Stage II Vapor Recovery Systems Issues Paper

U. S. EPA
Office of Air Quality Planning and Standards
Emissions Monitoring and Analysis Division
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Executive Summary

The U.S. Environmental Protection Agency (EPA) has been reviewing emissions quantification issues associated with Stage II vapor recovery systems (VRS) at gasoline dispensing facilities (GDF) to addresse the need to evaluate data to: (1) define "widespread use" of on-board refueling vapor recovery (ORVR) canisters, (2) decide what algorithms may be needed to determine "widespread use," and (3) determine whether additional emissions testing is needed to define "widespread use." EPA is also considering other ancillary issues associated with emissions from vehicle refueling that are discussed in this document. The purpose of this paper is to: (1) provide background information regarding available data, (2) discuss EPA's ideas regarding the definition of widespread use, and (3) solicit comments from stakeholders.

Volatile organic compounds (VOC) and hazardous air pollutants (HAP) are emitted from the refueling of light-duty gasoline vehicles and trucks (hereafter referred to as vehicles) at GDF and from fugitive sources at GDF. VOC and HAP emissions occur during Stage II processes at GDF; Stage II refers to delivery of gasoline from the underground storage tank (UST) to the vehicle fuel tank. VOC emissions from Stage II 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).

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" or worse 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.

Stage II VRS include vapor balance and vacuum assist systems. Some vacuum assist Stage II control systems are not fully compatible with ORVR-equipped vehicles; that is, ORVR-equipped vehicles impact the effectiveness of the vacuum assist Stage II VRS. This incompatibility results in an increase in emissions from the level expected when refueling a non-ORVR equipped vehicle. These excess emissions are referred to in this paper as "incompatibility excess emissions." There are usually no incompatibility excess emissions when non-ORVR vehicles refuel at vacuum assist VRS or for vapor balance VRS. Northeast States for Coordinated Air Use Management (NESCAUM), California Environmental Protection Agency Air Resources Board (CARB), and American Petroleum Institute (API) have been very interested and active in Stage II VRS issues, and they have conducted studies to address the incompatibility excess emissions issue and to evaluate widespread use.

With respect to defining widespread use, EPA is considering four definitions of widespread use of ORVR controls. These definitions 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. EPA asks for comment on which of the four definitions should be used to make the widespread use determination, and what percentage is appropriate for definitions (a), (b), and (d). Currently, EPA is considering selecting definition (c) to determine when widespread use occurs in a State or area. EPA is also considering use of the equations in MOBILE6 to calculate vehicle refueling emissions and using either established or to-be-developed emissions factors for UST vent emptying and breathing, fugitive, and incompatibility excess emissions. EPA also anticipates that individual States or areas will make a demonstration regarding widespread use, i.e, the widespread use determination will be State, region, or area-specific. EPA asks for comment on the approach for determining widespread use, using MOBILE6 algorithms for computing widespread use, and making the definition of widespread use specific to States, regions, or areas.

EPA is also considering providing additional SIP credits related to use of Stage II VRS, including: (1) the use of Stage II controls is continued after the determination that widespread use has occurred, (2) States opt to require Stage II controls in new areas, and (3) improved monitoring is applied to Stage II control systems to increase rule effectiveness. Another improved monitoring option may be to implement an inspection, maintenance, and regular replacement schedule of equipment components on the dispenser. Adoption of some aspects of CARB’s Enhanced Vapor Recovery (EVR) program in SIPs is another option. For example, pressure/vacuum (P/V) valves, add-on air pollution control devices, or unihose dispensing could be added as SIP requirements. EPA asks for comments on SIP credit options listed above.

EPA has identified several ancillary 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. Each of these issues is discussed in the paper, and EPA requests comments on these as well. It is our belief that there has not been sufficient emissions testing of the UST vent to adequately quantify the breathing and emptying emissions that occur from the UST. It is our belief that there has also not been sufficient emissions testing of fugitive emissions. We understand that CARB and Western States Petroleum Association (WSPA) are planning emissions testing to measure and quantify the pressure-related fugitive emissions and UST vent emissions related to Stage II controls which will provide more information to evaluate the emissions from these emissions points. We have not yet determined what other emissions testing may also need to be conducted. EPA requests comments on the need for development of additional emissions factors to help quantify emissions from GDF.

Stage II Vapor Recovery Systems Issues Paper

The U.S. Environmental Protection Agency's (EPA) Office of Air Quality Planning and Standards (OAQPS), Emissions Monitoring and Analysis Division (EMAD) has been reviewing emissions quantification issues associated with Stage II vapor recovery systems (VRS). This paper evaluates data and discusses: (1) defining "widespread use" of on-board refueling vapor recovery (ORVR) canisters, (2) deciding what algorithms may be needed to determine "widespread use," and (3) determining how much additional testing (if any) would be needed to define "widespread use." In addition, there are other ancillary issues associated with emissions from vehicle refueling that are discussed in this document, including:

- potential opportunities to provide SIP credits for extending Stage II VRS controls past the widespread use date or enhancing inspections of gas stations,
- the quantification of fugitive VOC emissions from gasoline dispensing,
- determining the incompatibility between Stage II VRS and ORVR canisters, and
- providing new or updated emissions factors for Stage II.

EPA recognizes that many stakeholders have been involved in the discussion of Stage II issues and are very interested in participating in their resolution. The purpose of this paper is to solicit comments from stakeholders on EPA's proposed ideas and potential resolutions to Stage II issues.

I. Background

A. Process Operations at Gasoline Dispensing Facilities

Volatile organic compounds (VOC) and hazardous air pollutants (HAP) are emitted from the refueling of light-duty gasoline vehicles and trucks (hereafter referred to as vehicles) at gas stations or, more formally, gasoline dispensing facilities (GDF) and from fugitive sources at GDF. Controlling these emissions has been an issue for all stakeholders involved in the reduction of ozone and the production and dispensing of gasoline since the late 1980s. VOC and HAP emissions occur from two types of sources at GDF: Stage I and Stage II processes. Stage I refers to processes at GDF when the gasoline is delivered or transferred from the tanker truck to the underground storage tank (UST). Stage II refers to processes at GDF when the gasoline is delivered or transferred from the UST to the vehicle fuel tank. Emissions from Stage II processes are the focus of this paper. Stage I processes are mentioned only for clarity.

Emissions from GDF are a nationwide problem, and gasoline use in vehicles and trucks is increasing annually. In 1999, U.S. gasoline consumption was 167 billion gallons per year (gal/yr).[1] VOC emissions from Stage II 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).[2, 3] 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.[4]

B. Statutory Requirements for Stage II Process Operations

The Stage II vapor recovery program is required by section 182(b)(3) of the Clean Air Act (CAA), 42 U.S.C. 7511a(b)(3). The CAA directs State or Local air pollution control agencies with "moderate" or worse ozone national ambient air quality standards' (NAAQS) nonattainment areas to require Stage II VRS at GDF. However, section 202(a)(6) of the CAA, 42 U.S.C. 7521(a)(6), states that the section 182(b)(3) Stage II requirement shall not apply in moderate areas after ORVR is promulgated. (EPA issued a clarification memorandum in June 1993 regarding use of Stage II controls in moderate areas after ORVR promulgation.)[5] In addition, the CAA provides that EPA may revise or waive the 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. This effort is especially important now as EPA has designated nonattainment areas under the new 8-hour ozone standards. (See Attachment A for the latest non-attainment area classifications.) Section 182(b)(3) also directs EPA to issue a guidance document that addresses the effectiveness of Stage II VRS. This document, *Technical Guidance: Stage II Vapor Recovery Systems for Control of Vehicle Refueling Emissions at Gasoline Dispensing Facilities*, was issued in November 1991.[6]

Section 202(a)(6) of the CAA, 42 U.S.C. 7521(a)(6) also requires EPA to develop standards for ORVR controls on light-duty vehicles. The ORVR controls on vehicles are

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[1] Annual Energy Review 2002. U.S. Department of Energy, Energy Information Administration. October 2003.

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

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

[4] 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.

[5] Memorandum from J. Seitz, OAQPS, to EPA Regions. June 23, 1993. Impact of the Recent Onboard Decision on Stage II Requirements in Moderate Nonattainment Areas.

[6] *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.

generally charcoal canisters that collect the vapors by adsorbing them during refueling and, sometime afterwards, releasing them into the engine. EPA promulgated regulations that required the phase-in of ORVR controls on new vehicles (59 FR 16262; April 16, 1994, and 40 CFR Parts 86, 88 and 200). ORVR is required to be installed on some new vehicles beginning in 1998; all new vehicles (including sport utility vehicles and pickup trucks) will be required to have ORVR installed by 2006. Heavy-duty vehicles above 10,000 pounds gross vehicle weight rating and incomplete heavy-duty vehicles such as motor home cab/chassis vehicles will not be subject to ORVR requirements.

For the Ozone Transport Region (the OTR is comprised of eleven states in the northeastern U.S. and the District of Columbia), there is an additional requirement in section 184(b)(2) of the CAA, 42 U.S.C. 7511c(b)(2) for: (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 State Implementation Plans (SIP) to require Stage II controls or comparable measures. The results of the comparable control measures study are provided in *Stage II Comparability Study for the Northeast Ozone Transport Region*.[7] This requirement under section 184(b)(2) is not affected by EPA's promulgation of ORVR rules, or by any future widespread use determination under CAA section 202(a)(6).

At the point when EPA determines that ORVR is in widespread use and waives or revises the section 182(b)(3) Stage II requirement for serious and above nonattainment areas, and possibly even sooner, EPA believes it could also be appropriate to provide an additional mechanism for OTR States to be able to phase out the section 184(b)(2) Stage II or comparable measure requirement. One approach would be for EPA to update the "Stage II Comparability Study" to provide an option for establishing a new baseline for comparability. The new baseline could coincide with the year that ORVR is determined to be in widespread use, or some other year, taking into consideration the anticipated rate of phase in of ORVR-equipped motor vehicles. The original baseline for comparability was 1999. Because ORVR controls just began phasing in during model year 1998, in 1999 nearly all the reductions in refueling vapors were due to Stage II. At a possible new future baseline, the ORVR would be capturing a significantly greater proportion of the refueling vapors, and reductions attributable to Stage II would likely be correspondingly reduced. Thus, the level of emissions reductions necessary for alternative measures to qualify as comparable to Stage II would also be reduced.

Depending on fleet turnover rates and the remaining utility of Stage II VRS in obtaining emissions reductions at that point, it is possible that OTR States would be able to identify measures already in their SIPs that would qualify as comparable to Stage II for the purpose of meeting the section 184(b)(2) requirement. Provided these measures are not already prescribed by the CAA and subject to the procedural requirements and substantive limitations of section 110(l), OTR States would simply need to list the comparable measures and document the associated emissions reductions in the SIP revision for EPA to be able to approve their request to remove the Stage II program. While this action could be coordinated with EPA's actions to

[7] *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.

waive the Stage II program for serious and worse nonattainment areas so that the phase out of the Stage II program under both of the statutory provisions would happen at the same time, it would not be necessary for these actions to occur simultaneously, or for either specific action to precede the other.

C. Emissions Points from GDF Stage II Processes

The emissions points from uncontrolled Stage II process operations are shown in Figure 1. The emissions points include vehicle refueling, spillage, UST vent breathing and emptying, and fugitives.

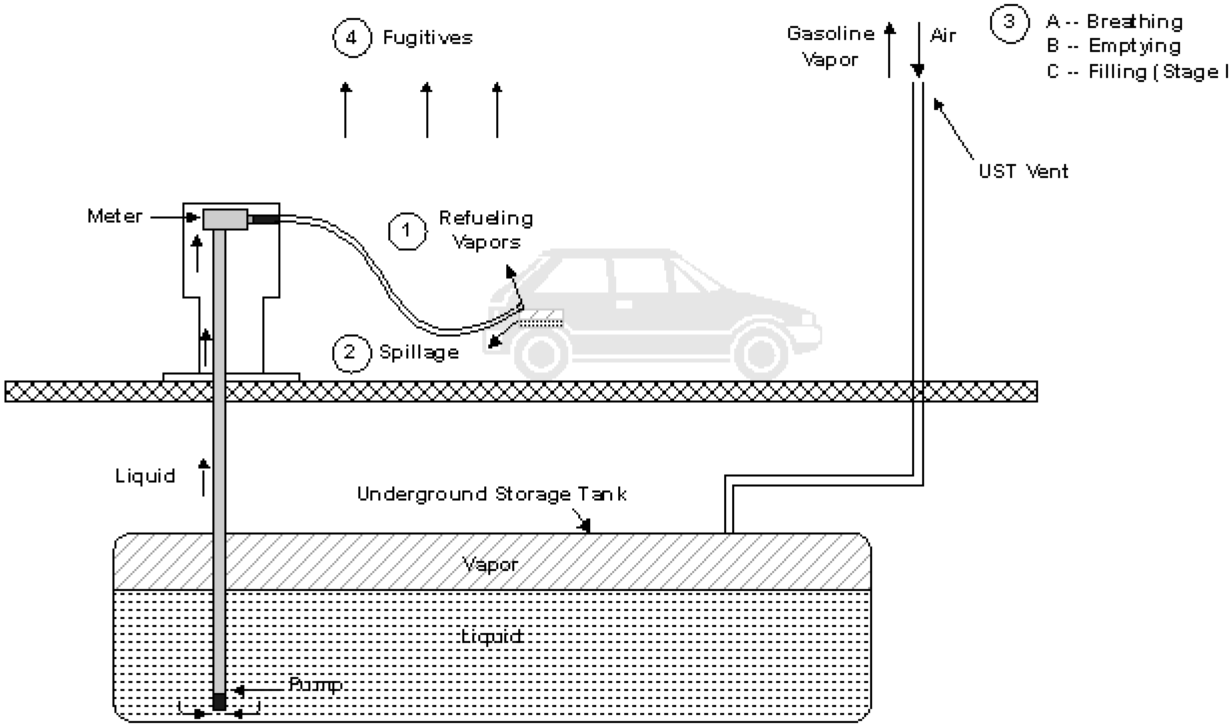

Figure 1. Emissions points from uncontrolled Stage II process operations.

In Stage II processes, gasoline is delivered from the UST to the vehicle fuel tank. Vehicle refueling emissions are generated when gasoline vapors in the vehicle fuel tank are displaced to the atmosphere through the vehicle fillpipe by dispensed gasoline. Spillage emissions may also occur during Stage II processes; spillage includes nozzle drips, spit-back, or overflow of the vehicle fuel tank.[8]

In general, emissions from the UST vent include filling losses, breathing losses, and emptying losses. Filling losses (vapors displaced during the filling of the UST) are associated with Stage I processes, and therefore are not the focus of this paper. Breathing losses are

[8] Ref. 6, p. 3-9

associated with temperature and barometric changes experienced within the UST. Emptying losses occur when gasoline is pumped out of the UST to the vehicle fuel tank, and air is drawn into the UST to replace the volume of liquid removed. Prior to introduction of air to the UST, the vapor space above the gasoline in the tank is at equilibrium. The introduction of air upsets this equilibrium, and a small amount of gasoline evaporates into the vapor space to move the system back to equilibrium. This evaporation causes an increase in volume, and the excess volume may be expelled through the UST vent pipe.[9] For the purposes of this paper, both breathing and emptying losses from the UST vent are included as part of the discussion of Stage II emissions.

Fugitive emissions occur from vapor leaks in the refueling and dispensing equipment, UST, associated piping, pressure/vacuum (P/V) valve (not when the maximum pressure setting is exceeded and the valve opens), and the Stage II VRS. For the purposes of this paper, fugitive emissions are included as part of the discussion of Stage II emissions.

D. Controls for Emissions from Stage II Processes

Controls for emissions from Stage II processes include VRS and ORVR controls. Other controls that are used to control UST vent emissions include a P/V valve or an add-on air pollution control device (APCD). The Automotive Society of Engineers (ASE) conducted an informal estimate of the number and types of VRS systems at their 1997 meeting; they estimated that nationwide, 70 percent of GDF have no Stage II controls, and that 30 percent have Stage II controls.[10] A description of each control and the effect of the control on each emission point is discussed below.

1. Stage II vapor recovery systems.[6, 11, 12] The emissions points from controlled Stage II process operations are shown in Figure 2. The emissions points include vehicle refueling emissions at the nozzle/fillpipe interface (these emissions are significantly reduced compared to the uncontrolled system), spillage (these emissions are reduced as well), UST vent breathing and emptying (these emissions are reduced from the uncontrolled system), and pressure-related fugitives.

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[9] Ref. 6, p. 3-9 and 10.

[10] Conversation with D. Good, OMS, and T. Driscoll, EPA/OAQPS/EMAD. July 22, 2004.

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

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

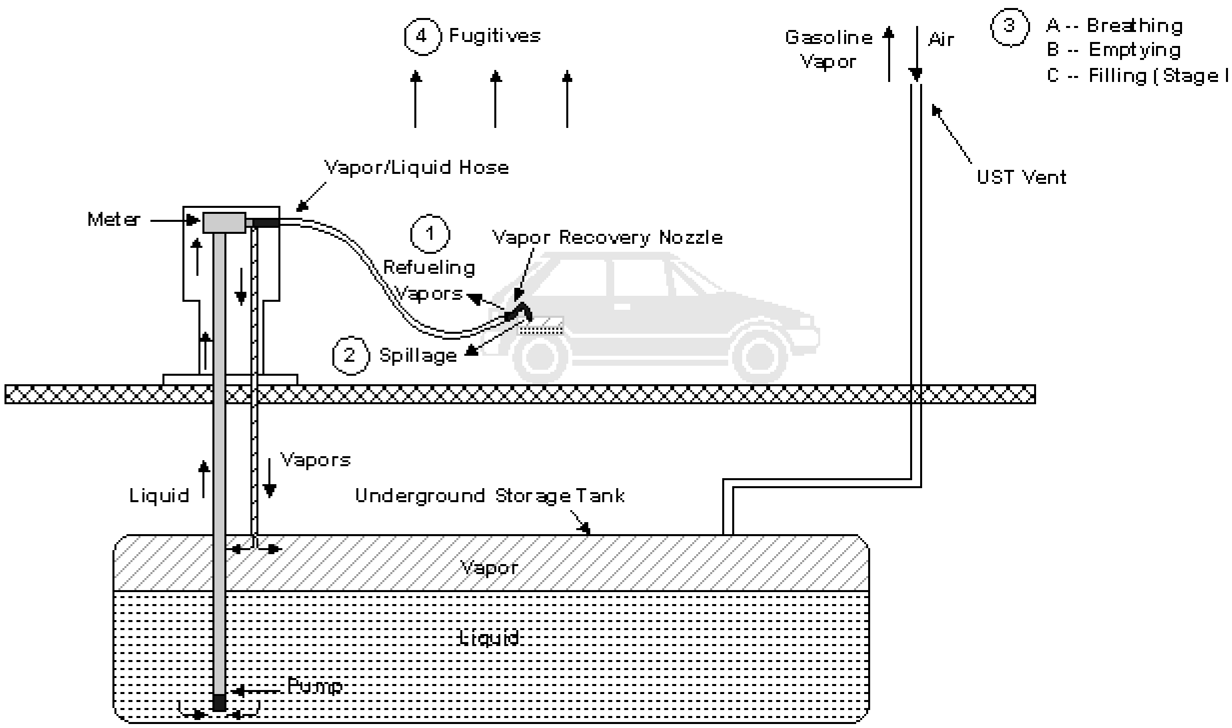

Figure 2. Controlled Stage II Process Operations with vapor recovery system.

A VRS captures the vehicle refueling vapors normally emitted at the vehicle fillpipe and returns them to the UST.[13] A VRS also has an impact on the UST vent emptying emissions as the UST is emptied during refueling.[14] Rather than introducing air to the UST vapor space, the vapor space is filled with the returned gasoline vapors. The returned vapor from the vehicle fuel tank headspace may consist of approximately 30 to 40 percent gasoline vapor and 60 to 70 percent air in the summer.[15, 16] The returned vapors suppress evaporation of liquid gasoline, thus has less effect on the equilibrium in the UST than the introduction of pure air. Emptying emissions from the UST vent are reduced because there is less vapor growth. 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

[13] Ref. 6, p. 3-9

[14] Ref. 6, p 3-10

[15] Ref. 11, p. 2-2.

[16] Ref. 12, p. 2-3.

of the quantity of vapor and air returned to the UST headspace to the quantity of gasoline pumped out of the UST.[17,18]

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.[19, 20] The ASE estimated that 53 percent of controlled systems in the U. S. are vapor balance systems and 47 percent are vacuum assist systems.[21]

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.[22, 23] 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.[24] The vapor balance VRS depends on an adequate seal being established between the vehicle being refueled and the faceplate of the fueling nozzle.[25, 26] 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 often “bootless”; instead a vacuum (by a pump) is used to pull the gases back through a series of holes in the nozzle spout (perforations) during refueling to the headspace of the UST.[27, 28] 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

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[17] Ref. 6, p. 3-1 and 2.

[18] A V/L ratio of 1.0 is more compatible with ORVR controls.

[19] Ref. 6, p. 4-2

[20] *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.

[21] Ref. 10.

[22] Ref. 20, p. 8.

[23] Ref. 11, p. 2-3.

[24] Ref. 11, p. 2-3

[25] Ref. 6, p. 4-2.

[26] Ref. 11, p. 2-3.

[27] Ref. 20, p. 8.

[28] Ref. 11, p. 2-3.

required to be equipped with a P/V valve designed to open only if the pressure or vacuum inside the tank increases beyond a defined threshold.[29, 30] Soon, California is expected to require P/V valves on all UST vents for Stage I control, including those equipped with vapor balance systems. The V/L ratio for vapor balance VRS is generally 1.0 or less, and the ratio for vacuum assist is generally in the range of 0.9 to 2.4.[31] Hybrid vacuum assist systems usually have a much lower V/L ratio than traditional vacuum assist. A hybrid VRS has a V/L ratio close to 1.0.

Stage II VRS can achieve 95 percent control efficiency. The 95 percent is a certification control efficiency. The in-use control efficiency achieved, however, is affected by rule effectiveness and rule penetration. The in-use control efficiency accounts for rule effectiveness when various defects/leaks or malfunctions occur within the VRS. 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. 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). The range of in-use control efficiencies for Stage II VRS are 62 to 92 percent depending on the inspection frequency (this is for no exemptions, i.e., 100 percent rule penetration).[32] 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.[33] 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.[34]

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[29] Ref. 6, p. 4-30.

[30] Ref. 11, p. 2-3.

[31] Ref. 20, p. 60.

[32] Ref. 6, p. 4-50.

[33] Ref. 6, p. 4-54.

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

2. ORVR control systems. The emissions points from Stage II process operations for a vehicle equipped with ORVR are shown in Figure 3. The emissions points include vehicle refueling emissions at the nozzle/fillpipe interface (these emissions are significantly reduced compared to the uncontrolled system), spillage (these emissions are reduced as well), UST vent breathing and emptying (these emissions are comparable to the uncontrolled systems), and fugitives.

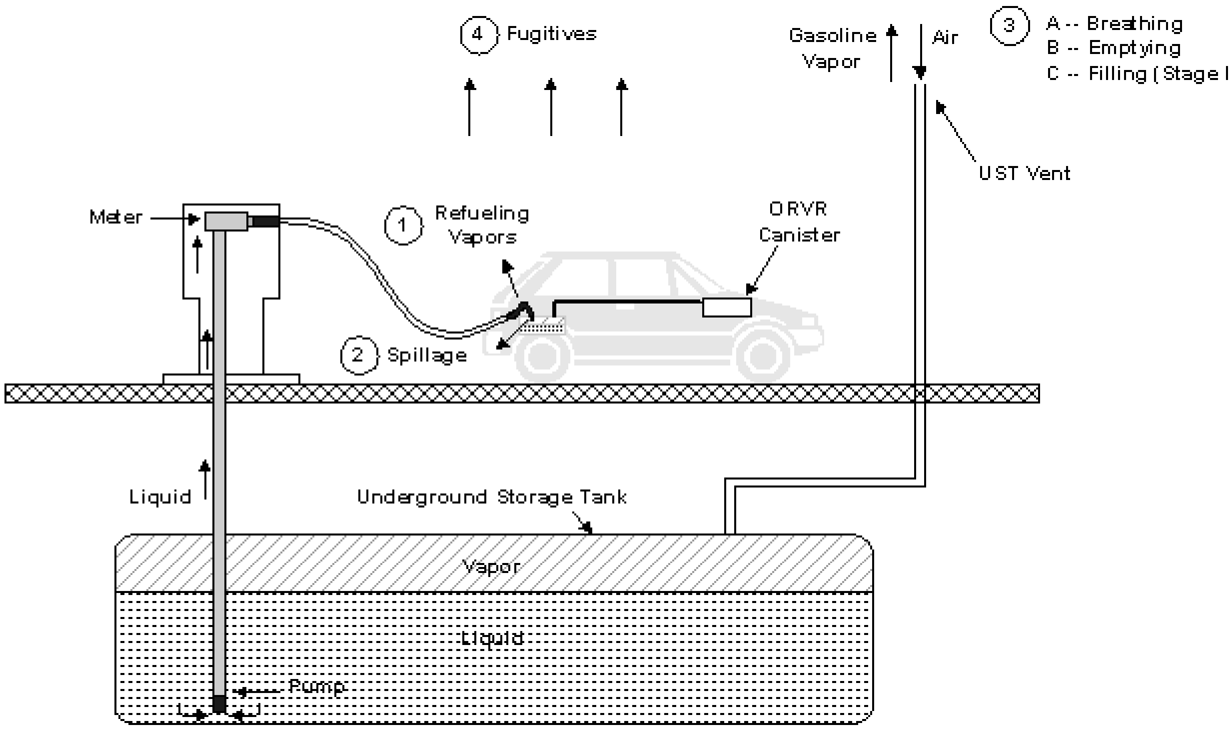

Figure 3. Stage II Process Operation with ORVR-equipped vehicle.

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). For ORVR control only, ORVR does not affect UST vent breathing and emptying losses.[35] In 1998, the phase-in period for installing ORVR canisters in cars began; now all new manufactured cars and new pickup trucks up to 6000 pounds gross vehicle weight category have ORVR. The phase-in period for installing ORVR canisters is just beginning in the 2004 model year for new pickup trucks and sport utility vehicles in the 6001 to 8500 pounds gross vehicle weight category and will not be totally phased in until the 2006 model year. The phase-in period for heavy-duty vehicles (8501 to 10,000 pounds gross vehicle weight category) will begin in the 2005 model year (80 percent) and be totally phased in for the 2006 model year.

[35] Ref. 7, p. 15.

3. Combined Stage II VRS and ORVR systems. 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.[36] These excess emissions are referred to in this paper as "incompatibility excess emissions."

4. P/V valves on the UST vent. The emissions points from a Stage II VRS with a P/V valve on the UST vent are shown in Figure 4. In the past, not all Stage II VRS required P/V valves on the UST vents to meet the required control efficiencies; P/V valves are more likely to be installed on vacuum assist Stage II VRS. Several districts in California have required P/V valves on UST to reduce emptying and breathing emissions for small pressure changes,[37] and the California Environmental Protection Agency Air Resources Board (CARB) will require P/V valves on all UST vents as part of their enhanced vapor recovery (EVR) program for Stage I.[38] P/V valves have been shown to improve the effectiveness of Stage I systems and to enhance the performance of and/or are essential to many Stage II systems.[39] The CARB EVR program requires a P/V valve for Stage I, with pressure limits from -8 inches w.c. to +3 inches w.c.[40] The CARB EVR requirements for Stage II include pressure limits of less than +1.5 inches w.c. maximum, and a daily average limit of less than or equal to 0.25 inches w.c; Stage I operation is excluded from the average.[41]

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[36] Ref. 20, p. 36.

[37] Ref. 20, pp. 21 and 51.

[38] Ref. 20, p. 21.

[39] Ref. 20, pp. 20 and 51.

[40] Ref. 20, p. 22.

[41] Ref. 20, p. 27.

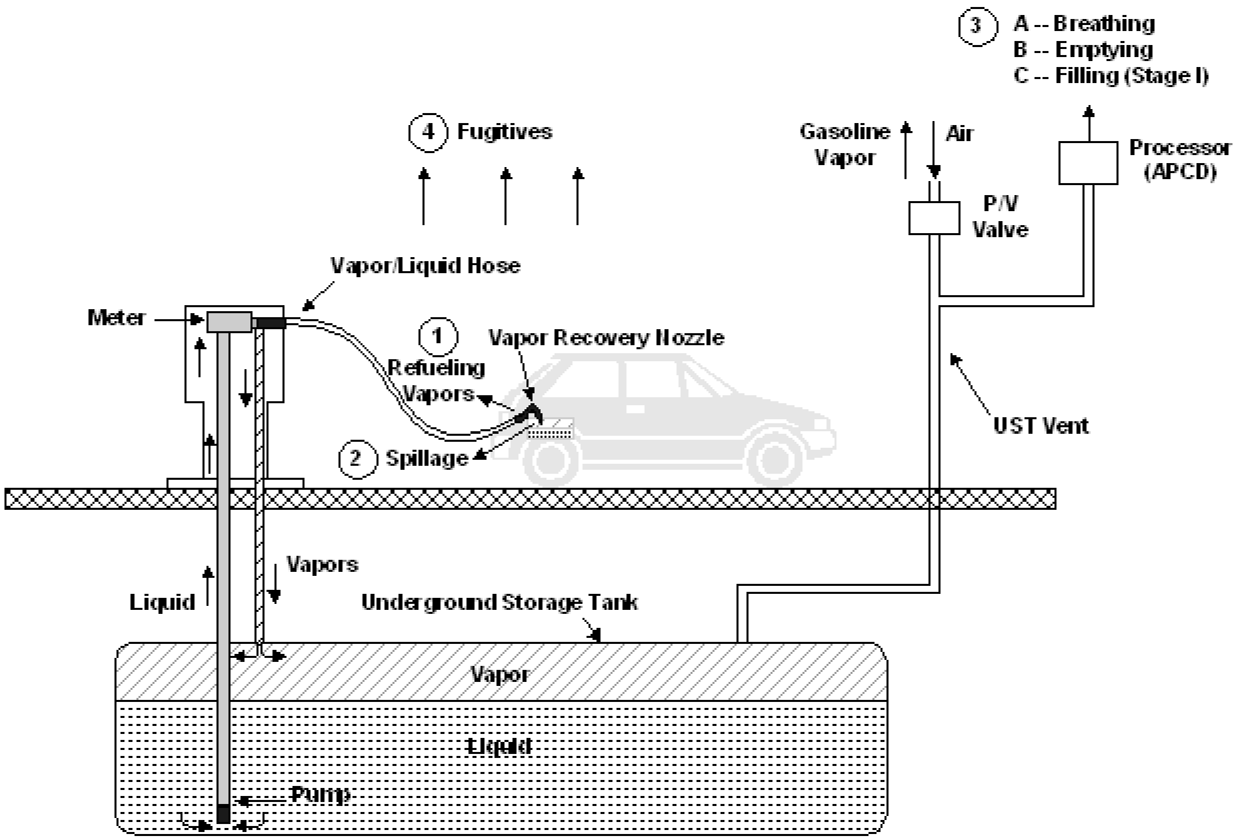

Figure 4. Controlled Stage II Process Operation with vapor recovery system, P/V valve, and add-on control device (processor).

On both vapor balance and vacuum assist VRS, the P/V valve on the UST vent helps reduce UST vent emptying and breathing emissions (and also Stage I UST vent emissions). On a vapor balance system, the P/V valve limits air ingestion into the UST through the vent line and vapor growth from the UST. When fuel is dispensed, the system maintains a slight negative pressure, which actually enhances the effectiveness of the vapor balance system, and slowly equilibrates the vapor space, if the UST is leak-tight.[42] There are also no significant pressure-related fugitive emissions for a vapor balance system.[43] In a vacuum assist system, the vapor pump collects a fixed volume of vapor, which is returned to the UST. Gasoline evaporation in the UST vapor space (vapor growth) causes a positive pressure in the UST and emissions from the UST vent, depending on the pressure setting of the valve.[44] With a P/V valve, the pressure-related fugitive emissions can be significant for vacuum assist systems.[45]

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[42] Ref. 20, pp. 51 and 53.

[43] Ref. 20, p. 56.

[44] Ref. 20, p. 53.

[45] Ref. 20, pp. 27, 53-54.

5. Add-on control devices on the UST vent. An add-on air pollution control device (APCD), or processor, may be placed on the UST vent to collect emissions from the UST. The emissions points from a Stage II VRS with a P/V valve and an APCD are shown in Figure 4. If used, add-on control devices are generally used on vacuum assist Stage II VRS, not on vapor balance systems.[46] As mentioned above, vacuum assist systems operate at positive pressure and emissions from the UST vent occur when the pressure setting on the valve is exceeded. The add-on device controls vapor growth emissions from the UST vent. Having a control device on the UST vent also allows the UST to be maintained at lower pressures (the pressure setting on the valve could be lower) without an increase in emissions.[47] A lower pressure setting also reduces pressure-related fugitive emissions.[48] The APCD or processor may be a combustion device, refrigeration unit, carbon bed, or membranes.[49]

6. California Enhanced Vapor Recovery (EVR) requirements.[50] CARB has promulgated a new program in California called EVR. The purpose of the EVR program is to increase the control efficiency achieved by Stage II VRS in ozone nonattainment areas. The program includes six main modules; the following is a very brief description of the module requirements:

a. Module 1 - Stage I vapor recovery. Changes control efficiency requirement to 98 percent. Requires P/V valves on all systems. Contains additional specifications to vapor adaptor to prevent leaks.

b. Module 2 - Stage II vapor recovery. Improves the certification process. Changes control requirements to 95 percent control efficiency and 0.38 pounds per 1000 gallons summer fuel throughput. Includes fugitive emissions in calculation of the emission factor. Requires pressure limit of +0.25 inches w.c. daily average and +1.5 inches w.c. maximum to help minimize pressure-related fugitive emissions. Contains multiple other requirements related to Module 2 including:

– Static pressure performance
– Compatibility with Phase I (Stage I)
– Liquid removal
– Nozzle/dispenser Compatibility
– Unihose multi-product (UMP) configuration
– Vapor Piping Requirements
– Liquid Condensate Traps
– Leak-tight Connectors and Fittings
– Dynamic Backpressure
– Balance system Component Pressure Drops

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[46] Ref. 20, pp. 8, 54, 56, and 107.

[47] Ref. 20, p. 54.

[48] Ref. 20, p. 33.

[49] Ref. 20, p. 34.

[50] Ref. 20.

– Maximum A/L limits (1.0 for systems without processors; 1.3 for systems with processors

– HAPS limits for processor emissions

– Maximum hydrocarbon rate from processor

c. Module 3 - ORVR compatibility. Requires emissions factor limit of 0.38 pounds per 1000 gallons and the pressure-related fugitive emissions must be less than 50 percent of this amount.

d. Module 4 - Liquid retention. Requires liquid retention emissions factor of less than 100 milliliters per 1000 gallons. Limits nozzle spitting to 1.0 milliliters per nozzle.

e. Module 5 - Spillage and Dripless nozzle. Requires spillage emissions factor of 0.24 pounds per 1000 gallons. Hold on a limit for nozzle drips.

f. Module 6 - In-station diagnostics. Provides continuous real-time monitoring of critical emissions-related VRS parameters and components to alert operator of problems so corrective action can be taken. Assures compliance of installed vapor balance and vacuum assist VRS.

E. Stakeholders and Studies Conducted To Date

The Northeast States for Coordinated Air Use Management (NESCAUM) and northeastern States have been very interested and active in Stage II VRS issues. In addition, CARB has been a major stakeholder in the Stage II VRS forum. CARB has conducted several projects to assess the emissions from GDF and vehicles equipped and not equipped with ORVR. CARB also certifies gasoline dispensing systems with the Stage II VRS equipment. In a recent meeting, CARB announced that the State would probably continue to require Stage II VRS for gas stations after "widespread use" is achieved in California. The American Petroleum Institute (API) has also been very engaged in these issues. The API has conducted several emissions testing projects and has published several reports on: (1) examining widespread use and comparing annual emissions under different control scenarios (e.g., Stage II VRS controls only, ORVR controls only, and combined Stage II VRS and ORVR controls), and (2) determining incompatibility excess emissions caused by Stage II VRS and ORVR controls. Other engaged stakeholders include other state and local air pollution control agencies, GDF operators, vendors of gasoline dispensing equipment, and vendors of UST vent controls.

1. Studies to assess incompatibility excess emissions. Several tests have been conducted to quantify the excess emissions that occur due to the incompatibility between vacuum assist VRS and ORVR controls. As discussed above in section I.D, because the vacuum assist systems return vapor with a higher concentration of air (lower vapor concentration) to the UST headspace when refueling an ORVR-equipped vehicle, incompatibility excess emissions occur. The quantity and concentration of vapor returned to the UST is a significant factor in the amount of incompatibility excess emissions. The V/L ratio for vacuum assist VRS generally causes the greatest incompatibility excess emissions due to the larger quantity of dilute vapor returned to the UST.[51] The incompatibility excess emissions are significantly lower for hybrid VRS and vapor balance VRS; both have lower V/L ratios. API and CARB have conducted testing to try to quantify the excess emissions from the incompatibility of Stage II VRS with ORVR-equipped

[51] Ref. 20, p. 36.

vehicles. The emissions factors for incompatibility excess emissions from several test reports are provided in Table 1. There are some differences in the magnitude of the incompatibility excess emissions factors estimated by API and CARB: (1) in their 2004 study, API estimated excess emissions from incompatibility to be 0.33 lb/1000 gallons and accounted for the decrease in vehicle fillpipe emissions resulting from the combined Stage II VRS and ORVR controls; and (2) in their 1999 study, CARB estimates total excess emissions from incompatibility to be 0.86 lb/1000 gallons (and did not account for decreased vehicle fillpipe emissions). We are currently evaluating their test data and incompatibility excess emissions factors.

Table 1. Comparison of Test Data for Determining Incompatibility Excess Emissions Factors

Test Data	Incompatibility Excess Emissions Factor (IEEF), lb/1000 gal			
	Gilbarco vacuum assist VRS (Certified V/L ratio is 1.0 to 1.2)	Wayne-Dresser vacuum assist VRS (Certified V/L ratio is 0.9 to 1.1)	ORVR - Vehicle fuel tank fillpipe savings (reduction)	Overall (Gilbarco) excess emissions factor
CARB Test 1999 [52]	0.86 [a]	0.06 [a]	NA	0.86
API analysis of CARB IEEF [53]	0.78 [b]	0.08 [b]	NA	0.78 [b]
API Report -Phase 1 2004 [54]	NA	NA	0.31	0.55 [c]
API report - Phase 2 2004 [54]	0.72	NA	0.39	0.33

[a] CARB report provides average emissions for baseline and ORVR-simulated refueling; the incompatibility excess emission factors were calculated by EPA's contractor from these values and the percent of ORVR vehicles simulated; for the Wayne -Dresser system, only the test with the P/V valve intact was used.

[b] API used a linear regression of the CARB test results to determine the emission factor at 100 percent ORVR vehicle simulation and adjusted the factors for a lower Reid vapor pressure (assumed uncontrolled emissions of 7.6 lb/1000gal versus 8.4 lb/1000 gal.).

[c] API calculated 0.55 lb/1000 gal based on the CARB factor of 0.86 lb/1000 gal. (0.86 – 0.31 = 0.55).

To address the incompatibility issue, CARB has also looked at "mini-boot" equipment, pressure-sensing diaphragm in the nozzle, and hydrocarbon sensing technology for vacuum assist

[52]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.

[53] Letter from P. Searles, API to W. Loscutoff, CARB. June 14, 2002. Review of CARB estimates of Enhanced Vapor Recovery (EVR) reductions.

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

Stage II VRS equipment.[55] These technologies help prevent the ingestion of air to the UST when refueling an ORVR vehicle by adjusting the vapor collection (or V/L ratio).[56] In the future, it is our understanding that CARB plans to require VRS to be compatible with ORVR controls. API testing has shown that the mini-boot reduces the amount of incompatibility excess emissions that occurs due to combined vacuum assist Stage II VRS and ORVR-equipped vehicles. Testing has also shown that with the mini-boot installed, the emissions from vacuum assist Stage II VRS and non-ORVR-equipped vehicles may be increased.[54]

We believe there are adequate test data available to determine an excess VOC emissions factor from the incompatibility of vacuum assist Stage II VRS with ORVR-equipped vehicles. However, we are seeking more information regarding the testing results from API, CARB, and ARID Technologies, Inc. (ARID is a vendor of UST vent controls.) We are also seeking information from other stakeholders who may have also conducted or are planning to conduct source testing at GDF to try to quantify incompatibility excess emissions. CARB and the Western States Petroleum Association (WSPA) are currently planning an emissions test to assess pressure-related fugitive emissions and UST vent emissions (the test protocol is not publicly available yet).

2. Studies to define widespread use.[57, 58] As mentioned above, several studies of GDF control measures for ozone nonattainment areas have been conducted by stakeholders. API conducted some studies that looked at the emissions levels associated with multiple control measures, including: (1) ORVR-equipped vehicles alone, (2) Stage II VRS alone, and (3) combined ORVR and Stage II VRS (with the incompatibility excess emissions), and (4) combined ORVR and Stage II VRS (without the incompatibility excess emissions). In these studies, the VOC emissions levels for each control measure were projected over time to see the expected trends. Figure 5 shows example emissions levels that have been projected for 30 years for a hypothetical State for each of the four control scenarios (based on the algorithms and type of analyses conducted by API).

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[55] Ref. 20, pp. 60 and 62.

[56] Ref. 20, p. 62.

[57] Ref. 11.

[58] Ref. 12.

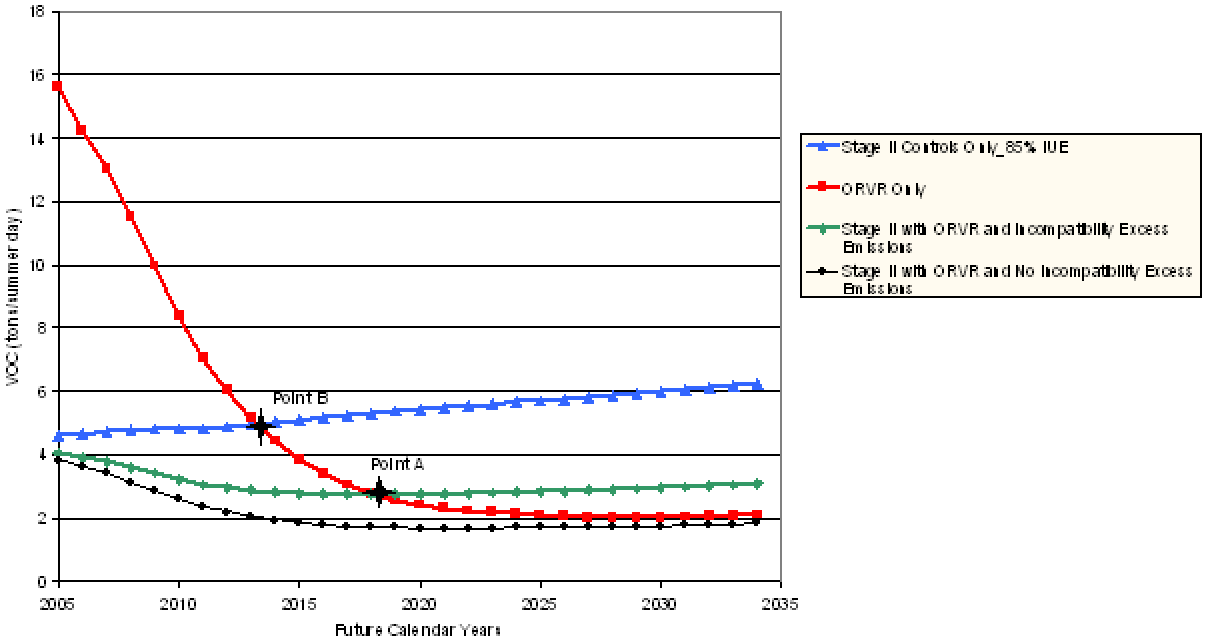

Figure 5. General emissions trends expected for refueling emissions in future calendar years for a hypothetical State (based on API studies).

The Stage II VRS-only emissions levels as shown in Figure 5 for a hypothetical State include vehicle refueling emissions and spillage emissions. They do not include UST vent breathing and emptying, and fugitive emissions. The in-use control efficiency for the Stage II VRS used in the calculations is 85 percent. The vehicle refueling emissions factors (lb/1000 gal) were developed using MOBILE6 refueling equations and the emissions were calculated based on gasoline throughput data. Spillage was calculated using the EPA procedures in MOBILE6 (which is based on an AP-42 emissions factor).

The ORVR-equipped vehicles-only emissions levels in Figure 5 include vehicle refueling emissions and spillage emissions. UST vent breathing and emptying emissions and fugitive emissions are not included. The control efficiency used in this study for ORVR controls was 98 percent and applies to the vehicle refueling emissions only. Again, the vehicle refueling emissions factors (lb/1000 gal) were developed using MOBILE6 refueling equations and the emissions were calculated based on gasoline throughput data. Spillage was calculated using MOBILE6 equations which apply 50 percent lower emissions for spillage for ORVR use (50 percent of AP-42 emissions factor).[59]

For the combined ORVR controls and Stage II VRS scenario, the incompatibility excess emissions were calculated using the "adjusted" CARB incompatibility excess emissions factor of

[59] Ref. 20, pp. 37-40.

0.78 lb/1000 gal and applied the factor to the estimated portion of gallons dispensed to ORVR-equipped vehicles via vacuum assist VRS systems.

Stage II VRS controls have already been implemented in most ozone nonattainment areas; if ORVR were not being implemented, the general trend on Figure 5 is that VOC emissions are expected to continue to increase over time as nationwide gasoline throughput continues to increase (Stage II controls only). However, ORVR equipment currently is being phased in for new vehicles, and, over time, non-ORVR vehicles will continue to be replaced with ORVR vehicles. The ORVR control measure is expected to result in a significant decrease in emissions over time until all subject vehicle classes are ORVR-equipped. After most vehicles are ORVR-equipped, VOC emissions are expected to begin to increase over time as gasoline throughput continues to increase. With the combined ORVR and Stage II VRS control measures, emissions are expected to be lower than with either ORVR controls alone or Stage II VRS controls alone, and will decline over time (theoretically until all subject vehicles are ORVR-equipped). However, with the combined control measures, an incompatibility excess emission occurs where ORVR controls and some Stage II VRS (vacuum assist) coexist. The emission levels with the incompatibility excess emissions are shown on Figure 5. There is a point (see point A on Figure 5) at which emissions from the combined control measures may actually be higher than they would be with ORVR alone due to the incompatibility excess emissions.

The relative control efficiency used in the calculations for Stage II VRS affects the emissions levels on the chart. If the in-use control efficiency for Stage II is lower than 85 percent, the emissions will be higher and the Stage II controls only line on the chart will cross the ORVR only line at an earlier date. In addition, the combined Stage II VRS and ORVR-equipped controls line on the chart would be higher and would also cross the ORVR only line at an earlier date.

The relative size of the incompatibility excess emissions is related to: (1) the portion of vacuum assist systems that are used in an area, (2) the rate of fleet turnover, and (3) the incompatibility excess emissions factor. The combined Stage II and ORVR incompatibility excess emissions in Figure 5 are based on a hypothetical area with approximately 50 percent vacuum assist systems. California estimates that vacuum assist systems now compose approximately 20 percent of their VRS.[60] In New Jersey, the estimated percentage of vacuum assist systems is 10 percent,[61] and in the Houston-Galveston area of Texas, the percentage of vacuum assist systems is 64 percent.[62] In an informal study, the Automotive Society of Engineers estimated in 1997 that approximately 47 percent of VRS nationwide are vacuum assist.[63] The incompatibility excess emissions would be larger for those instances where the

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[60] Ref. 20, p. 11.

[61] Ref. 11.

[62] Ref. 12.

[63] Ref. 10.

percentage of vacuum assist VRS in place is greater (such as in Houston-Galveston). If the fleet turnover rate is higher for a particular State, the incompatibility excess emissions will be larger because there are more ORVR-equipped vehicles in the area.

II. Discussion

A. Determine the "Widespread Use" Definition

As mentioned above in section I, Background, EPA may determine that ORVR control systems are in widespread use throughout the motor vehicle fleet. This issue has several facets to it, including: (1) what should be the definition of widespread use, (2) when can it be predicted to occur, and (3) how can it 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. There have been several discussions of ways to interpret widespread use and some of the potential definitions 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 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. We are seeking your comments on these or other definitions of widespread use.

1. Definition (a) - Percentage of ORVR-equipped Vehicles. Definition (a) for widespread use is a simple approach. 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. It is important to note that while the approach accurately represents the vehicle fleet, more vehicle miles are traveled for newer vehicles, as people tend to drive newer vehicles more often and for longer trips than for older vehicles. This approach may not reflect this fact. This approach also may not address differences in vehicles such as fuel economy (miles per gallon) and useful life.

2. Definition (b) - Percentage of VMT by ORVR-equipped vehicles. This definition 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), that newer vehicles are often driven more miles than older vehicles; 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.

3. 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). Definition (c) is represented by point B on Figure 5. 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 VRS must be correctly determined (range was provided as 56 to 90 percent).[64]

4. 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). One disadvantage with 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 address differences in vehicles such as fuel economy/gas mileage for each vehicle type. As part of the Regulatory Impact Analysis (RIA) document developed for the ORVR regulations in January 1994, the widespread use analysis conducted was based on gasoline dispensed to ORVR-equipped vehicles.[65]

5. Combinations of definitions. Because of uncertainties inherent in measuring the VOC emissions from vehicle refueling, a combination of widespread use definitions may be beneficial. For example, widespread use may be determined to be when the refueling VOC emissions with Stage II VRS controls only equal the refueling VOC emissions with ORVR controls only and when "X" percent of the vehicles are equipped with ORVR (for example, 95 percent). This is an example of a combination of definitions (a) and (c). An advantage of a combination approach is that, in theory, declaration of widespread use is balanced between two criteria rather than relying solely on one factor. The disadvantage is that each of the "factors" being considered may be interrelated anyway. Another disadvantage of the combination approach is that the algorithm is more complex and States would be required to expend more effort to demonstrate that the criteria are met.

6. Use of definition (c). EPA is currently considering use of definition (c) to define when widespread use of ORVR occurs. This definition considers and compares emissions levels directly. EPA would like your comments on which widespread use definition is appropriate.

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[64] Ref. 6, p. 4-54.

[65] *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.

B. Uniform, Nationwide Widespread Use Definition

There is a question of whether the definition of "widespread use" should be the same for all areas or States. We believe that the definition of widespread use should be consistent nationwide. However, we anticipate that the data supplied to the algorithms will be State-specific. Therefore, when widespread use will be predicted to occur in each State may be different. At a recent NESCAUM meeting, NESCAUM and State representatives pointed out that vehicle turnover occurs more quickly in the Northeast U.S. (because road salt used in winter on roads deteriorates the vehicle bodies) than in States with less snow and ice. Therefore, they expect a higher rate of vehicle turnover in the northeastern U.S. than in States with more temperate climates. Conversely, CARB studies indicate that they expect vehicles to last longer, thus a lower fleet turnover rate is expected in California. Studies conducted by CARB show widespread use (based on definition b at 90 percent VMT) is expected to occur in California after 2020, however studies conducted on some NESCAUM states show widespread use may occur sooner, maybe as soon as 2011 (definition c) or 2013 (definition b at 90 percent VMT).[66, 67]

The MOBILE6 equations factor in such variables as VMT (States are now developing their 2002 emissions inventories and will have VMT data soon), fleet turnover rates, and temperature of gasoline stored in UST that are "State-specific" data. Thus, we believe use of State-specific data will make the determination of widespread use State-specific as well. We currently plan to provide default data needed for the equation variables (i.e., MOBILE6 defaults) for factors where a State may not collect the data needed for MOBILE6, such as VMT. However, where a State does not agree with default values, it will be welcome to collect its own data and/or conduct its own testing.

Because the Northeast States are all part of the OTR, they have indicated that a regional application of the widespread use definition may be appropriate for them. We believe a regional determination of widespread use is appropriate, although a regional average of each of the 11 State's (plus the District of Columbia) data may be needed. [See discussion in section I.B above for OTR States.]

C. Widespread Use Algorithm Development

Our approach to developing the widespread use algorithm is to start at the end of the process and work backwards. In other words, first we plan to define widespread use and then develop the appropriate algorithm for the calculations. We would work "backwards" to determine what data are needed and/or whether more emissions testing will be needed for the algorithm or to support the definition. We will need the involvement of stakeholders.

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[66] Memorandum from G. Lew, CARB, to J. Guerrero, CARB. April 16, 2002. Updated ORVR Penetration Calculations.

[67] Ref. 11.

If we select a definition of widespread use that requires the calculation of emissions, our current thinking is to use the MOBILE6 model equations to compute the emissions from refueling. The MOBILE6 model calculates VOC emissions from all facets of mobile vehicle use, including refueling and vehicle operation. There are modules in this model that pertain to automobile refueling – these are the parts of the model we will use. Because the MOBILE6 model and its assumptions are already accepted by most stakeholders, we will not need to develop and defend new equations/algorithms. We would also use emissions factors to estimate the emissions from spillage, UST vent emptying and breathing, and fugitive emissions. However, no variable currently exists to account for the excess emissions from the incompatibility of Stage II VRS and ORVR-equipped vehicles. We will need to determine how to factor these incompatibility excess emissions into the calculations. This will require defining an incompatibility excess emissions factor(s).

We want to involve stakeholders in this process of developing a workable definition of widespread use and we are asking for comment on the algorithm, including the use of MOBILE6 equations and other emissions factors. We also want to establish a process that confirms widespread use is actually achieved when predicted to occur and ensure there is no backsliding afterwards.

D. SIP Credits

There are several questions 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 6 shows the relative emissions for several control measures and in-use efficiencies. The figure shows the full range of possible in-use efficiencies and its relation to the ORVR only control (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. On Figure 5, depending on which definition is selected and the data inputs, the widespread use definition may be met many years prior to point A (for example, at point B on Figure 5, which would satisfy definition (c) above); if an area continued to use both control measures beyond the widespread use date, SIP credits could be provided for many years. EPA requests comments on the SIP credit options discussed below. If a State applied control measures in its projected emissions baseline, it could not receive additional SIP credit for those same measures, i.e., to avoid double-counting.

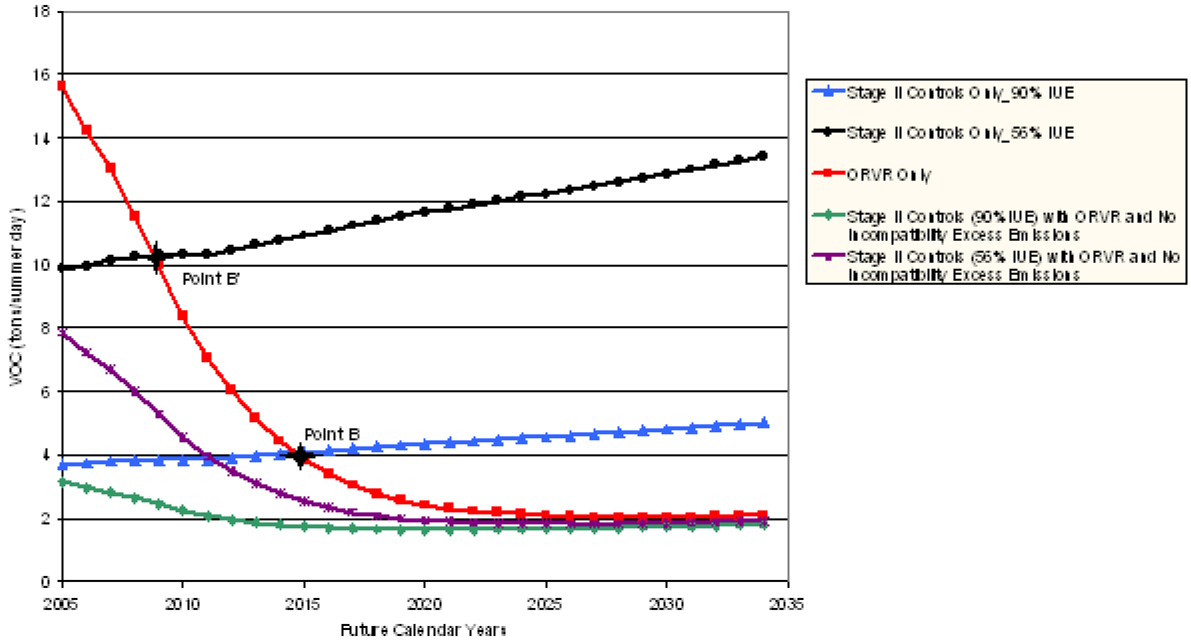

Figure 6. General emissions trends expected for refueling emissions in future calendar years for a hypothetical State, no incompatibility excess emissions (based on API studies).

1. 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" or worse 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 is achieved. 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. In the OTR, Stage II or comparable emissions-reducing controls are required under section 184(b)(2) of the CAA throughout the States regardless of their classifications. [See discussion in section I.B above for OTR States.] EPA may consider providing additional SIP credits where States (non-OTR) retain Stage II VRS after widespread use occurs. EPA would 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 (point A on Figure 5). CARB staff plan to retain Stage II controls after widespread use occurs in California.

If SIP credits can be given when VRS are continued after the widespread use date, the calculation would include emission reductions that reflect combined Stage II and ORVR controls. Essentially, for these counties, there would be no change in the emissions that have already been projected for the nonattainment area, if reductions for ORVR are already included in their projections.

2. 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 (see Attachment A), (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. There are a few moderate areas (outside of OTR) that did retain 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, achieving the reduction from the ORVR only line on Figure 5 to the combined Stage II and ORVR line (with incompatibility excess emissions). This credit could be taken from the implementation of Stage II controls through the date associated with point A on Figure 5.

3. Improved Monitoring for Stage II VRS. There are several types of improved monitoring 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). California has determined that Stage II VRS have not achieved the emissions reductions that have been assumed in their SIPs. California assumed in their 1994 SIP that the Stage II VRS had an in-use control efficiency of 90 percent.[68] However, in 1995 they assumed their in-use control efficiency to be

[68] Ref. 20, pp. 96-97.

84.5 percent,[69] and in 2000, they estimated that the in-use efficiency was approximately 76 percent.[70] To improve their Stage II in-use efficiency, they implemented the EVR program.[71]

a. Inspections. Oversight inspections of the Stage II VRS at GDF are conducted by area inspectors and generally focus on Stage II VRS equipment defects and visual inspection of the nozzles, boots, faceplates, and hoses for cuts, tears or other disrepair (some states require more than visual inspections); checks of the nozzle check valves, nozzle latches, etc.; inspection of the APCD on the UST vent, if any (i.e., the processor); on-site paperwork and records; and 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.[72] EPA requests information on the Stage II inspection frequency in nonattainment areas and also requests information on any leak check requirements and the frequency for the leak checks.

As discussed above in section I.C, the in-use control efficiency ranges from 56 to 90 percent, depending on the inspection frequency and the exemption levels.[73] 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.[74] Data analyzed during preparation of the EPA's *Technical Guidance Document* indicate that conducting semi-annual inspections provide in-use efficiency of 92 percent, annual inspections provide in-use control efficiency for Stage II VRS of 86 percent, and minimal or less frequent inspections provide 62 percent in-use efficiency (these values assume no exemptions).[75] 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.

Another closely related option for improved monitoring might include a maintenance program for dispenser components. A GDF could implement a program of scheduled

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[69] Ref. 10.

[70] Ref. 20, pp. 96-97.

[71] Ref. 20, p. 14.

[72] Ref. 6, pp. 6-22 through 32.

[73] Ref. 6, p. 4-54.

[74] Ref. 6, p. 4-53.

[75] Ref. 6, p. 4-50.

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.

b. In-station diagnostics. We believe that better (and more frequent) monitoring, coupled with good operation and maintenance programs, results in emissions reductions. There are several potential VOC emissions points at GDF other than the refueling interface that are monitored infrequently, at best. CARB will require an ISD monitoring system as a part of their EVR program for improved monitoring at GDF. ISD is a program that measures operating parameters of the Stage II VRS and GDF equipment to ensure it is operating properly. The ISD 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 V/L ratio with a flow meter would be measured.[76] 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.[77] If the assist VRS also has an APCD (or processor) on the UST vent, operating parameters of the APCD such as hydrocarbon concentration, flow rate, flame detection, pressure would be monitored.[78] 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 efficiency currently assumed in the inventory.[79] For other States that adopt ISD programs, SIP credits may be provided.

There is also a corollary question concerning the continuation of GDF testing after widespread use occurs. Because most of the current monitoring/testing focuses on the refueling, testing of gas stations after widespread use of ORVR occurs may be pointless. We are seeking your comments on the efficacy of monitoring/testing after widespread use occurs.

c. Other CARB EVR requirements. We ask for comment on adding UST vent controls as possible SIP control measures after Stage II VRS requirements are removed, for those States or areas that remove Stage II. The control measures may include a P/V valve or an add-on control device (processor) or possibly other CARB EVR requirements. We also ask for comment on addition of UST vent controls as possible SIP control measures when a State decides to keep Stage II VRS requirements in place (i.e., combination of Stage II and ORVR controls and UST vent controls). In addition, we ask for comments regarding other EVR requirements, such as unihose dispensers.

E. Ancillary Emissions Issues

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[76] Ref. 20, p. 66.

[77] Ref. 20, p. 67.

[78] Ref. 20, p. 67-68.

[79] Ref. 20, p. 94.

The following discussions include additional potential issues we have identified. We ask for your comments on the significance of these issues.

1. UST vent emptying and breathing emissions. Emissions from an UST vent could result from one or more of the following:[80] (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.)[81] At a recent NESCAUM meeting, a representative of the State of Massachusetts indicated that OPW, a Stage II equipment manufacturer, had conducted some testing of these vents. OPW found that some of the P/V valves on the UST vents stayed open during the entire test, regardless of whether vehicles were being refueled and regardless of whether ORVR-equipped vehicles were being refueled, implying there were continuous VOC emissions from the UST vents. Lastly and as a separate issue, some studies suggest that there are significant emissions from the UST vents, other than those from refueling vehicles.[82] We believe more emissions testing may be needed to determine whether controls and/or more frequent monitoring of these vents is warranted.

Currently, UST vent emissions are 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/1000 gal] to 11.1 lb VOC/1000 gal for an uncontrolled refueling emissions factor to 1.0 lb VOC/1000 gal for UST vent and fugitive emissions).[83, 84] However, when ORVR-equipped vehicles are in widespread use and refueling emissions are controlled from 95 to 98 percent (i.e., emissions from refueling are much lower), emptying and breathing emissions from an UST vent may become a more significant portion of total VOC emissions and may warrant a closer look.[85] At that time, EPA and States may want to revisit the issue of requiring controls on the UST vent. In addition, a P/V valve on the UST vent is

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

[81] 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

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

[83] CARB. *Uncontrolled Vapor Emissions Factor at Gasoline Dispensing Facilities*. January 2000.

[84] Ref. 81.

[85] Ref. 81.

currently required in some areas of the country as part of the Stage I controls or Stage II vacuum assist VRS. We believe when or if Stage II is removed, removal of the UST vent P/V valve will have to be reviewed.

2. 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 (uncontrolled refueling operations); (2) the normal fugitive emissions expected from GDF when Stage II VRS is used (controlled); (3) the excess fugitive emissions from the GDF resulting from the incompatibility of combined Stage II Vacuum assist VRS with ORVR-equipped vehicles during refueling; and (4) the potential fugitive emissions from the deterioration and aging of gasoline dispensing equipment. Few studies of potential fugitive emissions from GDF have been conducted and as such, it is not clear whether these emissions are significant. Also there could be fugitive emissions caused by deterioration and aging of equipment, although this issue has not been studied.

Similar to other types of larger facilities, there is the potential for fugitive emissions from hoses, pipes, flanges, etc. 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 Stage II Vacuum assist VRS is used in conjunction with ORVR-equipped vehicles.[86] 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 concludes that the CARB calculations overestimate fugitive emissions.[87] Some additional evaluation and emissions testing will probably be needed to quantify fugitive emissions under the various uncontrolled and controlled scenarios at GDF.

3. Potential Need to Develop New Emissions Factors for VOC and HAP. Currently, AP-42 (the repository for EPA emissions factors) section 5.2 includes average emissions factor information for VOC and also an equation for developing the vehicle refueling emissions factor based on site-specific Reid vapor pressure and temperature. The average VOC emissions factors are: (1) uncontrolled Stage II refueling operations (11.0 lb VOC/1000 gal), (2) controlled Stage II refueling operations (1.1 lb VOC/1000 gal), and (3) UST vent breathing and emptying and fugitives (1.0 lb VOC/1000 gal).[88] These average VOC emissions factors, developed from some testing conducted in 1985, are higher in some instances than those shown in the review of recent test data from CARB and API. The current average AP-42 emissions factor information is almost 20 years old and does not account for the changes in gasoline composition. There is also some HAP emissions factor information in *Volume III: Introduction to Area Source Emission Inventory Development* (Revised Final, January 2001), *Chapter 11, Gasoline Marketing (Stage I*

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[86] Ref. 52.

[87] Ref. 54.

[88] Ref. 81.

and Stage II) (Revised Final, January 2001).[89] Table 11.3-2 in Volume III, labeled "HAP Percent of VOC Emissions," includes a species profile for 8 HAP.[90] We believe more emissions testing may be needed to develop new emissions factors, especially for air toxics.

The list of refueling-related activities that may possibly need additional emissions factor work or where there are no emissions factors includes:

(a) incompatibility excess emissions from Stage II vacuum assist VRS and ORVR-equipped vehicles, which would include breathing and emptying emissions from UST vent and vehicle refueling emissions, as well as fugitive emissions from GDF systems and VRS;

(b) UST vent breathing and emptying emissions from UST without Stage II VRS, with and without P/V valves; and

(c) fugitive emissions from the UST and dispensing equipment, including equipment leaks from pipes, hoses, flanges, etc., for uncontrolled systems and for Stage II VRS controls.

[89] Volume III is part of a series of documents developed by the Emissions Inventory Improvement Project (EIIP) that are part of a cooperative effort between US EPA and State and local air pollution control agencies to document direct and cost-effective methods for developing emissions inventories.

[90] Ref. 4.

Attachment A

8-Hour Ozone Nonattainment Areas Listed by Category/Classification (Attainment Date)*

__SEVERE 17 (June 2021)__
Los Angeles South Coast Air Basin, CA
Los Angeles County (P)[n], Orange County [n], Riverside County (P)[n], San Bernardino County (P)[n]

__SERIOUS (June 2013)__
Riverside Co, (Coachella Valley), CA
Riverside County (P)[n]

Sacramento Metro, CA
El Dorado County (P)[n], Placer County (P)[n], Sacramento County [n], Solano County (P)[n], Sutter County (P)[n], Yolo County [n]

San Joaquin Valley, CA
Fresno County [n], Kern County (P)[n], Kings County [n], Madera County [n], Merced County [n], San Joaquin County [n], Stanislaus County [n], Tulare County [n]

__MODERATE (June 2010)__
Baltimore, MD
Anne Arundel County [n], Baltimore (City)[n], Baltimore County [n], Carroll County [n], Harford County [n], Howard County [n]

Boston-Lawrence-Worchester (E. MA), MA
Barnstable County [n], Bristol County [n], Dukes County [n], Essex County [n], Middlesex County [n], Nantucket County [n], Norfolk County [n], Plymouth County [n], Suffolk County [n], Worcester County [n]

Boston-Manchester-Portsmouth(SE), NH
Hillsborough County (P)[n], Merrimack County (P)[n], Rockingham County (P)[n], Strafford County (P)[n]

Cass Co, MI
Cass County

Charlotte-Gastonia-Rock Hill, NC-SC
North Carolina – Cabarrus County, Gaston County [m], Iredell County (P) (Davidson Township, Coddle Creek Township), Lincoln County, Mecklenburg County [m], Rowan County, Union County
South Carolina – York County (P)
Chicago-Gary-Lake County, IL-IN

Illinois – Cook County [n], Du Page County [n], Grundy County (P) [n] (Aux Sable Township, Goose Lake Township), Kane County [n], Kendall County (P) [n] (Oswego Township), Lake County [n], McHenry County [n], Will County [n]
Indiana – Lake County [n], Porter County [n]

Cleveland-Akron-Lorain, OH
Ashtabula County [m], Cuyahoga County [m], Geauga County [m], Lake County [m], Lorain County [m], Medina County [m], Portage County [m], Summit County [m]

Dallas-Fort Worth, TX
Collin County [n], Dallas County [n], Denton County [n], Ellis County, Johnson County, Kaufman County, Parker County, Rockwall County, Tarrant County [n]

Detroit-Ann Arbor, MI
Lenawee County, Livingston County [m], Macomb County [m], Monroe County [m], Oakland County [m], St Clair County [m], Washtenaw County [m], Wayne County [m]

Fredericksburg, VA
Fredericksburg, Spotsylvania County, Stafford County [n]

Greater Connecticut, CT
Hartford County [n], Litchfield County [n], New London County [n], Tolland County [n], Windham County [n]

Houston-Galveston-Brazoria, TX
Brazoria County [n], Chambers County [n], Fort Bend County [n], Galveston County [n], Harris County [n], Liberty County [n], Montgomery County [n], Waller County [n]

Jefferson Co, NY
Jefferson County [n]

Kent and Queen Anne's Cos, MD
Kent County [n], Queen Annes County [n]

La Porte, IN
La Porte County

Lancaster, PA
Lancaster County [n]

Los Angeles-San Bernardino Cos(W Mojave),CA
Los Angeles County (P)[n], San Bernardino County (P)[n]

Memphis, TN-AR
Tennessee – Shelby County [m]
Arkansas – Crittenden County

Milwaukee-Racine, WI
Kenosha County [n], Milwaukee County [n], Ozaukee County [n], Racine County [n], Washington County [n], Waukesha County [n]

Muskegon, MI
Muskegon County [m]

New York-N. New Jersey-Long Island,NY-NJ-CT
Connecticut – Fairfield County [n], Middlesex County [n], New Haven County [n]
New Jersey – Bergen County [n], Essex County [n], Hudson County [n], Hunterdon County [n], Middlesex County [n], Monmouth County [n], Morris County [n], Passaic County [n], Somerset County [n], Sussex County [n], Union County [n], Warren County [n]
New York – Bronx County [n], Kings County [n], Nassau County [n], New York County [n], Queens County [n], Richmond County [n], Rockland County [n], Suffolk County [n], Westchester County [n]

Philadelphia-Wilmin-Atlantic City,PA-NJ-MD-DE
New Jersey – Atlantic County [n], Burlington County [n], Camden County [n], Cape May County [n], Cumberland County [n], Gloucester County [n], Mercer County [n], Ocean County [n], Salem County [n]
Delaware – Kent County [n], New Castle County [n], Sussex County [n]
Maryland – Cecil County [n]
Pennsylvania – Bucks County [n], Chester County [n], Delaware County [n], Montgomery County [n], Philadelphia County [n]

Poughkeepsie, NY
Dutchess County [n], Orange County [n], Putnam County [n]

Providence (All RI), RI
Bristol County [n], Kent County [n], Newport County [n], Providence County [n], Washington County [n]

Richmond-Petersburg, VA
Charles City County [m], Chesterfield County [m], Colonial Heights [m], Hanover County [m], Henrico County [m], Hopewell [m], Petersburg, Prince George County, Richmond [m]

Sheboygan, WI
Sheboygan County [m]

Springfield (Western MA), MA
Berkshire County [n], Franklin County [n], Hampden County [n], Hampshire County [n]

St Louis, MO-IL
Missouri – Franklin County [m], Jefferson County [m], St Charles County [m], St Louis [m], St Louis County [m]
Illinois – Jersey County [m], Madison County [m], Monroe County [m], St Clair County [m]

Ventura Co, CA
Ventura County (P)[n], that part of Ventura County excluding the Channel Islands of Anacapa and San Nicolas Islands.

Washington, DC-MD-VA
Entire District of Columbia [n]
Maryland – Calvert County [n], Charles County [n], Frederick County [n], Montgomery County [n], Prince George's County [n]
Virginia – Alexandria [n], Arlington County [n], Fairfax [n], Fairfax County [n], Falls Church [n], Loudon County [n], Manassas [n], Manassas Park [n], Prince William County [n]

MODERATE EARLY ACTION COMPACT (December 2007)
Greensboro-Winston Salem-Highpoint, NC
Alamance County, Caswell County, Davidson County [m], Davie County [m], Forsyth County [m], Guilford County [m], Randolph County, Rockingham County

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*** Effective June 15, 2004**
(P) = part of the county
n = area has whole or part county or counties in a current 1-hr Ozone nonattainment area
m = area has whole or part county or counties in a current 1-hr Ozone maintenance area

Previously, moderate nonattainment areas were also required to have Stage II. However, Section 202(a)(6) of the Clean Air Act states that the Section 182(b)(3) requirement to adopt Stage II controls shall not apply to moderate areas after the promulgation of onboard rules. In addition, EPA stated in their June 23, 1993 memorandum that after onboard refueling vapor recovery (ORVR) was adopted that moderate areas could remove their Stage II control requirement without penalty. Most moderate areas did remove Stage II control requirements.

Also, on April 15, 2004, the 8-hour ozone nonattainment designations were published; these designations went into effect on June 15, 2004. Under the new 8-hour designations, several areas are classified as moderate nonattainment and will still have Stage II controls on GDF (they will have Stage II controls because under the 1-hour ozone nonattainment designations these areas are classified as serious or higher.) These areas are highlighted above in yellow. For example, areas in EPA Region I (Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut) that are included as additions to the new 8-hour moderate nonattainment designation are areas that were previously classified as "serious" for the 1-hr ozone standard.

In addition, the Clean Air Act requires all states in the Ozone Transport Region (OTR) to adopt Stage II or comparable measures, regardless of their classification. The OTR States include: Connecticut, Delaware, District of Columbia, Maine, Maryland, Massachusetts, New Hampshire, New Jersey, New York, Pennsylvania, Rhode Island, and Vermont. New Hampshire only has Stage II in certain areas. New Hampshire submitted, and EPA approved, a Stage II comparability SIP revision (64 FR 52434; September 29, 1999). In its comparability SIP revision, New Hampshire relied on reductions from its Stage II program (which is implemented in Hillsborough, Merrimack, Rockingham, and Strafford counties) and reductions from its reformulated gasoline (RFG) program.