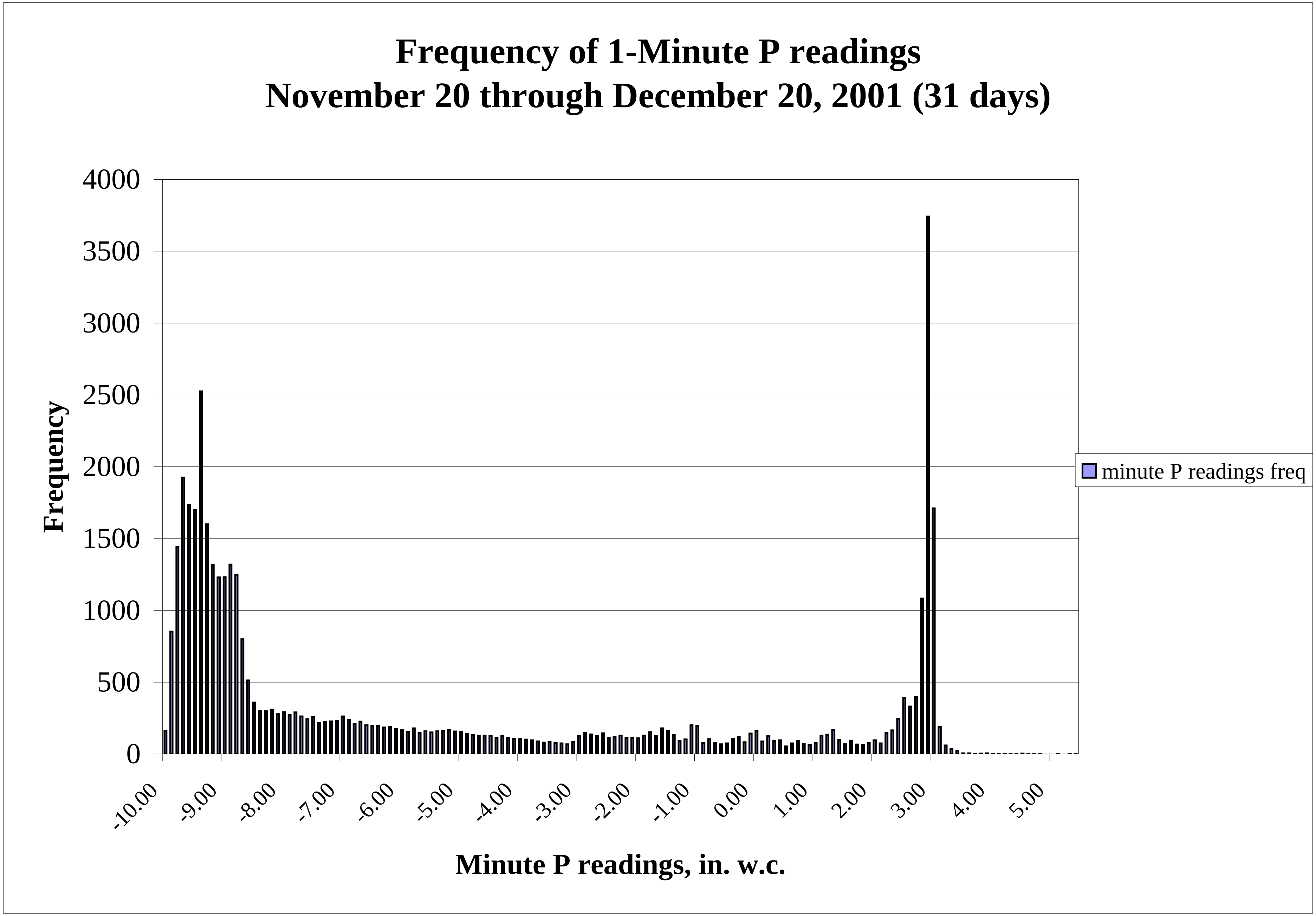


These data are for an uncontrolled UST with no vapor returned to the tank; there is a P/V valve on the UST vent.
There was leak occurring during this time period.

Frequency of 1-Minute P readings
September 9 through November 19, 2001 (72 days)



These data are for an uncontrolled UST with no vapor returned to the tank; there is a P/V valve on the UST vent.
There was leak occurring during this time period.



These data are for an uncontrolled UST with no vapor returned to the tank; there is a P/V valve on the UST vent.

These data are for after a leak was fixed.

A total of 10 minutes with P > +5.5 in. w.c. occurred over the 31 day period and are not shown.

Calculation of Pressure-Related Fugitives for September 9 through December 20, 2001

TP1	TP2	SumOfMinutes	AvgOfLPM	VolL	LBS HC
0.25	0.75	5,087	0.02	76.31	0.27
0.75	1.25	2,395	0.04	95.80	0.34
1.25	1.75	2,574	0.06	144.79	0.52
1.75	2.25	2,835	0.15	418.95	1.51
2.25	2.75	7,639	0.40	3,074.70	11.06
2.75	3.25	18,675	2.00	37,277.38	134.06
3.25	3.75	273	4.35	1,186.71	4.27
3.75	4.25	47	44.45	2,089.09	7.51
4.25	4.75	26	64.33	1,672.49	6.01
4.75	5.25	5	104.08	520.41	1.87
5.25	5.75	4	143.84	575.36	2.07
5.75	6.25	1	183.60	183.60	0.66
6.25	6.75	2	223.35	446.70	1.61
6.75	7.25	1	263.11	263.11	0.95
7.25	7.75	1	302.86	302.86	1.09
7.75	8.25	1	342.62	342.62	1.23
8.25	8.75	1	382.38	382.38	1.38
8.75	9.25	1	422.13	422.13	1.52
9.25	9.75	0	461.89	0.00	0.00
9.75	10.25	3	501.64	1,504.93	5.41
10.25	10.75	0	541.40	0.00	0.00
10.75	11.25	0	581.16	0.00	0.00
11.25	11.75	0	620.91	0.00	0.00
11.75	12.25	2	660.67	1,321.34	4.75
12.25	12.75	2	700.43	1,400.85	5.04
12.75	13.25	1	740.18	740.18	2.66
13.25	13.75	2	779.94	1,559.88	5.61
13.75	14.25	1	819.69	819.69	2.95
14.25	14.75	0	859.45	0.00	0.00
14.75	15.25	4	899.21	3,596.83	12.93
15.25	15.75	2	938.96	1,877.93	6.75
15.75	16.25	3	978.72	2,936.16	10.56
16.25	16.75	5	1018.48	5,092.38	18.31
16.75	17.25	2	1058.23	2,116.46	7.61
17.25	17.75	1	1097.99	1,097.99	3.95
17.75	18.25	1	1137.74	1,137.74	4.09
18.25	18.75	3	1177.50	3,532.50	12.70
18.75	19.25	0	1217.26	0.00	0.00
19.25	19.75	0	1257.01	0.00	0.00
19.75	20.25	0	1296.77	0.00	0.00
20.25	20.75	0	1336.52	0.00	0.00
20.75	21.25	0	1376.28	0.00	0.00
21.25	21.75	0	1416.04	0.00	0.00
21.75	22.25	0	1455.79	0.00	0.00
22.25	22.75	0	1495.55	0.00	0.00

SumOfLBS HC	SumOfGallons Dropped	Expr1	
281.26	885,450	0.3176	lb/1,000 gal

>0.25 in. w.c.	39,600	minutes	281.26	lbs HC
p-related fug em and UST	27.50	days		
	660	hours		
>3 in. w.c.	19,070	minutes		
UST vent P/V valve em	13.24	days		
	318	hours		

Data Source Company/Organization (include Title and date):
MO/PETP Testing Report for Ford Motor Company St. Louis Assembly Plant, Hazelwood, Missouri. URS Corporation. August 27, 2003. [Sent by AAM]

Approval Letter 2004-01 for Ford Motor Assembly Plant. From L. Mosby, MDNR, to M. Szafranski, Ford Motor Company. [Sent by AAM]

Ford Hazelwood MOPETP Testing Final Report, Ford Motor Company, St. Louis Assembly Plant (SLAP), Hazelwood, Missouri. July 2002 through March 2003. Remote Sensing Air, Inc., for Missouri Department of Natural Resources (DNR). [Sent by RSA]

Test Scenario (Describe):
All vehicles fueled at the facility are 100 percent ORVR vehicles. No Stage II controls (no return of vapors to the UST) are used. No UST vent control devices are used (i.e., no vapor processor). There is one 30,000-gal UST tank, with 2 UST vents; one of these UST vents was permanently capped off, and the other UST vent has a P/V valve. All models have the same fuel tank, fill port, and ORVR canister configuration for a given model year. MY2003 vehicles were in production at the time of the test, and all were dual canister systems for ORVR. [In MY2004 and later model years, a single canister was used.] Both types of canisters were tested: MY2003 as fully produced vehicles and MY2004 as mockups. Emissions were collected with a sleeve around the nozzle interface. Emissions at the outlet of the ORVR canister were routed to the area of the nozzle fillport, so both sources of emissions are measured. The only vehicle fueling emissions are at the nozzle/fillport interface. Prior to testing, MDNR had approved disconnection of the Stage II vapor recovery control system because all vehicles are ORVR.

Gasoline is chilled to approximately 43°F prior to fueling. A special nozzle prevents spillage by via purge-puff. For MY2003, unchilled gasoline fueling was performed without ORVR; these emissions will match up to the MY2004 emissions tests as well because the vehicle fuel tanks are identical. Some emissions information is based on calculations.

Emissions Testing Data:
The following MO/PETP tests were conducted:

- Bench Testing (Modified MO/TP-201.2B) - requires bench testing of nozzles, P/V valves, drain valves for transition flow, and leak rates
- Static Pressure (Leak Decay) Testing (Modified MO/TP-201.3B)
- Stage I Efficiency Test (MO/TP-201.1)
- Stage II Efficiency Test (Modified MO/TP-201.2)
- Spillage and Pseudo-Spillage (MO/TP-201.2C)
- Final V/L Testing

Operating Data:
Some typical operating data are available in the final test report. Continuous T and P data for 5 months were recorded as part of the system testing; the facility provided example data for 11 of these days, November 8 through November 18, 2002. The data available for all 11 days are

shown in the table below with the daily average pressure and the minimum and maximum 1-min P value for each day; data are provided for both the north end and the south end of the UST (pressure is monitored at two locations within the tank). In general, the pressure pattern shows high vacuum during production operations on weekdays (i.e., during fueling) and high pressures at the cracking P of the P/V valves during off times, i.e., overnight and over weekends. The weekday graphs show increasing pressures (due to vapor growth) overnight and negative pressures during the day while fueling operations are occurring. On Friday November 8, the average pressure for the day for the north end of the UST was -6.10 in. w.c. (minimum 1-min P of -9.29 in. w.c. and maximum 1-min P of +3.38 in. w.c.). The weekend day graphs show continued vapor growth and positive pressure for the entire day. On Sunday November 10, the average pressure for the day at the north end of the UST was 2.58 in. w.c. (minimum 1-min P of 1.26 in. w.c. and maximum 1-min P of +3.32 in. w.c.)

There are several weekdays with pressure spikes in mid-afternoon when ostensibly the facility would be operating and fueling vehicles; it is not clear what event these pressure spikes represent. [These data plots were provided in hardcopy and not in color; it was difficult to decipher which line represented which data. We made assumptions regarding which lines were tank P.]

Summary of Weekday and Weekend UST Vent Pressures

Pressure, in. w.c.	Friday, 11/08		Saturday, 11/09		Sunday, 11/10		Monday, 11/11		Tuesday, 11/12		Wednesday, 11/13		Thursday, 11/14	
	N	S	N	S	N	S	N	S	N	S	N	S	N	S
Minimum	-9.29	-10.62	-9.12	-10.48	1.26	1.19	-9.16	-10.72	-9.25	-10.65	-9.23	-10.58	NA	NA
Maximum	3.37	3.30	3.40	3.35	3.32	3.22	3.36	3.34	3.39	3.38	3.63	3.58	3.59	3.51
Average	-6.10	-6.87	1.80	1.62	2.58	2.49	-5.27	-5.90	-6.59	-7.33	-5.81	-6.43	-15.44	-11.17
Pressure, psi	**Friday, 11/15**		**Saturday, 11/16**		**Sunday, 11/17**		**Monday, 11/18**							
	N	S	N	S	N	S	N	S						
Minimum	-9.06	-10.47	1.60	1.52	2.27	2.26	-9.29	-10.77						
Maximum	3.38	3.35	3.12	3.06	3.04	3.03	3.06	3.03						
Average	1.58	1.44	2.64	2.59	2.79	2.76	-5.08	-5.77						

Note: Data are provided for pressure gauges at both the north (N) and south (S) ends of the UST.

Results and Conclusions Reported:

Summary of Emissions Factors and Efficiency Determinations for both Stage I and Stage II.

Source	Uncontrolled System MY2003 mockup tanks, dual canister lb/1,000 gal	MY 2003 assembly line, dual canister lb/1,000 gal	Efficiency Relative to Uncontrolled System	MY2004 mockup tanks, single canister, lb/1,000 gal	Efficiency Relative to Uncontrolled System
Loading (Stage I)	13.5 [AP-42 EF eqn]	0.0 [measured]	100%	same	same
Vehicle Fueling	13.5 [emissions measurement]	0.0118 [emissions measurement]	99.9%	0.0033 [emissions measurement]	greater than 99.9%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.063 [measured]	91.6%	same	same
Breathing (Pressure Related Fugitives) - UST em - fugitives	2.09 [modified AP-42 EF]	0.267 [calculation based on P, T, time]	87.2%	same	same
TOTAL	**29.9**	**0.342**	**98.8%**	**0.333**	**98.9%**

Uncontrolled: No chilling of gasoline, no ORVR, no Stage II VRS, and with P/V valve.
Controlled: Chilling of gasoline, with ORVR, no Stage II VRS, with P/Vvalve, and with purge puff nozzle.

Summary of Emissions Factors and Efficiency Determinations for Stage II alone.

Source	Uncontrolled System MY2003 mockup tanks, dual canister, lb/1,000 gal	MY 2003 assembly line, dual canister, lb/1,000 gal	Efficiency Relative to Uncontrolled System	MY2004 in mockup tanks, single canister, lb/1,000 gal	Efficiency Relative to Uncontrolled System
Vehicle Fueling	13.5 [emissions measurement]	0.0118 [emissions measurement]	99.9%	0.0033 [emissions measurement]	greater than 99.9%
Spillage/Pseudo-Spillage	0.75 [CARB EF]	0.063 [measured]	91.6%	same	same
Breathing (Pressure Related Fugitives) - UST em - fugitives	2.09 [modified AP-42 EF]	0.267 [calculation based on P, T, time]	87.2%	same	same
TOTAL	**16.3**	**0.342**	**97.9%**	**0.333**	**98.0%**

Uncontrolled: No chilling of gasoline, no ORVR, no Stage II VRS, w/ P/V valve.
Controlled: Chilling of gasoline, with ORVR, no Stage II VRS, with P/V valve, and with purge puff nozzle.

In addition to the testing shown in the tables above, an additional analysis of the mockup testing for MY2003 showed controlled vehicle fueling emissions levels of 0.1965 lb/1000 gal, which is a control efficiency of 98.5 percent. These data are representative of ambient temperature fuel, no Stage II VRS, and dual canister ORVR.

Comments:
Breathing emissions from the UST vent are unrelated to throughput.

At automobile manufacturing facilities, the gasoline dispensing stops for longer periods over weekends in addition to overnight periods. The UST at automobile manufacturing facilities likely operate at positive pressure for a higher percentage of time than would be likely at a traditional uncontrolled GDF. These periods at pressures greater than 0.0 in. w.c. are when UST fugitive and vent emissions occur.

Chilling of gasoline suppresses vaporization and therefore emissions, so vehicle fueling emissions are lower than they would be otherwise at ambient conditions. Chilling of gasoline is a unique operating condition that is used at several, but not all, facilities nationwide; chilling may not be representative of automobile manufacturers nationwide.

The green tank effect, i.e., no gasoline vapors present prior to fueling, may affect the vehicle fueling emissions. AAM has indicated that refueling emissions would be lower with the green tank effect because no vapors are present to be displaced, however, one State agency has indicated that the emissions may be higher, particularly for the immediate splash into the vehicle tanks, then the emissions would be similar to refueling emissions for the remainder of the fueling event. At any rate, the green tank effect is a universal condition for all automobile manufacturers, and these data may not be representative of traditional refueling at GDF.

The emissions levels from the UST tank are essentially similar to an uncontrolled UST (i.e, no Stage II VRS) with a P/V valve and may be representative of traditional refueling at GDF, with one noted difference. One difference in the UST emissions would be that the facility typically fuels on Monday through Friday and shut downs over the weekend (i.e., no fueling operations for a 2-day period), causing an extended vapor growth period and more UST fugitive and vent emissions. A traditional GDF would be open 7 days per week without an extended shut down or vapor growth period. The levels for UST emissions shown in this report may actually be higher than UST emissions from a traditional GDF.

<u>Notes on Specific Emissions Factors</u>:
Uncontrolled vehicle fueling EFs with ambient T fuel may affected by the green tank effect.
Vehicle fueling EFs with ORVR-control with ambient temperature fuel may be affected by the green tank effect.
Vehicle fueling EFs with ORVR-control and with chilled gasoline may be lower because of the lower vapor pressure of the gasoline and may be affected by the green tank effect.
Vehicle fueling EFs with chilled gasoline may be lower because of the lower vapor pressure of the gasoline and may be affected by the green tank effect.
Uncontrolled UST vent and fugitives EF with P/V valve may be similar to other uncontrolled

tanks (i.e., non-Stage II VRS) with one noted difference, increased UST emissions related to the longer shut down periods of the facility.
Spillage EF is for a purge puff nozzle.

Source Company/Organization:
New Hampshire DES Report on MTBE Levels in Groundwater Near GDF. September 30, 2004. [Submitted by Healy, Inc.]

Test Scenario:
NH DES monitored approximately 300 GDF in New Hampshire to determine the extent of groundwater pollution with MTBE. The GDF monitored included a number of different control types, including balance, vacuum assist, and some GDF without Stage II VRS controls. MTBE is an oxygenate additive to gasoline that is used to reduce CO emissions from automobiles and improve attainment with the NAAQS.

Operating Data:
None.

Results and Conclusions Reported:
The groundwater monitoring data show that a number of the 300 GDF have detectable levels of MTBE and a number have exceeded the groundwater limit. The standard for MTBE in groundwater is 13 ppb. Approximately 88 GDF exceed the limit, and 51 of these are confirmed vacuum assist VRS that are not ORVR-compatible. The table below summarizes the data for the GDF.

Comments:
None.

Summary of MTBE Concentration Data in Groundwater at GDF in New Hampshire.

Site No.	Historical MTBE high, ppb	Recent range MTBE, ppb	Last MTBE reading, ppb	Type of control	Site No.	Historical MTBE high, ppb	Recent range MTBE, ppb	Last MTBE reading, ppb	Type of control
1	5,800	44-5,800	480	Exempt	22	NA	NA	NA	Exempt
2	11,000	2,270-4,300	4,300	Gilbarco Retrofit	23	NA	NA	NA	Coaxial, Exempt
3	150,000	3,580-7,460	6,250	Balance	24	16,000	272 to 16,000	16,000	Gilbarco Retrofit
4	NA	NA	NA	Wayne Vapor Vac	25	NA	NA	NA	2 pt. Gilbarco
5	108,000	55-20,300	55	Balance	26	6,500	2,200-6,500	2,200	Manifolded, Unknown
6	NA	NA	NA	Exempt, Manifolded	27	190,000	20,000-190,000	33,000	2 pt. Gilbarco
7	150,000	17,000-46,000	46,000	2 pt. Wayne Vapor Vac	28	NA	NA	NA	Exempt
8	22,000	Old Data	8,400	2 pt. Wayne Vapor Vac	29	5,500	2 to 5,500	5,500	Manifolded, Gilbarco
9	20,000	20-20,000	20	Manifolded, Wayne Vapor Vac	30	16,000	460 to 16,000	16,000	Manifolded, Exempt
10	122,000	165-40,800	40,800	Manifolded, Unknown	31	NA	NA	NA	Exempt
11	120,000	27-64,000	64,000	2 pt. Wayne Vapor Vac	32	27,000	BDL to 550	550	Wayne
12	17,000	2-4,200	2,350	2 pt. Wayne Vapor Vac	33	NA	NA	NA	Exempt
13	26,000	44-18,000	57	Wayne Vapor Vac	34	23,500	76 to 3,300	640	Wayne Vapor Vac
14	1,040	20.4 to 1,040	1,040	2 pt. Balance	35	67,000	1,800 to 67,000	67,000	Manifolded, Gilbarco
15	NA	NA	NA	Exempt	36	1,420	BD to 56	56	Coaxial, Exempt
16	18,000	2,000-18,000	2,900	Manifolded, Unknown	37	NA	NA	NA	2 pt. Gilbarco
17	17,000	180-17,000	2,300	Manifolded, Balance	38	17,000	BDL to 1,300	BDL	Wayne Vapor Vac
18	492	ND-492	492	Wayne Vapor Vac	39	5,830	60.9 to 173	60.9	Coaxial, Exempt
19	50,000	480-50,000	50,000	2 pt. Gilbarco	40	41,000	130 to 41,000	3,210	2 pt. Gilbarco
20	110,000	260-110,000	33,000	2 pt. Wayne Vapor Vac	41	59,800	444 to 59,800	444	2 pt. Wayne Vapor Vac
21	239,000	53,500-239,000	239,000	2 pt. Gilbarco	42	14,700	660 to 9,080	660	Manifolded, Wayne Vapor Vac

Site No.	Historical high, ppb	Recent range, ppb	Last reading, ppb	Type of control	Site No.	Historical high, ppb	Recent range, ppb	Last reading, ppb	Type of control
43	101,000	12,200 to 101,000	12,200	Manifolded, Gilbarco Retrofit	65	34,600	356 to 34,600	1,090	2 pt. Wayne Vapor Vac
44	10,000	BDL to 5,200	5,200	2 pt. Wayne Vapor Retrofit	66	NA	NA	NA	Exempt
45	605	192 to 605	192	Manifolded, Gilbarco Retrofit	67	NA	NA	NA	Balance
46	39,500	815 to 39,500	39,500	2 pt. Tokheim	68	2,510	3 to 2,510	53	2 pt. Healy 400
47	1,110,000	574,000 to 1,110,000	1,110,000	Manifolded, Wayne Retrofit	69	81,500	51,000 to 81,500	81,500	Exempt
48	9,500	32 to 3,270	442	2 pt. Balance	70	33,100	809 to 9,360	9,360	Gilbarco
49	NA	NA	NA	2 pt. Gilbarco	71	6,000	264 to 6,000	264	Exempt
50	25,000	35 to 638	442	2 pt. Balance	72	39,000	130 to 4,500	4,500	Wayne Vapor Vac
51	NA			Manifolded Gilbarco	73	2,180	129 to 2,180	129	Coaxial, Balance
52	7,520	17 to 6,750	325	2 pt. Exempt	74	NA	NA	NA	2 pt. Unknown
53	LNAPL	LNAPL	LNAPL	2 pt. Wayne Vapor Retrofit	75	NA	NA	NA	2 pt. Gilbarco
54	149,000	2,400 to 35,900	16,400	Manifolded Gilbarco	76	130,000	5,600 to 130,000	5,600	2 pt. Wayne Vapor Vac
55	NA	NA	NA	Manifolded Gilbarco	77	23,200	23,200	23,200	2 pt. Wayne Vapor Vac
56	NA	NA	NA	2 pt. Gilbarco	78	NA	NA	NA	Coaxial, Balance
57	NA	NA	NA	2 pt. Wayne Vapor Vac	79	NA	NA	NA	2 pt. Tokheim
58	5,000	980 to 3,820	1,100	Gilbarco Retrofit	80	113,000	3,200 to 55,000	55,000	2 pt. Healy 600
59	11,000	1,500 to 4,300	2,300	2 pt. Wayne Vapor Vac	81	NA	NA	NA	2 pt. Balance
60	18	18	18	Gilbarco	82	24,000	79 to 24,000	24,000	Wayne
61	NA	NA	NA	Exempt	83	8,190	946 to 8,190	946	Balance
62	18,000	3,900 to 18,000	18,000	Manifolded, Wayne Vapor Vac	84	NA	NA	NA	Exempt
63	88,100	2,080 to 88,100	18,200	Manifolded, Unknown	85	NA	NA	NA	Manifolded, Unknown
64	High MTBE in Indoor Air			2 pt. Wayne Vapor Vac	86	2,600	350 to 2,600	440	Wayne Vapor Vac

Site No.	Historical high, ppb	Recent range, ppb	Last reading, ppb	Type of control	Site No.	Historical high, ppb	Recent range, ppb	Last reading, ppb	Type of control
87	NA	NA	NA	2 pt. Gilbarco	106	13,000	3,100 to 13,000	3,400	Wayne Vapor Vac
88	NA	NA	NA	Manifolded, Gilbarco	107	NA	NA	NA	Exempt
89	5,500	2,500 to 5,500	5,500	2 pt. Gilbarco	108	140,000	420 to 140,000	420	2 pt. Gilbarco
90	168,000	50,400 to 103,000	50,400	Gilbarco	109	190,000	970 to 190,000	190,000	2 pt. Wayne Vapor Vac
91	NA	NA	4,470 near tanks	Exempt	110	68,000	15,000	5,000	Wayne
92	NA	NA	NA	Exempt ?	111	NA	NA	NA	2 pt. Wayne Vapor Vac
93	NA	NA	NA	Exempt	112	6,400	740 to 2,000	740	Wayne
94	NA	NA	NA	2 pt. Gilbarco	113	50,000	3,400 to 44,000	44,000	2 pt. Wayne Vapor Vac
95	120,000	880 to 120,000	880	2 pt. Wayne Vapor Vac	114	166,000	230 to 166,000	230	Manifolded, Gilbarco Retrofit
96	50,000	BD to 50,000	50,000	Gilbarco Retrofit	115	5,890	531 to 2,790	2,000	Gilbarco Retrofit
97	13,000	1,960 to 13,000	13,000	Gilbarco	116	29,000	22,000 to 29,000	22,000	Gilbarco Retrofit
98	47,200	BDL to 8,200	2,900	Wayne Vapor Vac	117	121,000	8,760 to 121,000	10,500	Manifolded, Gilbarco
99	24,000	6,800 to 24,000	6,800	2 pt. Wayne Vapor Vac	118	3,100	3,100	3,100	Manifolded, Gilbarco Retrofit
100	24,100	35 to 24,100	24,100	Coaxial, Exempt	119	409,000	18,000 to 140,000	18,000	Manifolded, Gilbarco Retrofit
101	76,900	24,000 to 76,900	35,000	Manifolded, Balanced	120	NA	NA	NA	2 pt. Unknown
102	NA	NA	NA	Manifolded, Wayne Vapor Vac	121	32,000	9 to 32,000	17,000	Wayne
103	58,900	336 to 20,400	20,400	Manifolded, Wayne Vapor Vac	122	2,200	93 to 2,200	93	2 pt. Unknown
104	8,380	BDL to 2,600	398	2 pt. Tokheim	123	7,900	250 to 7,900	7,900	Balance
105	NA	NA	NA	Manifolded Healy Slap Lock	124	30,400	2,620 to 30,400	2,610	Coaxial, Exempt

Source Company/Organization:
Data Table on Failure Rates for Pressure Decay Testing, Dynamic Backpressure Tests, and Air-to-Liquid Ratio Tests for 17 States, for June 30, 2003 through September 17, 2004.
[Submitted by Crompco Corporation]

Test Scenario:
Testing for GDF with Stage II VRS controls was conducted in multiple States (17). Testing included pressure decay tests (static pressure performance test), dynamic backpressure tests, and A/L ratio testing. Information on the testing frequency in each State is also provided.

Results and Conclusions:
A summary of the test information is provided in the table. A total of 7,514 pressure decay tests were conducted over this time period in 17 States. Of the pressure decay tests, approximately 19 percent failed. The failure rate from State to State ranged from 0 percent (only 2 GDF were tested) to 29 percent. These failures included maintenance attempts by the test technician to repair tank fittings, dispenser fittings, and hanging hardware while onsite when a GDF failed an initial try and then retesting.

A number of dynamic backpressure tests were conducted, with 3,974 tests on the gasoline (wet) side and 3,916 on the vapor (dry) side. These tests check for any blockage in the gasoline or vapor piping or hoses. Overall, approximately 6.5 percent of the wet backpressure tests were failures (ranging from 0 to 33 percent from State to State) and 3.4 percent of the dry backpressure tests were failures (ranges from 0 to 25 percent).

There were 4,313 A/L ratio tests summarized in the data. Approximately 27 percent of the tests were failures; these tests are considered to be failures if even one fueling point fails and cannot be repaired by the technician or if a fueling point is out of order when the test is conducted. All fueling points must be working properly to pass the test.

Comments:
None.

Stage II Testing Performed by Crompco Corp. Between 6/30/03 and 9/17/04

ST.	PD Test Pressure (in. w.c.)	PD Tests	PD Fails	Fail %	WetB Tests	WetB Fails	Fail %	DryB Tests	DryB Fails	Fail %	A/L Tests	A/L Fails	Fail %	Test Frequency
CT	**10**	180	34	19	143	5	4	143	3	2	54	22	41	Every 3 years (changed from every 5 years on 7/26/04, A/L not required before this date)
DC	**2**	60	6	10	46	1	2	46	-	-	70	30	43	Annual (Vac-assist), 5 years balance
DE	**10**	115	14	12	50	4	8	49	-	-	106	33	31	Annual all tests
FL	**2**	92	8	9	60	2	3	60	2	3	51	2	4	PD & A/L Annual, blockage every 2 years in Miami-Dade and every 5 years in Broward
MA	**10**	1,268	115	9	678	18	3	680	9	1	1,029	248	24	PD & A/L annual for all systems, wet/dry blockage every 3 years for all systems
MD	**2**	723	142	20	71	8	11	71	5	7	621	211	34	PD & A/L annual for all systems, dry blockage annual for balance, wet blockage every 5 years for all systems
ME	**10**	28	5	18	3	1	33	3	-	-	24	7	29	PD & A/L Annual for vac-assist, blockage every 5 years, PD and Blockage every 5 years for balance
NC	**10**	2	-	-	2	-	-	2	-	-	-	-	-	PD & Blockage every 5 years
NH	**10**	67	8	12	56	1	2	56	1	2	44	15	34	Every 3 years all tests
NJ	**2**	2,496	672	27	1,533	113	7	1,532	52	3	606	153	25	PD & A/L annual for all systems, wet/dry blockage every 3 years for all systems (PD changed from every 5 years to annual last year)
NY	**10**	914	223	24	731	64	9	732	35	5	279	93	33	PD & B Every 5 years (No A/L requirement)
OH	**2**	131	8	6	64	-	-	4	1	25	157	27	17	PD & A/L annual for all systems, wet/dry blockage every 5 years for all systems
PA	**2**	1,039	128	12	378	29	8	379	20	5	1,019	251	25	PD & A/L Annual for vac-assist, blockage every 5 years, PD and Blockage every 5 years for balance
RI	**10**	155	16	10	76	5	7	76	1	1	157	51	33	PD & A/L annual for all systems, wet blockage every 3 years for all systems
SC		2	-	-	-	-	-	-	-	-	-	-	-	No requirements
VA	**2**	231	67	29	82	8	10	82	6	7	95	33	35	PD & Blockage every 5 years for all systems (A/L at discretion of agency)
VT	**10**	11	-	-	1	-	-	1	-	-	1	-	-	PD & A/L every 5 years for all systems, wet/dry blockage for every 5 years for balance only
Total		7,514	1,446	19.2%	3,974	259	6.52%	3,916	135	3.45%	4,313	1,176	27.3%	
				avg			avg			avg			avg	

Notes:

Pressure decay failures are considered failures after all attempts have been made by the technician to repair tank fittings, dispenser fittings and hanging hardware while on-site.

Blockage failures are underground blockage failures.

A/L failures are considered failures even if 1 fueling point at the site fails and cannot be repaired by the technician while on site or if a fueling point is out of order at the time of the test.

The only time A/L is considered a pass is if all fueling points are working properly at the time the test was conducted.

PD=Static Pressure Performance Test

Wet B/Dry B=Dynamic Back Pressure Test

A/L=Air to liquid ratio test

Source Company/Organization:
Stage II Vapor Recovery Pilot Testing Project. Prepared by the Vermont Department of Environmental Conservation. April 26, 2000. [Submitted by NESCAUM.]

Test Scenario:
In 1996, Vermont adopted a regulation requiring Stage II VRS on all GDF that pump more than 400,000 gallons of gasoline per year. The implementation period ranged from December 31, 1997 (for stations pumping more than 1,200,000 gallons per year) to December 31, 2000 (for stations pumping more than 400,000 gallons per year).

A total of 32 stations with Stage II VRS were tested by the State of Vermont, after they had been operating for at least 1 year and for most, it had been at least 12 months since they were last tested. (However, 3 GDF had been tested just 4 months before this testing.) The stations were heavily weighted toward bootless vacuum-assist stage II systems, with only 6 of the stations tested being equipped with balance systems.

Tests conducted included: (1) the pressure decay test at all stations, (2) the air-to-liquid (A/L) ratio test at all stations equipped with bootless vacuum-assist systems, and (3) the vacuum line integrity test at two stations using the Healy Systems, Inc. VRS with a central vacuum pump. Testing was performed on an "as is" condition (i.e., without first doing any maintenance to facilitate passing the test, such as tightening loose tank top fitting or replacing worn or broken parts).

The testing included balance systems and four varieties of vacuum-assist systems as shown in Table 1:

Table 1. Types of Stage II VRS Tested

Type of System	Number Tested	Percentage of Total Stations Tested
Balance	6	19
Franklin Intellivac	1	3
Gilbarco Vapor Vac	8	25
Healy Systems with Model 600 Nozzle	2	6
Wayne Vac	15	47
Total	32	100

Emissions Testing:
None.

Operating Data:
None.

Results and Conclusions Reported:
The pressure decay results are in Tables 2 through 5. The total number of system components tested included 90 USTs, 128 gasoline dispensers, and 360 gasoline nozzles. As shown in Tables 2 and 3, the results do not provide definitive evidence for how many months a GDF is likely to maintain compliance with the pressure integrity standard but note that the 3 GDF that had been tested within the last 4 months all passed the pressure decay test. At most GDF that failed, more than one leaking component contributed to the test failure. The two components most frequently observed to be leaking were fill caps (41 percent of all test failures had fill caps found to be leaking) and Stage I poppet valves, dry breaks (41 percent of all test failures had Stage I poppet valves found to be leaking) (totals add to more than 100 percent because multiple components contributed to test failure).

Vacuum Line Integrity Test: Vacuum line integrity testing was performed at the two stations equipped with the Healy Systems Inc. system and using a central vacuum source. Both stations passed this test on the initial attempt.

Air-to-Liquid Ratio Test: The A/L ratio test was performed at 26 stations and involved testing of 298 nozzles. Test results are presented in Table 6. The values in Table 5 are read from Figure 3 of the report; therefore, the numbers may be slightly off.

The Vermont Agency of Natural Resources concluded that "it is apparent that a significant number of gasoline stations cannot pass a pressure decay test without ongoing maintenance. The pressure integrity of Stage II systems degrades over time and it is evident that most gasoline stations would not pass a pressure decay test by the time their five year retesting requirement comes due."

The Vermont Agency of Natural Resources also concluded that the A/L testing results indicate a high compliance rate with the A/L ratio performance standard.

Table 2. Initial Pressure Decay Test Results

	Number of Stations	Percentage of Total Stations
All Stations	31	100
Pass	10	32
Fail	21	68
Vacuum Assist Stations	25	
Pass	10	40
Fail	15	60
Balance Stations	6	
Pass	0	0
Fail	6	100

Table 3. Pressure Decay Test Results – All Stations

	Percent of Total Stations
Pass – Within Allowed Leak Rate	32
Fail – Up to 10% Above Allowed Leak Rate	26
Fail – Between 10% and 50% Above Allowed Leak Rate	13
Fail – Greater than 50% Above Allowed Leak Rate	29

Table 4. Equipment Problems that Contributed to a Pressure Decay Test Failure

	Percent of Failing Stations Where Component Was a Factor
Fill Cap	41
Stage I Poppet Valves	41
Fill Adaptor	32
Spill Bucket Drain Valve	27
Nozzle*	27
Breakaway	14
In-Tank Monitor	5
Submersible Pump	5

* Note: Nozzles were a contributing factor only at balance stations.

Table 5. Parts Found Leaking During Pressure Decay Tests

Part	Number Leaking	% Leaking, Out of Total Number Tested
Fill Cap	11	12
Fill Adaptor	9	10
Spill Bucket Drain Valve	12	not determined
Stage I Poppet Valve	15	27
In-Tank Monitor	3	not determined
Submersible Pump	1	1
Balance System Nozzle	13	23
Breakaway	3	<1

Table 6. Air-to-Liquid Testing Results for Each Type of System

Status	Percent of Nozzles			
	WayneVac	Gilbarco Vapor Vac	Healy	Franklin Intellivac
Within Allowable Range	85	94	92	100
Fail– Within 10% of Allowable Range	11	4	4	0
Fail– Between 10% and 50% of Allowable Range	2	2	4	0
Fail– Greater than 50% of Allowable Range	2	0	0	0

Number of Systems Tested: WayneVac = 15 (186 nozzles); Gilbarco VaporVac = 8 (48 nozzles); Healy = 2 (56 nozzles); Franklin = 1 (8 nozzles).

Comments:

This testing did not include emission measurements, however, the testing does indicate that, at least for the pressure decay test, the systems fail the test without ongoing routine maintenance. The A/L test results were more favorable regarding compliance.

Source Company/Organization:
EPA In-Use Evaporative Testing, Ann Arbor, Michigan. April 15, 2003. [Submitted by NC Petroleum Marketers Association]

Test Scenario:
Two-day evaporative system testing was conducted on ORVR vehicles of various ages. After the two-day evaporative test, the vehicles were refueled to a full tank of gasoline and any refueling problems or fuel spitback was noted. The odometer readings ranged from 6,800 to 190,000 miles, with an average mileage of 45,000 miles. While the evaporative system testing does not provide data on the control efficiency of ORVR canisters, it does provide data indicating that the ORVR system is operating correctly.

Results and Conclusions:
A total of 32 ORVR vehicles were tested. Of these vehicles, 28 passed the evaporative testing, which represents a 12 percent failure rate.

Comments:
None.

EPA In-Use Evaporative Testing
Ann Arbor, Michigan

Test Date	Model Year	Class- Veh ID	Mfr	Model	Displ Liters	Odometer Miles	Eng Fam/ Test Grp	Evap Family*	Diurnal Grams	Hot Soak Grams	Total Evap Grams	Yes/No	Comments
10/30/2001	1999	F100--0022	Chrysler	Concorde	3.5	17,917	XCRXV03.5VBO	XCRXR0101GBF	0.45	0.06	0.51	No	Pass
11/15/2001	1999	F102-0019	Ford	Mercury Sable	3.0	42,538	XFMXV03.0VBB	XFMXR0115BAE	0.56	0.04	0.60	No	Pass
05-22-01	1999	E104-0018	Kia	Sephia	1.8	35,639	XKMXV01.8A02	XKMXR0100A02	0.72	0.07	0.78	No	Pass
05-18-01	1999	E104-0021	Kia	Sephia	1.8	38,136	XKMXV01.8A02	XKMXR0100A02	NA	NA	NA	Yes	Kinked canister supply hose (after dealer performed Kia ORVR valve recall).
05-25-01	1999	E106-0005	VW	Beetle	2.0	34,947	XVWXV02.0222	XVWXR0110234	0.55	0.08	0.63	No	Pass
07-17-01	1999	E108-0006	Toyota	Solara	3.0	16,195	XTYXV03.0BBA	XTYXR0135AKI	0.71	0.04	0.75	No	Pass
07-25-01	1999	E114-0305	Jaguar	Vanden Plas	4.0	16,374	XJCXV04.0BN4	XJCXR0121M2X	2.07	0.32	2.39	No	Pass
09-07-01	1999	E114-0309	Jaguar	XJ8	4.0	19,624	XJCXV04.0BN4	XJCXR0121M2X	0.53	0.18	0.71	No	Pass
08-15-01	1999	E118-0023	Daewoo	Leganza	2.2	34,511	XDWXV02.2DO1	XDWXR0095AOL	0.35	0.05	0.40	No	Pass
12-04-01	1999	E120-0027	Subaru	Legacy Outack	2.5	39,197	XFJXV02.5CAC	XFJXR01251BB	3.53	0.16	3.69	No	Failed 2.5 Gram Standard
01-09-02	1999	E120-0027	Subaru	Legacy Outack	2.5	39,197	XFJXV02.5CAC	XFJXR01251BB	4.21	0.17	4.38	No	Retest, Failed 2.5 Gram Standard
12-19-00	1998	D124-0061	Mazda	626LX	2.0	42,618	WTKXV02.0VBA	WTKXR0125BFA	0.48	0.05	0.53	No	Pass
01-05-01	1999	D126-0053	VW	Beetle	2.0	7,162	WVWXV02.0226	WVWXR0110234	0.55	0.09	0.64	No	Pass
01-18-02	1999	F112-0025	Honda	Accord	2.3	187,066	XHNXV02.3PA3	XHNXR0130AAA	0.87	0.07	0.93	No	Pass
01-30-02	1999	F117-0003	Mazda	626	2.0	125,799	XTKXV02.0VBA	XTKXR0125BFA	0.75	0.04	0.79	No	Pass
01-30-02	1999	E121-0044	Subaru	Legacy	2.5	49,632	XFJXV02.5CAC	XFJXR01251BB	0.70	0.07	0.77	No	Pass
02-02-02	1999	F110-0077	GM	Cadillac Catera	3.0	13,801	XGMXV03.0061	XGMXR0124919	N/A	N/A	N/A	No	Shed N/A
03-01-02	1999	F123-0085	BMW	328i	2.8	53,933	XBMXV02.8LEV	XBMXR0136E46	1.23	0.21	1.44	No	Pass
03-12-02	1999	F127-0002	GM	Saturn SL1	1.9	74,642	XGMXV01.9001	XGMXR0080902	2.9	0.19	3.09	No	FAIL-2nd veh passed--no followup action
04-10-02	1999	F133-0008	FORD	ESCORT	2.0	53,396	XFMXV02.0VBA	XFMXR0080BAE	1.11	0.09	1.2	NO	PASS
05-01-02	1999	F127-0027	GM	Saturn SL1	1.9	57,227	XGMXV01.9001	XGMXR0080902	0.73	0.04	0.77	NO	PASS
05-08-02	2000	F142-0019	MAZDA	PROTÉGÉ	1.8	17,615	YTKXV01.8VBB	YTKXR0125BFB	0.47	0.06	0.53	NO	PASS
05-15-02	2000	F145-0046	NISSAN	MAXIMA	3.0	52,002	YNSXV03.0A6A	YNSXR0110RCC	0.84	0.11	0.95	NO	PASS
06-10-02	2000	F146-0011	Toyota	Camry	2.2	43,345	YTYXV02.2XBA	YTYXR0135AK1	0.5	0.04	0.55	NO	PASS
06-21-02	2000	F150-0016	VW	BEETLE	1.8	26,814	YVWXV01.8228	YVWXR0110234	0.77	0.07	0.84	NO	PASS
07-19-02	2000	F154-0020	Volvo	S 80 T6	2.8	26,701	YVVXV2.78EN3	YVVXR0133X48	0.85	0.13	0.99	NO	PASS
07-26-02	2000	F154-0114	Volvo	S 80 T6	2.8	37,331	YVVXV2.78EN3	YVVXR0133X48	0.89	0.09	0.99	NO	PASS
08-04-02	2001	F160-0024	Volvo	V70 XC	2.4	6,822	1VVXT2.43L5T	YVVXR0133X48	0.79	0.11	0.9	NO	PASS
12-20-02	2000	G115-0023	Honda	Civic LX	1.6	74,483	YHNXV01.6CA3	YHNXR0099AAD	1.15	0.05	1.2	NO	PASS
12-11-02	2000	G108-0325	GM	Deville	4.6	24,499	YGMXV04.6065	YGMXR013910	0.52	0.07	0.59	NO	PASS
01-21-03	2000	G121-0049	GM	Cavalier	2.4	66,685	YGMXV04.6065	YGMXR0124919	0.89	0.12	1.01	NO	PASS
03-19-03	2000	G135-0100	Honda	Acura 3.5RL	3.5	55,307	YHNV03.5YA3	YHNXR0160AAZ	0.84	0.11	0.95	NO	PASS
					min	6,822							
					max	187,066							
					avg	44,724						Count Pass 28	

* R as the fifth letter in the Evaporative Family code is ORVR.

Source Company/Organization:
EPA In-Use Verification Program (IUVP), Ann Arbor, Michigan. No date given, but likely 2004 and later.

Test Scenario:
Beginning in 2004, EPA has instituted an in-use testing program called the In-Use Verification Program (IUVP). The IUVP requires manufacturers to test customer-owned and -operated vehicles, including 1-year old and 5-year old vehicles (minimum 50,000 miles) are tested. EPA began receiving test data in calendar year 2005 on high mileage (50,000+) model years 2001 vehicles and low-mileage (10,000+) model year 2004 vehicles. EPA also conducts confirmatory in-use tests on approximately 150 vehicles per year to verify the results of the manufacturer in-use testing. These are EPA's preliminary testing data from this program.

Results and Conclusions:
Testing on the ORVR canister's outlet HC concentration by FTP method 24 was conducted on a total of 151 ORVR-equipped vehicles. Overall, 9.3 percent of the vehicles (14 out of 151) had emissions greater than the 0.2 g/gal limit. Of the high-mileage vehicles, 12.8 percent (6 out of 47) had emissions greater than the 0.2 g/gal limit. Of the low-mileage vehicles, 7.7 percent (8 out of 104) had emissions greater than the 0.2 g/gal limit.

Comments:
None.

Test Summary for Outlet Concentrations on In-Use ORVR Canisters.

Test Result	Overall		Low Mileage		High Mileage	
	Number	Percentage	Number	Percentage	Number	Percentage
< 0.2 g/gal	137	90.7	96	92.3	41	87.2
> 0.2 g/gal	14	9.3	8	7.7	6	12.8
Total	151	100	104	100	47	100

Appendix B

NESCAUM Widespread Use Study Supporting Documentation

I. Purpose

The purpose of Appendix B is to document and explain the equations used in the algorithm analysis for determining widespread use.

II. MOBILE6 Calculations

A. Definition (a)

The following equations were used to determine a widespread use date for definition (a) **[Note: the equations for definition (a) are not exact, because the equation is calculating the percentage of ORVR-equipped vehicles in a specific vehicle group, not the entire fleet]**:

Equation (1):

$$ORVR_{FLEET\_PER} = \sum_{i=1}^{n=25} ORVR_{PI} * VEH_{WT}$$

Where:

$ORVR_{FLEET\_PER}$	=	Percentage of vehicle fleet equipped with ORVR in a given year.
i	=	Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.
$ORVR_{PI}$	=	ORVR phase-in rate, based on estimated MY (MY_E) of vehicle.
VEHWT	=	Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (5).

Equation (2):

$$MY_E = CY - i + 1$$

Where:

MY_E	=	Estimated MY of vehicle.
CY	=	Calendar year.
i	=	Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.

Equation (2) is used to estimate the MY of the vehicle by subtracting the CY in question by the vehicle's age then adding one. For example, if the CY of interest is 2005 and vehicles of age one are being considered, then the calculation yields a MY 2005.

Intuitively, one would expect the result to be MY 2004 for a car of age one in the year 2005, however, ages are based on whole numbers and as such, a car of age one could possibly be a brand new car (i.e., MY 2005).

Equation (3):

$$VEH_{WT} = VAD_{SVT} * VMT_{SVT} / \sum_{i=1}^{n=25} (VAD_{SVT} * VMT_{SVT})$$

Where: VEH_{WT} = Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages.

VAD_{SVT} = Vehicle age distribution (fraction) in a model year for a specific vehicle type.

VMT_{SVT} = VMT per day in a given CY for a specific vehicle type, mile/day.

i = Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.

Equation (3) is used to calculate the weighted fractional average of VMT per day in a given CY for a specific vehicle type of a given age in relation to the VMT per day in the same CY for all vehicle types of all ages. The following methodology was used to calculate the weighted fractional average:

1. The vehicle age distribution (fractional value) of a specific vehicle type in a given MY is multiplied by the number of VMT per day in a given CY for a specific vehicle type.
2. For ages one through twenty-five for the specific vehicle type in a given CY, multiply the vehicle age distribution of the specific vehicle type in a given MY by the number of VMT per day in a given CY for the specific vehicle type (i.e., twenty-five separate calculations). The total VMT per day for a specific vehicle type in a given CY is the sum of the individual twenty-five calculations. .
3. Divide the result from step one by the result from step 2.

Equation (4):

$$VMT_{SVT} = AMAR / 365$$

Where: VMT_{SVT} = VMT per day in a given CY for a specific vehicle type, mile/day.

AMAR = Annual mileage accumulation rate for a specific vehicle type of a given age, miles/yr.

Equation (4) is used to determine VMT per summer day for a specific vehicle type of a given age in miles per day. This value is determined by dividing the annual mileage accumulation rate for a specific vehicle type of a given age by the number of days per year (i.e., 365 days per CY).

B. Definition (b)

The following equations in conjunction with the equations used for determining a widespread use date for definition (a) were used to determine a widespread use date for definition (b):

Equation (5):

$$\mathrm{VMT}_{\mathrm{ORVR\_PER}} = \sum_{\mathrm{j = vehicle\ type}} [ORVR_{FLEET\_PER} * GAS_{VMT\_MIX}] / \sum_{j=vehicletype} GAS_{VMT\_MIX}$$

Where:

$\mathrm{VMT}_{\mathrm{ORVR\_PER}}$	=	Percentage of VMT by ORVR-equipped vehicles in a given CY.
$\mathrm{ORVR}_{\mathrm{FLEET\_PER}}$	=	Percentage of vehicle fleet equipped with ORVR in a given CY. See Equation (1).
$\mathrm{GAS}_{\mathrm{VMT\_MIX}}$	=	Gasoline component of the VMT fractional mix.

Equation (6):

$$GAS_{VMT\_MIX} = (1 - \sum_{i=1}^{n=25} VEH_{WT} * DS_{F}) * VMT_{M}$$

Where:

$\mathrm{GAS}_{\mathrm{VMT\_MIX}}$	=	Gasoline component of the VMT fractional mix.
i	=	Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.
$\mathrm{VEH}_{\mathrm{WT}}$	=	Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).
DS_{F}	=	Diesel sales fraction for a specific vehicle type, based on MY_{E} of vehicle.
$\mathrm{VMT}_{\mathrm{M}}$	=	VMT fractional mix (fuel independent) in a given CY for a specific vehicle type.

C. Definition (c)

The following equations in conjunction with Equations (2), (3), and (4) were used to determine a widespread use date for definition (c):

Equation (7):

$$E_{S2} = \sum_{j = \text{vehicle type}} [VEH_R * AFE * GU / GU_T]$$

Where:

- E_{S2} = Stage II VRS emissions (without ORVR) on a summer day in a given CY for all vehicle types, grams/gal.
- VEH_R = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing Stage II VRS, grams/mile.
- AFE = Average fuel economy for a specific vehicle type in a given CY, miles/gal.
- GU = Gasoline usage in a given CY for a specific vehicle type, gal/day.
- GU_T = Total gasoline usage for a given CY for all vehicle types, gal/day.

Equation (7) was used to calculate Stage II VRS emissions in grams per gal, without ORVR, in a given CY for each vehicle type (based on summertime data). The following methodology was used to calculate emissions:

1. For a specific CY, calculate the Stage II VRS emissions associated with each individual vehicle type. This calculation is done by multiplying the *calculated* vehicle refueling and spillage emissions in grams per mile for the specific vehicle type in question by the average fuel economy (AFE) in miles per gal of the vehicle type, then by the percentage of gasoline used in the CY by the specific vehicle type (i.e., ratio of the gasoline usage of the specific vehicle type in gal per day to total gasoline usage for all vehicle types in gal per day in a given CY).
2. Total Stage II VRS emissions in a given CY equals the sum of the emissions calculated for each individual vehicle type.

Equation (8):

$$VEH_R = \sum_{i=1}^{n=25} [(E_R / FE * (1 - (CE_{IU} / 100)) + (SP / FE)) * VEH_{WT}]$$

Where:

- VEH_R = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing Stage II VRS, grams/mile.
- i = Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.
- E_R = Uncontrolled displacement losses from vehicle refueling, grams/gal.
- FE = Fuel economy of vehicle, based on MY_E of vehicle, miles/gal.

CE_{IU} = In-use control efficiency of Stage II VRS.
SP = Spillage emissions factor, grams/gal.
VEH_{WT} = Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).

Equation (8) was used to calculate vehicle refueling and spillage emissions in a given CY for a specific vehicle type in grams per mile. The following methodology was used to calculate emissions:

1. Emissions were calculated for a specific vehicle type from ages one to twenty-five (vehicles twenty-five years and older are grouped together), resulting in twenty-five calculations per individual vehicle type. Each calculation consisted of dividing the *calculated* uncontrolled displacement emissions from vehicle refueling in grams per gal by the fuel economy (FE) of the vehicle in miles per gal. The FE is based on the estimated model year (MY) of the vehicle type at a given age.
2. The result from step 1 is multiplied by the percentage of emissions not controlled by the Stage II VRS (i.e., one minus the in-use control efficiency).
3. The result from step 3 is added to the emissions attributed to spillage. Spillage emissions are calculated by dividing the spillage emissions factor in grams per gal by the FE of the vehicle in miles per gal.
4. The result from step 3 is multiplied by the weighted fractional average of the number of vehicle miles traveled (VMT) per day in the given CY for the specific vehicle type of a given age in relation to the total VMT per day in the same CY for all vehicle types of all ages.
5. Total vehicle refueling and spillage emissions in a given CY equals the sum of emissions calculated from ages one to twenty-five for a specific vehicle type.

Equation (9):

$$E_R = (-5.909) - (0.0949 * \Delta T) + (0.0884 * T_D) + (0.485 * RVP)$$

Where: E_R = Uncontrolled displacement losses from vehicle refueling (AP-42 equation 6), grams/gal.
ΔT = Difference between temperature of fuel in vehicle tank and temperature of dispensed fuel, °F.
T_D = Temperature of dispensed fuel, °F.
RVP = Reid vapor pressure, psia.

Equation (9) is taken from AP-42 (Chapter 5.2 Transportation and Marketing of Petroleum Liquids, Equation 6) to calculate uncontrolled displacement losses from vehicle refueling in grams per gal. This equation uses constants and takes into account the temperature difference between the fuel in the vehicle fuel tank and the temperature of the dispensed fuel, as well as the RVP of the fuel.

Equation (10):

$$AFE = 1 / \sum_{i=1}^{n=25} (1 / FE * VEH_{WT})$$

Where:

	AFE	=	Average fuel economy for a specific vehicle type in a given CY, miles/gal.
	i	=	Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.
	FE	=	Fuel economy of vehicle, based on MY_E of vehicle, miles/gal.
	VEH_{WT}	=	Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).

Equation (10) calculates the AFE for a specific vehicle type in a given CY in miles per gal. The following methodology was used to calculate the average fuel economy:

1. Divide the weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age by the vehicle type's fuel economy at the given age.
2. Perform step 1 for all ages one to twenty-five.
3. Sum each result from step 2 to get a total sum.
4. Take the inverse of the total sum.

Equation (11):

$$GU = [(1 - \sum_{i=1}^{n=25} (VEH_{WT} * DS_F)] * VMT_M * VMT_T / AFE$$

Where:

- GU = Gasoline usage in a given CY for a specific vehicle type, gal/day.
- i = Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.
- VEH_{WT} = Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).
- DS_F = Diesel sales fraction for a specific vehicle type, based on MY_E of vehicle.
- VMT_M = VMT fractional mix (fuel independent) in a given CY for a specific vehicle type.
- VMT_T = Total number of VMT per day in a given CY for all vehicle types.

Equation (11) calculates the gasoline usage for a summer day in a given CY for a specific vehicle type in gallons per day. The following methodology was used to calculate gasoline usage:

1. Multiply the weighted fractional average of the number of VMT per day in a given CY for a specific vehicle type of a given age by the diesel sales fraction of the specific vehicle type, which is based on the estimated MY of the vehicle type.
2. Perform step 1 for ages one to twenty-five.
3. Sum each result from step 2 to get a total sum.
4. Subtract one from the result obtained in step 3 (i.e., only account for gasoline fueled vehicles).
5. Multiply result from step 4 by the VMT fractional mix value then by the total number of VMT per summer day in a given CY for all vehicle types.
6. Divide the result from step 5 by the AFE for the specific vehicle type in a given CY.

Equation (12):

$$GU_T = \sum_{j=vehicletype} GU$$

Where:

- GU_T = Total gasoline usage for a given CY for all vehicle types, gal/day.
- GU = Gasoline usage in a given CY for a specific vehicle type, gal/day.

Equation (12) is used to determine total vehicle gasoline usage in a given CY for all vehicle types in gallons per day. This value is calculated by summing the gasoline usage for each specific vehicle type in gallons per day.

Equation (13):

$$E_{ORVR} = \sum_{j=vehicletype} (VEH_{ORVR} * AFE * GU / GU_T)$$

Where:

E_{ORVR}	=	ORVR emissions (without Stage II) on a summer day in a given CY for all vehicle types, grams/gal.
VEH_{ORVR}	=	Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing ORVR canisters, grams/mile.
AFE	=	Average fuel economy for a specific vehicle type in a given CY, miles/gal.
GU	=	Gasoline usage for a given CY for a specific vehicle type, gal/day.
GU_T	=	Total gasoline usage for a given CY for all vehicle types, gal/day.

Equation (13) is used to calculate ORVR emissions (without Stage II VRS) on a summer day in a given CY for all vehicle types in grams per gal. The following methodology was used to calculate ORVR emissions:

1. Multiply vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing ORVR in grams per gal by the AFE for the specific vehicle type in a given CY in miles per gal.
2. Multiply the result in step 1 by the ratio of gasoline usage in a given CY for the specific vehicle type in gallons per day to the total gasoline usage in a given CY for all vehicle types in gallons per day.
3. Repeat steps 1 and 2 for each vehicle types.
4. Sum each result from step 2 to get a total sum of ORVR emissions.

Equation (14):

$$VEH_{ORVR} = \sum_{i=1}^{n=25}[(E_R / FE * (ORVR_{VAR} + (1 - ORVR_{PI})) + SP_{ADJ}) * VEH_{WT}]$$

Where: VEH_{ORVR} = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing ORVR canisters, grams/mile.

i = Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.

E_R = Uncontrolled displacement losses from vehicle refueling, grams/gal.

FE = Fuel economy of vehicle, based on MY_E of vehicle, miles/gal.

$ORVR_{VAR}$ = ORVR emission rate adjustment for tampering and phase-in rate for model year.

$ORVR_{PI}$ = ORVR phase-in rate, based on MY_E of vehicle.

SP_{ADJ} = Adjusted spillage emissions, grams/mile.

VEH_{WT} = Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).

Equation (15):

$$ORVR_{VAR} = (1 - ORVR_{CE}) * (1 - TP_R) * ORVR_{PI} + (TP_R * ORVR_{PI})$$

Where: $ORVR_{VAR}$ = ORVR emission rate adjustment for tampering and phase-in rate for model year.

$ORVR_{CE}$ = Control efficiency of ORVR technology.

TP_R = Tampering rate for ORVR canisters.

$ORVR_{PI}$ = ORVR phase-in rate, based on MY_E of vehicle.

Equation (16):

$$SP_{ADJ} = SP / FE * (ORVR_{PI} * (1 - SP_{ORVR}) + 1 - ORVR_{PI})$$

Where: SP_{ADJ} = Adjusted spillage emissions, grams/mile.

SP = Spillage emissions factor, grams/gal.

FE = Fuel economy of vehicle, based on MY_E of vehicle, miles/gal.

$ORVR_{PI}$ = ORVR phase-in rate, based on MY_E of vehicle.

SP_{ORVR} = ORVR control efficiency for spillage.

Equation (16) is used to estimate the spillage emissions associated with ORVR-equipped vehicles in grams/gal. The following methodology was used to calculate ORVR spillage emissions:

1. Divide the spillage emissions factor in grams per gallon by the FE of the specific vehicle type of a specific MY in miles per gallon.

D. Definition (c2)

The following equations in conjunction with Equations (2), (3), (4), (9), (10), (11), (12), (13), (14), (15), and (16) were used to determine a widespread use date for definition (c2):

Equation (17):

$$E_{INC} = \sum_{j=vehicletype}[(VEH_{COM} + VEH_{INC} + VEH_{ADJ}) * AFE * GU / GU_T]$$

Where: E_{INC} = Emissions from incompatible Stage II and ORVR technologies on a summer day in a given CY for all vehicle types, grams/gal.

VEH_{COM} = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing both Stage II VRS and ORVR canisters (compatible technologies), grams/mile.

VEH_{INC} = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing both Stage II VRS and ORVR canisters (incompatible technologies), grams/mile.

VEH_{ADJ} = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing ORVR canisters at an adjusted control efficiency, grams/mile.

AFE = Average fuel economy for a specific vehicle type in a given CY, miles/gal. See Equation (10).

GU = Gasoline usage for a given CY for a specific vehicle type, gal/day. See Equation (11).

GU_T = Total gasoline usage for a given CY for all vehicle types, gal/day. See Equation (12).

Equation (18):

$$VEH_{COM} = \sum_{i=1}^{n=25}[(E_R / FE * (ORVR_{VAR} * (1 - CE_{IU} / 100) + (1 - ORVR_{PI}) * (1 - CE_{IU} / 100)) + SP_{ADJ}) * VEH_{WT}]$$

Where: VEH_{COM} = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing both Stage II VRS and ORVR canisters (compatible technologies), grams/mile.

i = Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.

E_R = Uncontrolled displacement losses from vehicle refueling, grams/gal. See Equation (9)

FE = Fuel economy of vehicle, based on MY_E of vehicle, miles/gal.

$ORVR_{VAR}$ = See Equation (15).

CE_{IU} = In-use control efficiency of Stage II VRS.

$ORVR_{PI}$ = ORVR phase-in rate, based on MY_E of vehicle.

SP_{ADJ} = Adjusted spillage emissions, gram/gal. See Equation (16).

VEH_{WT} = Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).

Equation (19):

$$VEH_{INC} = \sum_{i=1}^{n=25}[INC_E / FE * (1 - TP_R) * ORVR_{PI} * VEH_{WT}]$$

Where: VEH_{INC} = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing incompatible Stage II VRS and ORVR canisters, grams/mile.

i = Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.

INC_E = Incompatible emissions from Stage II and ORVR technologies, grams/gal.

FE = Fuel economy of vehicle, based on MY_E of vehicle, miles/gal.

TP_R = Tampering rate for ORVR canisters.

$ORVR_{PI}$ = ORVR phase-in rate, based on MY_E of vehicle.

VEH_{WT} = Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).

Equation (20):

$$INC_E = EE * PV_{PER} * (1 - ORVR_{MS}) * (1 - ORVR_{PROC})$$

Where: INC_E = Incompatible emissions from Stage II and ORVR technologies, grams/gal.

EE = Excess emissions from incompatibility of Stage II and ORVR technologies, grams/gal.

PV_{PER} = Adjusted percentage of GDFs equipped with functioning assist Stage II VRS and P/V valves on UST vents.

$ORVR_{MS}$ = Percentage of ORVR canisters with mechanical seals.

$ORVR_{PROC}$ = Percentage of vacuum assist Stage II with processors.

Equation (21):

$$EE = ((GIL_{EE} - WA_{EE}) / (GIL_{AL} - WA_{AL}) * VA_{AL} + (GIL_{EE} - ((GIL_{EE} - WA_{EE}) / (GIL_{AL} - WA_{AL}) * GIL_{AL}))) * 0.4536 * E_R / (8.4 * 0.4536)$$

Where: EE = Excess emissions from incompatibility of Stage II and ORVR technologies, grams/gal.

GIL_{EE} = Excess emissions for the Gilbarco vacuum assist VRS, lb/1,000 gal.[1]
WA_{EE} = Excess emissions for the Dresser Wayne vacuum assist VRS with P/V valve, lb/1,000 gal.[2]
GIL_{AL} = Air to liquid ratio (A/L) for the Gilbarco VRS.[3]
WA_{AL} = A/L for the Dresser Wayne VRS.[4]
VA_{AL} = A/L for a vacuum assist VRS, as reported by CARB.
E_R = Uncontrolled displacement losses from vehicle refueling, grams/gal. See Equation (9).

Equation (22):

$$PV_{PER} = CE_{IU} \ / \ 100 \ / \ 0.95 * VA_{PER} * VA_{PV}$$

Where:
PV_{PER} = Adjusted percentage of GDFs equipped with functioning assist Stage II VRS and P/V valves on UST vents.
CE_{IU} = In-use control efficiency of Stage II VRS.
VA_{PER} = Percentage of GDFs equipped with vacuum assist Stage II VRS.
VA_{PV} = Percentage of GDFs equipped with vacuum assist Stage II VRS and PV valves on UST vents.

Equation (23):

$$VEH_{ADJ} = \sum_{i=1}^{n=25} [E_R / FE * (ORVR_{CE} - ORVR_{ADJ}) * (1 - TP_R) * PV_{PER} * ORVR_{PI} * VEH_{WT}]$$

Where:
VHE_{ADJ} = Vehicle refueling and spillage emissions in a given CY for a specific vehicle type utilizing ORVR canisters at an adjusted ORVR control efficiency, grams/gal.
i = Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.
E_R = Uncontrolled displacement losses from vehicle refueling, grams/gal. See Equation (9).
FE = Fuel economy of vehicle, based on MY_E of vehicle, miles/gal.
$ORVR_{CE}$ = Control efficiency of ORVR technology.
$ORVR_{ADJ}$ = Adjusted Control efficiency of ORVR technology.
TP_R = tampering rate for ORVR canisters.

[1] CARB Preliminary Draft Test Report, "Total Hydrocarbon Emissions from Two Phase II Vacuum Assist Vapor Recovery Systems During Baseline Operation and Simulated Refueling of Onboard Refueling Vapor Recovery (ORVR) Equipped Vehicles," June 1999.
[2] Ref. 1
[3] Ref. 1
[4] Ref. 1

PV_{PER} = Adjusted percentage of GDFs equipped with assist Stage II VRS and P/V valves on UST vents.
$ORVR_{PI}$ = ORVR phase-in rate, based on MY_E of vehicle.
VEH_{WT} = Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (5).

E. Definition (d)

The following equations in conjunction with Equations (2), (3), (4), (10), (11) and (12) were used to determine a widespread use date for definition (d):

Equation (24):

$$GAS_{ORVR\_PER} = [\sum_{j=vehicletype} ORVR_{GAS\_PER} * GU] / GU_T$$

Where:
GAS_{ORVR_PER} = Percentage of gasoline dispensed to ORVR-equipped vehicles in a given CY.
$ORVR_{GAS\_PER}$ = Percentage of vehicle fleet equipped with ORVR, gasoline basis.
GU = Gasoline usage in a given CY for a specific vehicle type, gal/day. See Equation (11).
GU_T = Total gasoline usage for a given CY for all vehicle types, gal/day. See Equation (12).

Equation (25):

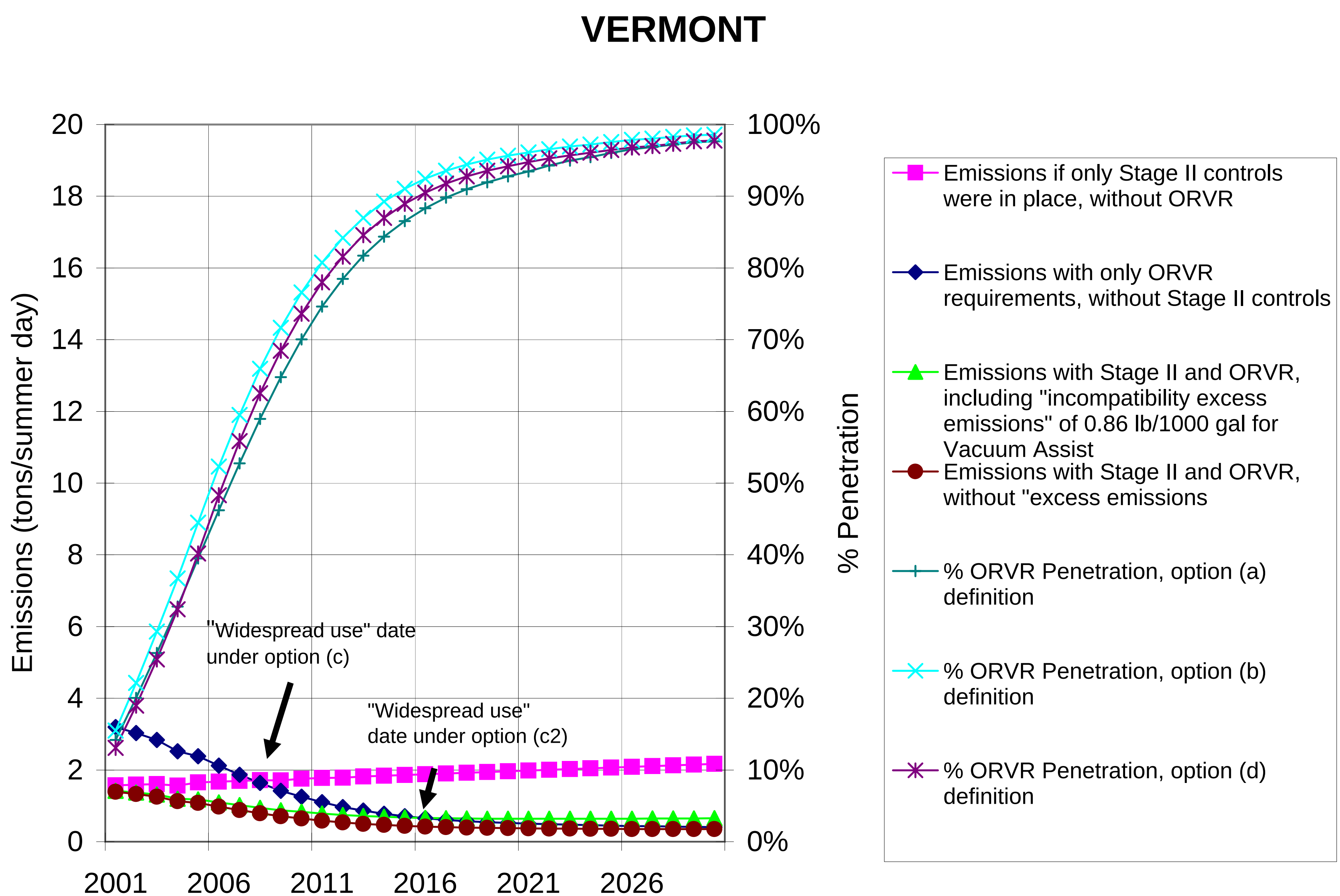
$$ORVR_{GAS\_PER} = \sum_{i=1}^{n=25} ORVR_{PI} * VEH_{WT} * AFE / FE$$

Where:

$ORVR_{GAS\_PER}$	=	Percentage of vehicle fleet equipped with ORVR, gasoline basis.
i	=	Vehicle age. The vehicle age for a specific vehicle type ranges from one to twenty-five years, with vehicles twenty-five years and older grouped together.
$ORVR_{PI}$	=	ORVR phase-in rate, based on MY_E of vehicle.
VEH_{WT}	=	Weighted fractional average of the number of VMT/day in a given CY for a specific vehicle type of a given age in relation to the total VMT/day in a given CY for all vehicle types of all ages. See Equation (3).
AFE	=	Average fuel economy for a specific vehicle type in a given CY, miles/gal. See Equation (10).
FE	=	Fuel economy of vehicle, based on MY_E of the vehicle, miles/gal.

Appendix C

Widespread Use Results for NESCAUM States


VERMONT
Emissions (tons/summer day)
% Penetration
20
18
16
14
12
10
8
6
4
2
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2001
2006
2011
2016
2021
2026
"Widespread use" date under option (c)
"Widespread use" date under option (c2)
Emissions if only Stage II controls were in place, without ORVR
Emissions with only ORVR requirements, without Stage II controls
Emissions with Stage II and ORVR, including "incompatibility excess emissions" of 0.86 lb/1000 gal for Vacuum Assist
Emissions with Stage II and ORVR, without "excess emissions
% ORVR Penetration, option (a) definition
% ORVR Penetration, option (b) definition
% ORVR Penetration, option (d) definition

TOTAL REFUELING EMISSIONS - VERMONT

Calendar Year	Grams Emitted Per Gallon Gasoline: Stage II Controls Only	ORVR Only	Stage II with ORVR, No Incompatibility	Stage II with ORVR, Incompatibility	% Decrease from Uncontrolled Emissions
2001	1.519	3.094	1.349	1.377	61%
2002	1.519	2.899	1.272	1.313	63%
2003	1.519	2.684	1.188	1.243	65%
2004	1.519	2.453	1.097	1.167	67%
2005	1.520	2.195	0.996	1.083	69%
2006	1.520	1.926	0.890	0.994	72%
2007	1.520	1.676	0.792	0.912	74%
2008	1.520	1.454	0.704	0.839	76%
2009	1.520	1.258	0.627	0.775	78%
2010	1.520	1.086	0.560	0.719	80%
2011	1.520	0.942	0.503	0.672	81%
2012	1.520	0.823	0.456	0.632	82%
2013	1.520	0.724	0.417	0.600	83%
2014	1.520	0.644	0.386	0.574	84%
2015	1.520	0.579	0.360	0.552	84%
2016	1.520	0.527	0.340	0.535	85%
2017	1.520	0.485	0.324	0.522	85%
2018	1.520	0.452	0.311	0.511	86%
2019	1.520	0.426	0.300	0.502	86%
2020	1.520	0.405	0.292	0.495	86%
2021	1.520	0.386	0.285	0.489	86%
2022	1.520	0.369	0.278	0.484	86%
2023	1.520	0.354	0.272	0.479	86%
2024	1.520	0.343	0.268	0.475	87%
2025	1.520	0.330	0.263	0.471	87%
2026	1.520	0.319	0.258	0.467	87%
2027	1.520	0.311	0.255	0.465	87%
2028	1.520	0.301	0.251	0.461	87%
2029	1.520	0.290	0.247	0.458	87%
2030	1.520	0.286	0.245	0.456	87%

Calendar Year	Tons Per Summer Day: Stage II Controls Only	ORVR Only	Stage II with ORVR, No Incompatibility	Stage II with ORVR, Incompatibility	Excess Emissions
2001	1.57	3.19	1.39	1.42	0.03
2002	1.59	3.03	1.33	1.37	0.04
2003	1.61	2.84	1.26	1.31	0.06
2004	1.56	2.52	1.13	1.20	0.07
2005	1.65	2.39	1.08	1.18	0.09
2006	1.67	2.12	0.98	1.09	0.11
2007	1.69	1.87	0.88	1.02	0.13
2008	1.71	1.64	0.79	0.95	0.15
2009	1.71	1.42	0.71	0.87	0.17
2010	1.76	1.25	0.65	0.83	0.18
2011	1.78	1.10	0.59	0.78	0.20
2012	1.78	0.97	0.54	0.74	0.21
2013	1.82	0.87	0.50	0.72	0.22
2014	1.84	0.78	0.47	0.69	0.23
2015	1.86	0.71	0.44	0.68	0.23
2016	1.88	0.65	0.42	0.66	0.24
2017	1.90	0.61	0.40	0.65	0.25
2018	1.92	0.57	0.39	0.65	0.25
2019	1.94	0.54	0.38	0.64	0.26
2020	1.96	0.52	0.38	0.64	0.26
2021	1.98	0.50	0.37	0.64	0.27
2022	2.00	0.49	0.37	0.64	0.27
2023	2.02	0.47	0.36	0.64	0.28
2024	2.05	0.46	0.36	0.64	0.28
2025	2.07	0.45	0.36	0.64	0.28
2026	2.09	0.44	0.35	0.64	0.29
2027	2.11	0.43	0.35	0.64	0.29
2028	2.13	0.42	0.35	0.65	0.29
2029	2.15	0.41	0.35	0.65	0.30
2030	2.17	0.41	0.35	0.65	0.30

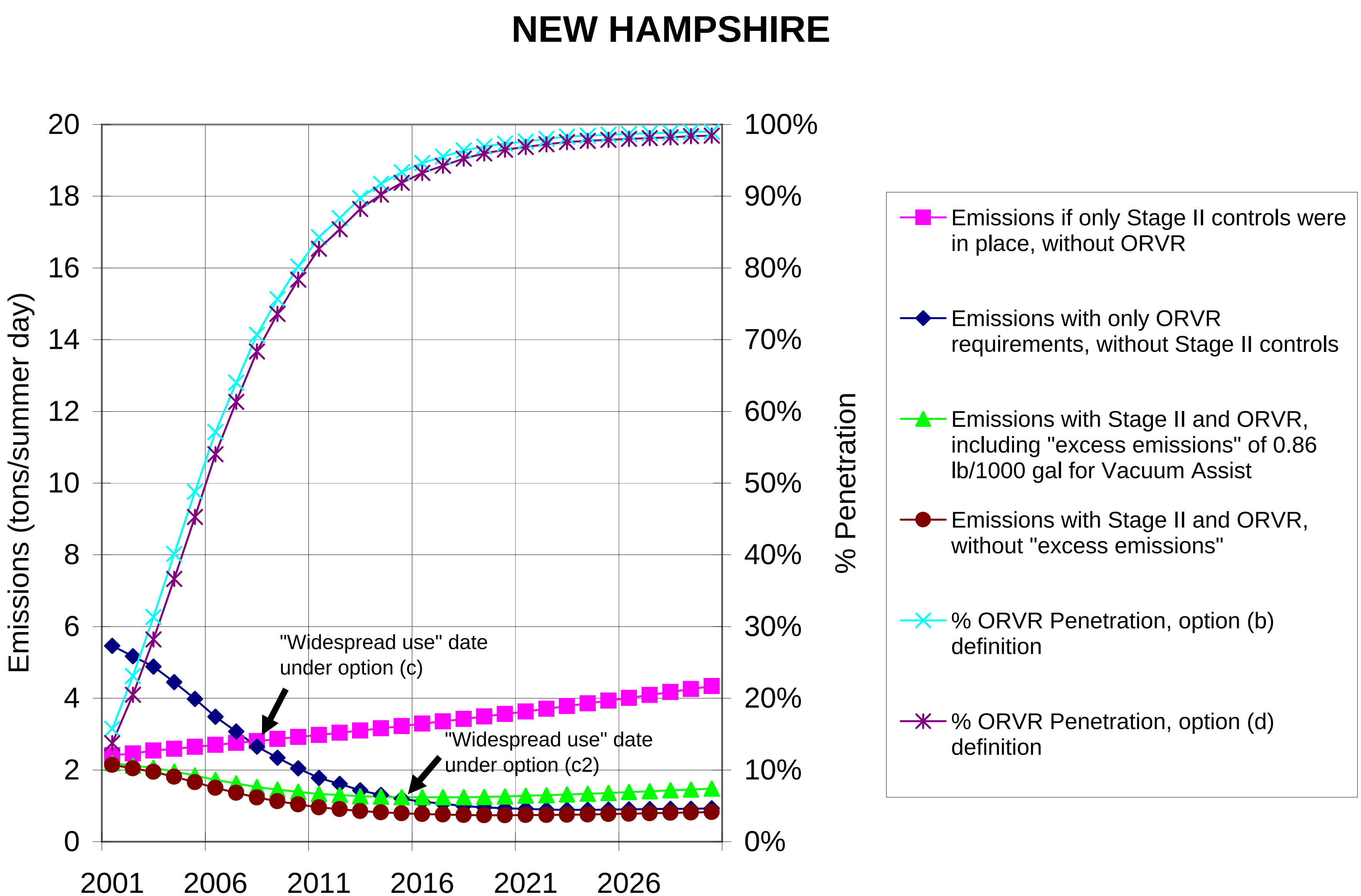
	Tons Per Summer Day: Estimated in Periodic Inventory
1996	**5.93**

Calendar Year	Environ Report: g/gal	tpsd
2001	0.902	0.93
2002	0.846	0.88
2003	0.795	0.84
2004	0.734	0.75
2005	0.669	0.73
2006	0.596	0.66
2007	0.533	0.59
2008	0.483	0.54
2009	0.441	0.50
2010	0.407	0.47

Calendar Year	ORVR Penetration — VMT Basis: Vehicles < 10,000 lb GVWR	VMT Basis: All Gas Vehicles	Fuel Usage Basis: Vehicles < 10,000 lb GVWR	Fuel Usage Basis: All Gas Vehicles	Vehicle Basis: Vehicles < 10,000 lb GVWR	Vehicle Basis: All Gas Vehicles, but not MC	Vehicle Basis: All Gas Vehicles, with MC
2001	16%	16%	13%	13%	15%	14%	14%
2002	22%	22%	19%	19%	21%	20%	20%
2003	30%	29%	26%	25%	27%	26%	26%
2004	37%	37%	33%	32%	34%	33%	32%
2005	45%	44%	41%	40%	40%	39%	39%
2006	53%	52%	50%	48%	47%	46%	45%
2007	60%	59%	57%	56%	54%	53%	52%
2008	67%	66%	64%	63%	60%	59%	58%
2009	73%	72%	70%	68%	66%	65%	63%
2010	78%	77%	75%	74%	72%	70%	68%
2011	82%	81%	80%	78%	76%	75%	73%
2012	85%	84%	83%	82%	80%	78%	77%
2013	88%	87%	87%	85%	84%	82%	80%
2014	91%	89%	89%	87%	86%	84%	82%
2015	92%	91%	91%	89%	89%	87%	85%
2016	94%	92%	93%	91%	90%	88%	86%
2017	95%	94%	94%	92%	92%	90%	88%
2018	96%	94%	95%	93%	93%	91%	89%
2019	96%	95%	96%	94%	94%	92%	90%
2020	97%	96%	96%	94%	95%	93%	91%
2021	98%	96%	97%	95%	96%	93%	91%
2022	98%	97%	97%	95%	97%	94%	92%
2023	98%	97%	98%	96%	97%	95%	93%
2024	99%	97%	98%	96%	98%	95%	93%
2025	99%	98%	99%	96%	98%	96%	94%
2026	99%	98%	99%	97%	99%	97%	94%
2027	99%	98%	99%	97%	99%	97%	95%
2028	100%	98%	100%	97%	100%	97%	95%
2029	100%	98%	100%	98%	100%	98%	95%
2030	100%	99%	100%	98%	100%	98%	95%

0.85714286

Calendar Year	Unc. HDGV g/gal
2001	0.865
2002	0.879
2003	0.894
2004	0.906
2005	0.919
2006	0.932
2007	0.946
2008	0.962
2009	0.977
2010	0.989
2011	1.001
2012	1.012
2013	1.021
2014	1.030
2015	1.038
2016	1.045
2017	1.051
2018	1.057
2019	1.063
2020	1.069
2021	1.069
2022	1.069
2023	1.069
2024	1.069
2025	1.069
2026	1.069
2027	1.069
2028	1.069
2029	1.069
2030	1.069


NEW HAMPSHIRE
Emissions (tons/summer day)
% Penetration
20
18
16
14
12
10
8
6
4
2
0
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
2001
2006
2011
2016
2021
2026
"Widespread use" date under option (c)
"Widespread use" date under option (c2)
Emissions if only Stage II controls were in place, without ORVR
Emissions with only ORVR requirements, without Stage II controls
Emissions with Stage II and ORVR, including "excess emissions" of 0.86 lb/1000 gal for Vacuum Assist
Emissions with Stage II and ORVR, without "excess emissions"
% ORVR Penetration, option (b) definition
% ORVR Penetration, option (d) definition

4

TOTAL REFUELING EMISSIONS - NEW HAMPSHIRE

	Grams Emitted Per Gallon Gasoline				
Calendar Year	Stage II Controls Only	ORVR Only	Stage II with ORVR, No Incompatibility	Stage II with ORVR, Incompatibility	% Decrease from Uncontrolled Emissions
2001	1.149	2.604	1.020	1.044	65%
2002	1.149	2.416	0.956	0.992	67%
2003	1.164	2.236	0.895	0.945	69%
2004	1.164	1.998	0.814	0.879	71%
2005	1.164	1.752	0.731	0.811	73%
2006	1.164	1.505	0.647	0.743	76%
2007	1.164	1.299	0.578	0.687	77%
2008	1.164	1.099	0.510	0.632	79%
2009	1.165	0.951	0.460	0.591	81%
2010	1.165	0.817	0.415	0.554	82%
2011	1.164	0.695	0.373	0.520	83%
2012	1.165	0.618	0.347	0.499	84%
2013	1.164	0.538	0.320	0.477	84%
2014	1.165	0.481	0.301	0.461	85%
2015	1.165	0.434	0.285	0.449	85%
2016	1.165	0.395	0.272	0.438	86%
2017	1.165	0.368	0.263	0.430	86%
2018	1.165	0.338	0.253	0.422	86%
2019	1.165	0.319	0.246	0.417	86%
2020	1.165	0.304	0.241	0.413	86%
2021	1.165	0.293	0.238	0.410	87%
2022	1.165	0.282	0.234	0.407	87%
2023	1.165	0.273	0.231	0.404	87%
2024	1.165	0.269	0.229	0.403	87%
2025	1.165	0.265	0.228	0.402	87%
2026	1.165	0.261	0.227	0.401	87%
2027	1.165	0.258	0.226	0.400	87%
2028	1.165	0.255	0.225	0.399	87%
2029	1.165	0.250	0.223	0.398	87%
2030	1.165	0.249	0.223	0.398	87%

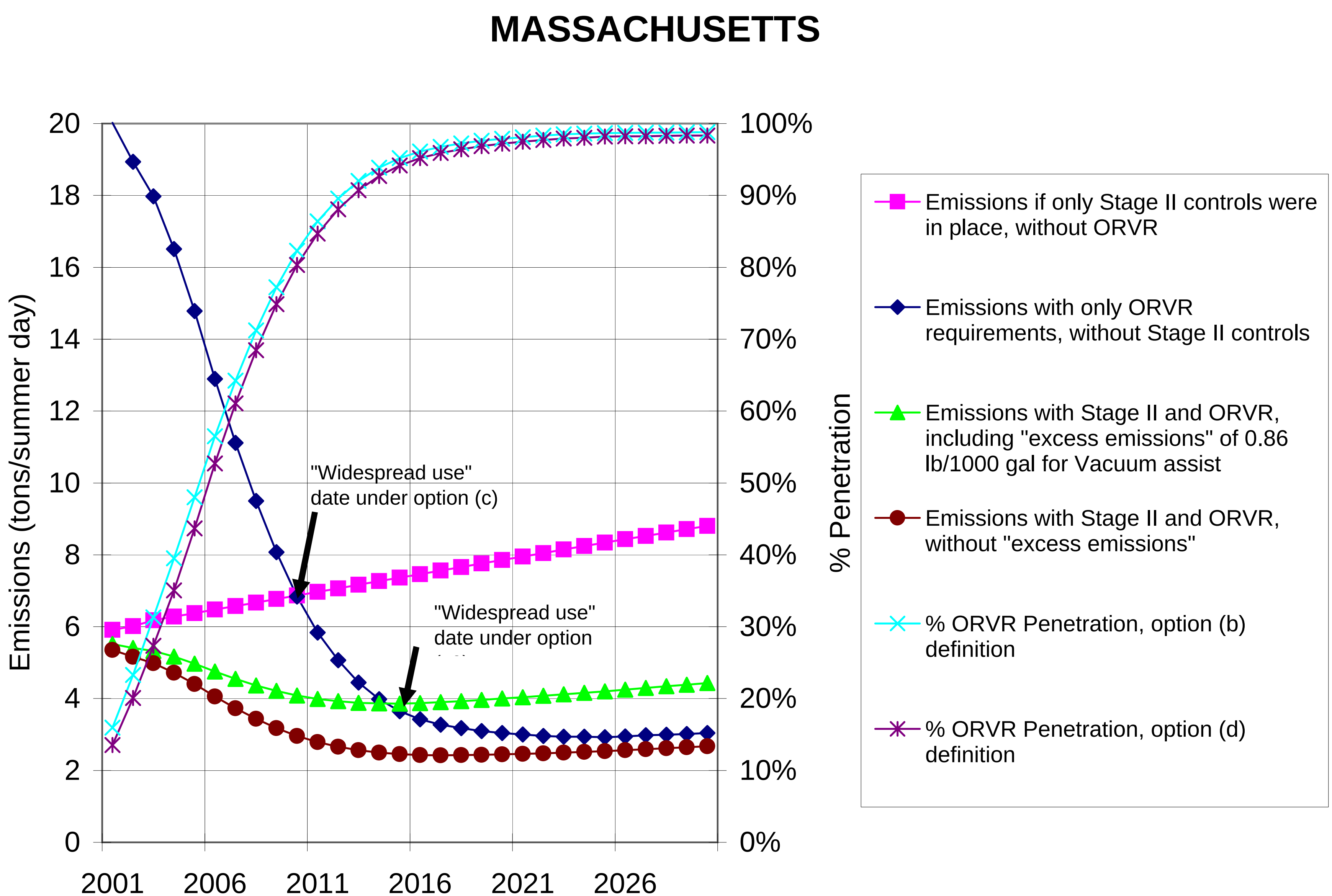
	Tons Per Summer Day				
Calendar Year	Stage II Controls Only	ORVR Only	Stage II with ORVR, No Incompatibility	Stage II with ORVR, Incompatibility	Excess Emissions
2001	2.41	5.46	2.14	2.19	0.05
2002	2.46	5.17	2.05	2.12	0.08
2003	2.54	4.88	1.95	2.06	0.11
2004	2.59	4.45	1.81	1.96	0.15
2005	2.64	3.98	1.66	1.84	0.18
2006	2.70	3.49	1.50	1.72	0.22
2007	2.75	3.07	1.36	1.62	0.26
2008	2.81	2.65	1.23	1.52	0.29
2009	2.86	2.34	1.13	1.45	0.32
2010	2.92	2.05	1.04	1.39	0.35
2011	2.98	1.78	0.95	1.33	0.38
2012	3.04	1.61	0.91	1.30	0.40
2013	3.10	1.43	0.85	1.27	0.42
2014	3.16	1.30	0.82	1.25	0.44
2015	3.22	1.20	0.79	1.24	0.45
2016	3.29	1.12	0.77	1.24	0.47
2017	3.36	1.06	0.76	1.24	0.48
2018	3.42	0.99	0.74	1.24	0.50
2019	3.49	0.96	0.74	1.25	0.51
2020	3.56	0.93	0.74	1.26	0.52
2021	3.63	0.91	0.74	1.28	0.54
2022	3.70	0.90	0.74	1.29	0.55
2023	3.78	0.89	0.75	1.31	0.56
2024	3.85	0.89	0.76	1.33	0.58
2025	3.93	0.89	0.77	1.36	0.59
2026	4.01	0.90	0.78	1.38	0.60
2027	4.09	0.91	0.79	1.41	0.61
2028	4.17	0.91	0.80	1.43	0.63
2029	4.26	0.91	0.82	1.45	0.64
2030	4.34	0.93	0.83	1.48	0.65

	Tons Per Summer Day
	Estimated in Periodic Inventory
1996	**5.93**

	Environ Report	
Calendar Year	g/gal	tpsd
2001	0.902	1.89
2002	0.846	1.81
2003	0.795	1.74
2004	0.734	1.63
2005	0.669	1.52
2006	0.596	1.38
2007	0.533	1.26
2008	0.483	1.16
2009	0.441	1.08
2010	0.407	1.02

	ORVR Penetration							
	VMT Basis		Fuel Usage Basis		Vehicle Basis			
Calendar Year	Vehicles < 10,000 lb GVWR	All Gas Vehicles	Vehicles < 10,000 lb GVWR	All Gas Vehicles	Vehicles < 10,000 lb GVWR	All Gas Vehicles, not MC	All Gas Vehicles, with MC	Unc. HDGV g/gal
2001	16%	16%	14%	14%				0.532
2002	23%	23%	21%	20%				0.538
2003	32%	31%	29%	28%				0.553
2004	41%	40%	37%	37%				0.559
2005	49%	49%	46%	45%				0.565
2006	58%	57%	55%	54%				0.571
2007	65%	64%	62%	61%				0.602
2008	71%	71%	69%	68%				0.584
2009	76%	76%	75%	74%				0.627
2010	81%	80%	80%	78%				0.638
2011	85%	84%	84%	83%				0.606
2012	88%	87%	87%	85%				0.657
2013	91%	90%	90%	88%				0.620
2014	93%	92%	92%	90%				0.627
2015	94%	93%	93%	92%				0.634
2016	96%	95%	95%	93%				0.641
2017	96%	96%	96%	94%				0.690
2018	97%	96%	97%	95%				0.656
2019	98%	97%	97%	96%				0.663
2020	98%	97%	98%	96%				0.670
2021	99%	98%	98%	97%				0.677
2022	99%	98%	99%	97%				0.684
2023	99%	98%	99%	98%				0.691
2024	99%	98%	99%	98%				0.698
2025	100%	99%	99%	98%				0.705
2026	100%	99%	100%	98%				0.712
2027	100%	99%	100%	98%				0.719
2028	100%	99%	100%	98%				0.725
2029	100%	99%	100%	98%				0.732
2030	100%	99%	100%	98%				0.739

0.85714286


MASSACHUSETTS
Emissions (tons/summer day)
% Penetration
0
2
4
6
8
10
12
14
16
18
20
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%
2001
2006
2011
2016
2021
2026
"Widespread use" date under option (c)
"Widespread use" date under option
Emissions if only Stage II controls were in place, without ORVR
Emissions with only ORVR requirements, without Stage II controls
Emissions with Stage II and ORVR, including "excess emissions" of 0.86 lb/1000 gal for Vacuum assist
Emissions with Stage II and ORVR, without "excess emissions"
% ORVR Penetration, option (b) definition
% ORVR Penetration, option (d) definition

9

TOTAL REFUELING EMISSIONS -MASSACHUSETTS

Calendar Year	Grams Emitted Per Gallon Gasoline: Stage II Controls Only	ORVR Only	Stage II with ORVR, No Incompatibility	Stage II with ORVR, Incompatibility	% Decrease from Uncontrolled Emissions	Tons Per Summer Day: Stage II Controls Only	ORVR Only	Stage II with ORVR, No Incompatibility	Stage II with ORVR, Incompatibility	Excess Emissions
2001	0.682	2.307	0.617	0.635	76%	5.92	20.02	5.35	5.51	0.16
2002	0.682	2.147	0.585	0.613	77%	6.01	18.93	5.16	5.41	0.25
2003	0.689	2.005	0.556	0.594	78%	6.18	17.97	4.98	5.33	0.34
2004	0.690	1.813	0.518	0.567	79%	6.28	16.51	4.72	5.17	0.45
2005	0.690	1.599	0.476	0.537	80%	6.38	14.78	4.40	4.97	0.57
2006	0.690	1.373	0.432	0.506	81%	6.48	12.90	4.06	4.75	0.69
2007	0.690	1.166	0.391	0.477	82%	6.57	11.12	3.73	4.55	0.82
2008	0.690	0.982	0.355	0.451	83%	6.67	9.50	3.44	4.36	0.93
2009	0.690	0.823	0.324	0.429	84%	6.77	8.08	3.18	4.21	1.03
2010	0.690	0.687	0.297	0.410	85%	6.87	6.84	2.96	4.08	1.12
2011	0.690	0.578	0.276	0.395	85%	6.97	5.84	2.79	3.99	1.20
2012	0.690	0.494	0.259	0.383	86%	7.07	5.06	2.66	3.92	1.27
2013	0.690	0.428	0.246	0.374	86%	7.17	4.45	2.56	3.88	1.32
2014	0.690	0.378	0.237	0.367	86%	7.27	3.98	2.49	3.86	1.37
2015	0.690	0.342	0.230	0.362	87%	7.36	3.65	2.45	3.86	1.41
2016	0.690	0.317	0.225	0.358	87%	7.46	3.43	2.43	3.88	1.44
2017	0.690	0.299	0.221	0.356	87%	7.56	3.27	2.42	3.90	1.48
2018	0.690	0.286	0.219	0.354	87%	7.66	3.17	2.43	3.93	1.50
2019	0.690	0.275	0.217	0.352	87%	7.76	3.09	2.44	3.96	1.53
2020	0.690	0.267	0.215	0.351	87%	7.86	3.04	2.45	4.00	1.55
2021	0.690	0.260	0.214	0.350	87%	7.95	3.00	2.46	4.04	1.58
2022	0.690	0.253	0.212	0.349	87%	8.05	2.96	2.48	4.08	1.60
2023	0.690	0.249	0.211	0.349	87%	8.15	2.94	2.50	4.12	1.62
2024	0.690	0.246	0.211	0.348	87%	8.24	2.94	2.52	4.16	1.64
2025	0.690	0.242	0.210	0.348	87%	8.34	2.92	2.54	4.20	1.67
2026	0.690	0.241	0.210	0.348	87%	8.43	2.95	2.57	4.25	1.68
2027	0.690	0.241	0.210	0.348	87%	8.53	2.98	2.59	4.30	1.70
2028	0.690	0.240	0.210	0.347	87%	8.62	3.00	2.62	4.34	1.72
2029	0.690	0.239	0.209	0.347	87%	8.71	3.01	2.64	4.39	1.74
2030	0.690	0.238	0.209	0.347	87%	8.81	3.04	2.67	4.43	1.76

	Tons Per Summer Day: Estimated in Periodic Inventory
1996	**5.93**

Calendar Year	Environ Report: g/gal	tpsd	ORVR Penetration, VMT Basis: Vehicles < 10,000 lb GVWR	All Gas Vehicles	Fuel Usage Basis: Vehicles < 10,000 lb GVWR	All Gas Vehicles	Vehicle Basis: Vehicles < 10,000 lb GVWR	All Gas Vehicles, not MC	All Gas Vehicles, with MC	Unc. HDGV g/gal
2001	0.902	7.83	16%	16%	14%	14%				0.646
2002	0.846	7.46	24%	23%	21%	20%				0.655
2003	0.795	7.13	32%	31%	28%	27%				0.679
2004	0.734	6.68	40%	40%	36%	35%				0.689
2005	0.669	6.19	49%	48%	45%	44%				0.701
2006	0.596	5.60	57%	57%	54%	53%				0.711
2007	0.533	5.08	65%	64%	62%	61%				0.723
2008	0.483	4.67	72%	71%	70%	68%				0.734
2009	0.441	4.33	78%	77%	77%	75%				0.745
2010	0.407	4.05	83%	82%	82%	80%				0.755
2011			88%	86%	86%	85%				0.764
2012			91%	90%	90%	88%				0.772
2013			93%	92%	93%	91%				0.779
2014			95%	94%	95%	93%				0.785
2015			96%	95%	96%	94%				0.791
2016			97%	96%	97%	95%				0.797
2017			98%	97%	98%	96%				0.801
2018			98%	97%	98%	96%				0.805
2019			99%	98%	99%	97%				0.808
2020			99%	98%	99%	97%				0.812
2021			99%	98%	99%	97%				0.812
2022			100%	98%	99%	98%				0.812
2023			100%	98%	100%	98%				0.812
2024			100%	99%	100%	98%				0.811
2025			100%	99%	100%	98%				0.810
2026			100%	99%	100%	98%				0.810
2027			100%	99%	100%	98%				0.811
2028			100%	99%	100%	98%				0.810
2029			100%	99%	100%	98%				0.810
2030			100%	99%	100%	98%				0.810

0.85714286