APPENDIX A: EMISSION BENEFIT ASSESSMENT FOR REMOVAL OF STAGE II GASOLINE VAPOR CONTROL PROGRAMS

TABLE OF CONTENTS

1.1 Introduction

1.2 Parameters and Variables for Stage II VRS and ORVR

1.2.1 Definition of Terms

1.2.2 Sources of Data and Values for Parameters and Variables

1.3 Calculating Impacts on the Area Wide Refueling Emission Inventory

1.3.1 Area Specific Increments

1.3.1.1 Fraction of Gasoline Dispensed to ORVR Equipped Vehicles

1.3.2 Area Specific Fuel Consumption

1.3.2.1 Gasoline Consumption Growth Factors

1.3.2.2 Projected Fuel Consumption

1.3.2.3 Nonattainment Area Ozone Season Daily Gasoline Consumption

1.3.3 Area Specific Emission Factor

1.4 List of References

LIST OF TABLES

Table 1: Summary of Stage II Variable Values and Data Sources
Table 2: BPA Stage II VOC Reduction Loss, Tons per Ozone Season Day
Table 3: DFW Stage II VOC Reduction Loss, Tons per Ozone Season Day
Table 4: ELP Stage II VOC Reduction Loss, Tons per Ozone Season Day
Table 5: HGB Stage II VOC Reduction Loss, Tons per Ozone Season Day
Table 6: Increment_i by Area in Year
Table 7: ORVR Penetration Rates by Model Year and Vehicle Type
Table 8: Projected Penetration of ORVR in Beaumont-Port Arthur by Year
Table 9: Projected Penetration of ORVR in Dallas-Fort Worth by Year
Table 10: Projected Penetration of ORVR in El Paso by Year
Table 11: Projected Penetration of ORVR in Houston-Galveston-Brazoria by Year
Table 12: Motor Gasoline Growth from 2011 to Projected Years
Table 13: National Gallons Motor Fuel Projected from 2011 to 2012
Table 14: Percent of 50 State Gasoline Consumption for Areas Covered by FCAA Sections 182(b)(3) or 184(b)(2)[1]
Table 15: 2012 Monthly, Ozone Season Total and Ozone Pre Day Gasoline Consumption for Four Texas Nonattainment Areas
Table 16: Ozone Season Daily Gasoline Consumption by Years and Areas
Table 17: Uncontrolled Displacement Refueling Emission Factor by Area

LIST OF SELECTED ACRONYMS AND ABBREVIATIONS

A/L	air to liquid ratio
FCAA	Federal Clean Air Act
CAPCOA	California Air Pollution Control Officers Association
CF	Compatibility Factor
EE	Excess Vent Emissions
EPA	Environmental Protection Agency
FR	Federal Register
GDF	gasoline dispensing facility
GPM	gallons per month
GVWR	gross vehicle weight rating
IUVP	Input Use Verification Program
MOVES	Motor Vehicle Emissions Simulator
NAAQS	National Ambient Air Quality Standards
NESHAP	National Emissions Standards for Hazardous Air Pollutants
NO_X	nitrogen oxides
OBD	onboard diagnostics
ORVR	onboard refueling vapor recovery
RFP	reasonable further progress
RFG	reformulated gasoline
RVP	Reid vapor pressure
SIP	state implementation plan
VOC	volatile organic compound
UST	underground storage tank
VMT	vehicle miles traveled
VRS	vapor recovery systems

1.1 INTRODUCTION

When gasoline is delivered or dispensed at a gasoline dispensing facility (GDF) gasoline vapors can be released into the surrounding air. In order to reduce the amount of vapor emissions, three forms of vapor recovery systems are used. Two of the vapor recovery systems are vacuum systems that have been implemented at GDFs. The vacuum systems at GDFs have two stages, one stage to control evaporative emissions when the fuel is dispensed from delivery trucks into the underground storage tanks, which is Stage I, and a second system to control evaporative emissions when the fuel is pumped from the underground storage tank into vehicles purchasing fuel, which is Stage II. The third form of vapor recovery system is installed on the vehicle that is purchasing fuel, which is referred to as onboard refueling vapor recovery (ORVR).

Stage II and ORVR are two types of emission control systems designed to control the same source of vapors, that result from refueling vehicles purchasing fuel. ORVR is installed on vehicles at the time of manufacture and has been phased in for new passenger vehicles beginning with model-year 1998 and starting in 2001 for light duty trucks and most heavy duty gasoline-powered vehicles. ORVR equipment has been installed on nearly all (~99%) new gasoline-powered light duty vehicles, light duty trucks and heavy duty vehicles since 2006. While Stage II was an important component in controlling vapors from refueling when first implemented, it is currently needed to capture vapors for vehicles that are not equipped with ORVR. As the percentage of vehicles equipped with ORVR increases, the emissions reduction benefit of Stage II declines, since Stage II only provides benefit from non-ORVR vehicles.

Since Stage II and ORVR control the same vapors, when ORVR has been determined to be in widespread use by the United States Environmental Protection Agency (EPA), it is appropriate to remove Stage II vapor recovery systems, since the emission reduction benefit from Stage II declines. However, an assessment of the exact amount of potential emission reduction benefit loss from removing Stage II needs to be calculated and any effect on air quality plans needs to be assessed. In order to assess the effect of the removal of Stage II control systems from GDFs in the four Texas ozone air quality planning areas, Beaumont-Port Arthur (BPA), Dallas-Fort Worth (DFW), El Paso (ELP), and Houston-Galveston-Brazoria (HGB), the data sources and equations documented in the United States Environmental Protection Agency's (EPA) guidance document, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, EPA-47/B-12-001, August 7, 2012, was used. The guidance provides a method to estimate the loss of benefit in the control of volatile organic compounds (VOC) emissions if the Stage II equipment is removed, which only affects non-ORVR vehicles, and accounts for the continuing increase in the percentage of vehicles equipped with ORVR. This method also takes into account area specific variables such as fuel properties and local vehicle age distributions.

The equations in the EPA's Stage II removal guidance, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, EPA-47/B-12-001, August 7, 2012, was used to calculate the benefit loss for four Texas ozone air quality planning areas: BPA, DFW, ELP, and HGB. A summary of the results of VOC reduction loss in tons per day for years 2012 through 2030 for the four Texas areas with Stage II systems is provided in Table 12.1: *Stage II VOC Emission Reduction Benefit Loss Estimates Summary in Tons per Day*, Chapter 12*: Demonstrating Noninterference under Federal Clean Air Act (FCAA), Section 110(l), Stage II Vapor Recovery Program State Implementation Plan (SIP) Revision*, Proposed, April 23, 2013. The losses for each area summarized in Table 12.1 represent less than half of 1% of the total VOC emissions inventory. As shown in Figure 12-1: *Stage II Reduction Loss Trend* in Chapter 12 of the proposed Stage II SIP revision, the potential emission reduction benefit losses from removing Stage II in Texas are

small in 2012 and decrease rapidly as the percentage of vehicles with ORVR increases over time. The step by step details of the methodology and results to determine the benefit losses in each of the Texas air quality plans are provided in Sections 12.3, *Stage II Removal and Air Quality Plans* through 12.3.5, *Dallas-Fort Worth and Houston-Galveston-Brazoria Attainment Demonstration Plan* in Chapter 12. Section 1.2, *Parameters and Variables for Stage II VRS and ORVR*, of this Appendix identifies and describes a series of parameters and variables related to the implementation of Stage II and ORVR. Section 1.3, *Calculating Impacts On The Area Wide Refueling Emission Inventory*, uses the parameters and variables in equations that evaluate the emission reduction effects of Stage II and ORVR control technologies in Texas in the context of the provisions of FCAA sections 110(ℓ), 184(b)(2), and 193 to conduct SIP-related analyses.

Details of the photochemical modeling used in the development of this assessment can be found at: ftp://amdaftp.tceq.texas.gov/pub/Area_EI/Refuel.

1.2 PARAMETERS AND VARIABLES FOR STAGE II VRS AND ORVR

To conduct analyses of the impact of phasing out Stage II VRS, several key pieces of information and data are needed for the equations used in the assessments. The variables and components are used as described in the EPA document *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012. Each of the parameters used for the phase out of Stage II calculations is described in Section 1.2.1, *Definition of Terms*. The data sources and values used for each variable are provided in Section 1.2.2, *Sources of Data and Values for Parameters and Variables*.

1.2.1 Definition of Terms

All terms used in the Stage II removal analysis are derived from the EPA document *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012. To facilitate reading of the documentation of the calculations for Texas air quality areas, the definitions from the guidance document are provided below for reference. Additional reference information for some of the variables are provided in the reference guidance document.

Gasoline dispensing facility (GDF): A location which dispenses gasoline to highway motor vehicles and serves as a fueling point for non-road engines and equipment. It includes all retail outlets such as traditional service stations, convenience stores, truck stops, and hypermarkets (e.g., warehouse clubs and big box stores) as well as private and commercial outlets such as those for centrally-fueled fleets, government operations, and private businesses as well as private outlets such as centrally-fueled fleet and government operations. For these purposes, it generally does not include marinas and general aviation airports dispensing aviation gasoline. Note that some lower throughput GDFs are exempt from Stage II vapor recovery by state regulations.

Stage II Vapor Recovery System (VRS): A system designed to capture displaced vapors that emerge from inside a vehicle's fuel tank, when gasoline is dispensed into the tank. There are two basic types of Stage II systems, the balance type and the vacuum assist type.

Balance-type Stage II system: The balance system transfers vapors from the vehicle tank to the GDF underground storage tank (UST) based on pressure differential. A key feature in the balance system is a hose nozzle that makes a tight connection with the fill pipe on the vehicle

fuel tank. The nozzle spout is fitted with an accordion-like bellows that presses snugly against the fill pipe lip. The vapors flow into the port, through the nozzle bellows, through a coaxial hose that connects the nozzle to the dispenser, and finally on through a vapor-return pipe back into the UST.

Vacuum assist-type Stage II system: This system relies on a vacuum source to help move the vapors out of the vehicle tank and into the UST. Current designs do not rely on a tight-fitting seal at the nozzle-fill pipe interface. Traditional vacuum systems are of two types: passive and active. In a passive vacuum-assist system, which is the dominant approach today, an electrically driven vacuum pump, typically in the dispenser cabinet, provides the vacuum power. An active system maintains a vacuum on the entire Stage II vapor recovery system through a central pump (jet pump) to recover vapors from the entire system to the tank. A key feature of vacuum assist system design and operation is the design air/liquid (A/L) volume ratio which is a measure of the volume of air returned to the tank to the volume of liquid dispensed. (When refueling a non-ORVR vehicle this “air” also contains gasoline vapor.) The larger the design A/L ratio, the greater the amount of fresh air returned to the UST. Some passive vacuum assist systems employ loose-fitting mini-bellows to help reduce the design A/L ratio. Sometimes these are called hybrid systems. Active vacuum assist systems often have A/L ratios somewhat greater than unity and employ a post-processor to reduce excess vent pipe emissions created by the higher A/L ratio with these systems.

Vent pipe: A pipe from the UST to the atmosphere which allows the tank to “breathe” during normal operation. This allows the tank to bring in fresh air to relieve negative pressure or release vapor to reduce positive pressure in the UST as needed. Vent pipes are generally 12 feet in height and two inches in diameter.

Pressure vacuum vent valve: A device, usually referred to as a "P/V vent valve," installed at the discharge end of a vent pipe connected to a gasoline storage tank, to regulate the pressure at which vapor is allowed to escape from the tank, and the vacuum at which outside air is allowed to enter the tank. The inflow/outflow of air through the vent pipe is controlled at specified pressures. These vent valves generally inhibit vapor release and are used to ensure the proper operation of Stage II balance systems. These P/V vent valves are now widely required as a result of EPA’s GDF “Stage I” National Emissions Standards for Hazardous Air Pollutants (NESHAP) regulation (40 CFR 63 CCCCCC).

Onboard Refueling Vapor Recovery (ORVR): A system employed on gasoline-powered highway motor vehicles to capture gasoline vapors displaced from a vehicle fuel tank during refueling events. These systems are required under section 202(a)(6) of the FCAA and implementation of these requirements began in the 1998 model year. Currently they are now used on all gasoline-powered passenger cars, light trucks, and complete heavy trucks of less than 14,000 pounds gross vehicle weight rating (GVWR). ORVR systems typically employ a liquid fill neck seal to block vapor escape to the atmosphere and otherwise share many components with the vehicle’s evaporative emission control system including the onboard diagnostic system (OBD) sensors.

ORVR/Stage II Compatibility: Compatibility problems can result in an increase in emissions from the UST vent pipe and other system fugitive emissions related to the refueling of ORVR vehicles with some types of vacuum assist-type Stage II systems. This occurs during refueling an ORVR vehicle when the vacuum assist system draws fresh air into the UST rather than an air vapor mixture from the vehicle fuel tank. Vapor flow from the vehicle fuel tank is blocked by the liquid seal in the fill pipe which forms at a level deeper in the fill pipe than can be reached by the end of the nozzle spout. The fresh air drawn into the UST enhances gasoline evaporation in the UST which increases pressure in the UST. Unless it is lost as a fugitive emission, any tank

pressure in excess of the rating of the pressure/vacuum valve is vented to the atmosphere over the course of a day. The magnitude of these emissions at a specific GDF is primarily a function of the fraction of total gasoline throughput dispensed to the ORVR vehicles and the A/L ratio of the dispensers.

The compatibility factor is an especially important consideration in calculating the emissions impacts of Stage II controls. Even if a state/local area wishes to keep Stage II controls to address non-ORVR equipped vehicles being refueled at Stage II GDFs, for non-ORVR compatible Stage II vacuum assist systems there will come a point where the emissions impact of the compatibility factor surpasses any gain from controlling non-ORVR vehicles. After that point, Stage II would lead to a net area-wide loss in emissions control. The point in time when this occurs depends on the nature of the Stage II program and the rate of ORVR penetration into the fleet.

ORVR-compatible vacuum assist-type Stage II system: A vacuum assist type Stage II system that is designed to sense when an ORVR vehicle is being refueled and reduces the A/L ratio to near zero to avoid compatibility emission effects. Current ORVR compatible nozzles are certified to meet California Air Resource Board (CARB) requirements for Stage II enhanced vapor recovery (EVR) efficiency with up to 80 percent ORVR vehicles in the fleet mix. Balance type nozzles are ORVR compatible as well.

η_{iuSII} - Stage II VRS in-use control efficiency: This is the current best estimate of the average in-use control efficiency for Stage II VRS in the state/area when applied to vehicles that are not equipped with ORVR. It is expressed as a fraction of 1. This value considers not only vapor capture at the vehicle fill pipe opening but also its transmittal to and storage in the UST. This value likely varies somewhat by state/area depending on how well GDF operators follow the inspection, testing, and maintenance activities specified in the state's implementing regulations and the frequency of inspection and follow-on enforcement actions by state/local authorities in implementing the regulations. This judgment should be informed by test data if available either from within the state/area or from other sources if no local data is available. Publicly available data suggests typical current values are in the range of 60-75 percent (0.60 – 0.75).12,13,14,15 As a result, it may be appropriate to identify significantly lower Stage II in-use control efficiencies than were identified in EPA's 1991 technical guidance on Stage II systems.

Q_{SII} - Fraction of highway gasoline throughput covered by Stage II VRS: The fraction of gasoline that is sold through dispensers equipped with Stage II VRS equipment expressed as a fraction of 1. This likely varies somewhat by state/area and can be derived from state data. Typical default values are 0.9 for states/areas that adopted the FCAA allowed exemption value of 10,000 gallons per month (gpm) for private GDFs and 50,000 gpm for independent small business marketers and 0.95-0.97 for states/areas that adopted 10,000 gpm exemption criteria for all GDFs.

Q_{SIIva} – Fraction of highway gasoline throughput dispensed through vacuum-assist type Stage II VRS: The fraction of annual gasoline consumption in the state/area dispensed through vacuum assist type Stage II VRS expressed as a fraction of 1. This would not include gasoline dispensed through dispensers with traditional nozzles, balance-type Stage II VRS nozzles, or ORVR-compatible Stage II nozzles. If the fraction dispensed through traditional vacuum assist VRS is not known, then the fraction of GDFs with traditional vacuum assist Stage II VRS may be substituted based on the assumption that throughput is evenly distributed across the various GDFs that are not exempt from Stage II requirements.

VMT_{ORVRi} - ORVR Vehicle Miles Traveled (VMT): The fraction of annual area-wide VMT traveled by ORVR-equipped vehicles. The subscript i denotes that this term varies by calendar year.

CF_i - Compatibility Factor: This is an increase in UST vent pipe emissions over the normal breathing/emptying loss emissions. As discussed above, this is a function of the fraction of gasoline dispensed to ORVR vehicles in any given year (using VMT of ORVR vehicles as a surrogate), the design features of the traditional vacuum assist Stage II nozzles, and the proportion of vacuum assist Stage II stations with various A/L ratios. This term may be calculated as the product of VMT_{ORVRi} and a constant term 0.07645. It should be noted that for a state/area with all balance systems or with a requirement for ORVR compatible nozzles, the CF term is zero because there is no compatibility problem by definition.

Q_{ORVRi} - Fraction of annual gallons of highway motor gasoline dispensed to ORVR-equipped vehicles: This is likely to vary by state/area depending on the fleet turnover/scrappage rate, annual VMT, and fuel economy of the vehicles involved in the analysis. The subscript i denotes that this term varies by calendar year. Table A-1, column 4 in the Appendix in the EPA guidance document, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, shows national average values that a state could use or adapt by extrapolation or interpolation as appropriate. For example, if the fleet in the state was one year newer than the national average then the analysis would use the data for the next calendar year (e.g., 2014 for 2013). Conversely, for example, if the fleet in the state was on average six months older than the national average then the analysis would interpolate between the current and past year (e.g., halfway between 2012 and 2013). Data on the fleet average age distributions by vehicle class for 2012 used in these calculations is provided in Appendix Table A-9 of the EPA guidance document, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*.

η_{ORVR} - In-use control efficiency for ORVR: EPA recommends a value of 0.98.21 States may use a lower or higher value, if justified. This value is based on testing of over 1,600 in-use vehicles with mileages ranging from about 6,000 – 135,000. This value does not reflect other adjustments found in the EPA's Motor Vehicle Emission Simulator (MOVES) model. The current MOVES model does not fully consider the in-use verification program (IUVP) test results as mentioned above. Other MOVES model efficiency adjustments are based on data from older vintage evaporative emission control systems and do not fully reflect the benefits derived from OBD, inspection and maintenance (I/M) programs, or improved durability resulting from the integrated ORVR/evaporative control systems used in vehicles meeting the progressively more stringent evaporative emission standards which were implemented in the mid-1990s and later.

Overall Stage II-ORVR increment: The overall increment identifies the annual area-wide emission control gain from Stage II installations at GDFs as ORVR technology phases in. Thus, it also indicates the emission reduction potential loss (in year i) from removing Stage II.

Overall Stage II - ORVR delta: The overall delta is the comparison between the Stage II efficiency and the ORVR efficiency with both technologies in place.

1.2.2 Sources of Data and Values for Parameters and Variables

The first step in the calculation of the loss of benefit from removal of Stage II controls is to define all variables used in the calculations. Once the variables are defined, values for each

variable need to be assigned collected from data sources or calculated. Whenever possible, values specific to each local area were obtained. In other cases EPA default values were used. Table 1: *Summary of Stage II Variable Values and Data Sources* summarizes the data sources and values used for each of the Stage II calculation variables. The equations used for values that required calculations to be determined are documented in Section 1.3, *Calculating Impacts on the Area Wide Refueling Emission Inventory*.

Table 1: Summary of Stage II Variable Values and Data Sources

Variable	Description	Value Used	Notes
$Increment_i$	Annual area wide emission control gain for year i from Stage II at GDFs as ORVR phases in the vehicle fleet	See *Section 3.1* EPA Guidance on Removing Stage II Gasoline Vapor Recovery Control Programs from SIPs and Assessing Comparable Programs, August 7, 2012	Area and year specific
Q_{SII}	Fraction of gasoline throughput covered by Stage II VRS	95%	Texas used 10,000 gpm for all GDFs.
Q_{ORVR}	Fraction of annual gallons of highway motor gasoline to ORVR vehicles	See *Section 3.1* EPA Guidance on Removing Stage II Gasoline Vapor Recovery Control Programs from SIPs and Assessing Comparable Programs, August 7, 2012	Analysis done by Area by Year
η_{iuSII}	In use Stage II efficiency	60%	In their guidance document, *Guidance on Removing Stage II Gasoline Vapor Recovery Control Programs from SIPs and Assessing Comparable Programs*, August 7, 2012, EPA suggested using a value in the range of 60-75%, however recommended using a lower Stage II in-use control efficiency unless test data is available to support the higher value. TCEQ staff agreed on a 60% value.

Variable	Description	Value Used	Notes
Q_{SIIva}	Fraction of gasoline throughput covered by traditional vacuum assist Stage II VRS	Zero	All GDFs in Texas are required to be ORVR compatible.
CF_i	Compatibility Factor	$0.07645VMT_{ORVR}$ (not needed because Q_{SIIva} is zero)	This value is multiplied by Q_{SIIva} which is zero in Texas, so the product becomes zero and is not really needed in the equation.
GC_i	Projected gasoline consumption for the area in year i	See Section 3.2*, Parameters and Variables Related to Implementing Stage II VRS and ORVR,* EPA *Guidance on Removing Stage II Gasoline Vapor Recovery Control Programs from SIPs and Assessing Comparable Programs*, August 7, 2012	Based upon base year and growth factor
ΔT	Temperature difference vehicle fuel tank temperature and dispensed fuel temperature	7.1	Five Month Ozone Season Value for Region 3 from Table A3, *Seasonal Variation In Temperature Difference Between Vehicle Fuel Tank and Dispensed Fuel*, of EPA guidance document, *Guidance on Removing Stage II Gasoline Vapor Recovery Control Programs from SIPs and Assessing Comparable Programs*, August 7, 2012, Page 27. The Region 3 categorization comes from Table 6, *Weighted Temperatures and RVP Parameters, Refueling Emissions from Uncontrolled Vehicles*, EPA.OMS, EPA-AA-SDSB-85-6. June 1985.

Variable	Description	Value Used	Notes
Td	Dispensed liquid temperature	80.8	Calculated five month ozone season average for Region 3 from values in Table A-2, *Monthly Average Dispensed Liquid Temperature*, EPA guidance document, *Guidance on Removing Stage II Gasoline Vapor Recovery Control Programs from SIPs and Assessing Comparable Programs*, August 7, 2012, Page 26 (76+82+83+84+79)/5. The Region 3 categorization comes from Table 6, *Weighted Temperatures and RVP Parameters, Refueling Emissions from Uncontrolled Vehicles*, EPA.OMS, EPA-AA-SDSB-85-6. June 1985.
RVP	Reid Vapor Pressure	7.8 BPA, 7.0 ELP, 6.8 DFW,6.8 HGB	BPA-1992 Federal RVP limit 7.8; ELP-Federal NNNNN, 7.0; DFW and HGB-RFG RVP combined with values from the Texas Summer Fuel Field Study provide specific values of 6.8 for both DFW and HGB
η_{ORVR}	In-use control efficiency for ORVR	98%	Not used because Stage II systems are 100% compatible with ORVR in Texas

1.3 CALCULATING IMPACTS ON THE AREA WIDE REFUELING EMISSION INVENTORY

There is a step by step process for calculating the loss of emission credit documented in the EPA guidance document, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012. Calculating the impact on the VOC inventory is important in the context of assessing a SIP action against the provisions of CAA section 110(l). The methodology involves multiplying three different terms, which are area/state specific, as well as appropriate unit conversion factors, and is shown in Equation 1.

Equation 1: $Tons_i = (Increment_i)*(GC_i)*(EF)*(ConversionFactor1)*(ConversionFactor2)$

Where:

$Tons_i$ = overall emissions effect of removing Stage II for year i

$Increment_i$ = Annual area wide emission control gain for year i from Stage II at GDFs as ORVR phases in, See *Section 3.1*

GC_i = Projected gasoline consumption for the area in year i, See *Section 3.2*

EF = uncontrolled displacement refueling emission factor in grams per gallon (g/gal), See *Section 3.3*

ConverisonFactor1 = 0.002204634 pounds per gram

ConverisonFactor2 = 0.0005 tons per pound

The results for Equation 1 for each area are summarized in Table 2: *BPA Stage II VOC Reduction Loss, Tons per Ozone Season Day* through Table 5: *HGB Stage II VOC Reduction Loss, Tons per Ozone Season Day*.

Table 2: BPA Stage II VOC Reduction Loss, Tons per Ozone Season Day

Year	Hardin	Jefferson	Orange	Total
2012	0.033	0.149	0.057	0.240
2014	0.023	0.104	0.040	0.166
2016	0.015	0.068	0.026	0.109
2018	0.011	0.049	0.019	0.078
2020	0.008	0.037	0.014	0.059
2022	0.007	0.030	0.012	0.048
2024	0.006	0.025	0.010	0.041
2026	0.005	0.023	0.009	0.038
2028	0.005	0.021	0.008	0.034
2030	0.005	0.020	0.008	0.032

Table 3: DFW Stage II VOC Reduction Loss, Tons per Ozone Season Day

Year	Collin	Dallas	Denton	Tarrant	Total
2012	0.313	0.965	0.277	0.870	2.425
2014	0.206	0.634	0.182	0.572	1.594
2016	0.130	0.400	0.115	0.361	1.006
2018	0.092	0.285	0.082	0.257	0.716
2020	0.071	0.220	0.063	0.198	0.552
2022	0.061	0.187	0.054	0.169	0.471
2024	0.053	0.164	0.047	0.148	0.412
2026	0.050	0.153	0.044	0.138	0.384
2028	0.044	0.137	0.039	0.123	0.343

Year	Collin	Dallas	Denton	Tarrant	Total
2030	0.042	0.128	0.037	0.116	0.322

Table 4: ELP Stage II VOC Reduction Loss, Tons per Ozone Season Day

YEAR	El Paso
2012	0.316
2014	0.224
2016	0.155
2018	0.113
2020	0.086
2022	0.071
2024	0.059
2026	0.053
2028	0.043
2030	0.038

Table 5: HGB Stage II VOC Reduction Loss, Tons per Ozone Season Day

Year	Brazoria	Chambers	Fort Bend	Galveston	Harris	Liberty	Montgomery	Waller	Total
2012	0.148	0.015	0.168	0.142	1.636	0.039	0.190	0.024	2.361
2014	0.097	0.010	0.109	0.092	1.066	0.025	0.124	0.016	1.539
2016	0.059	0.006	0.067	0.057	0.654	0.016	0.076	0.010	0.944
2018	0.042	0.004	0.047	0.040	0.462	0.011	0.054	0.007	0.667
2020	0.032	0.003	0.036	0.030	0.351	0.008	0.041	0.005	0.507
2022	0.027	0.003	0.030	0.026	0.295	0.007	0.034	0.004	0.426
2024	0.023	0.002	0.026	0.022	0.257	0.006	0.030	0.004	0.372
2026	0.022	0.002	0.025	0.021	0.240	0.006	0.028	0.004	0.347
2028	0.020	0.002	0.022	0.019	0.218	0.005	0.025	0.003	0.314
2030	0.019	0.002	0.021	0.018	0.207	0.005	0.024	0.003	0.298

1.3.1 Area Specific Increments

The overall Stage II-ORVR increment, $Increment_i$, identifies the annual area-wide emission control gain from Stage II installations at GDFs as ORVR technology phases in. Thus, it also indicates the emission reduction potential loss, in year I, from removing Stage II. Equation 2, from the EPA guidance, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012, is used to calculate $Increment_i$. Since Q_{ORVR} is area and year specific, $Increment_i$ is also area and year specific. Using the Q_{ORVR} values from Section 1.3.1.1, *Fraction of Gasoline Dispensed to ORVR Equipped Vehicles*, and the fixed values of 0.95 and 0.60 for Q_{SII} and η_{iuSII} respectively, the values for $increment_i$ can be calculated for all areas and analysis years. An example calculation for BPA in 2012 is provided. A summary of all the values is provided in Table 6: *Incrementi by Area in Year*.

Equation 2: $$increment_i = (Q_{SII})*(1-Q_{ORVRi})*(\eta_{iuSII}) - (Q_{SIIva})*(CF_i)$$

Where:

$Increment_i$ = increment percentage impact on the refueling inventory of removing Stage II

Q_{SII} = 0.95

Q_{ORVRi} = Calculated using Equation NN

η_{iuSII} = 0.60

Q_{SIIva} = Zero (100% of Texas Stage systems are ORVR compatible)

CF_i[1] = $(0.0777)*(Q_{ORVRi})$

Note 1: Because CFi is multiplied by Q_{SIIva}, and Q_{SIIva} is equal to zero in Texas, the last group in the equation is to zero, the value of CF_i will not affect the answer.

Example 1: BPA year 2012

$$Increment_{i,\ BPA,\ 2012} = (Q_{SII})(1-Q_{ORVRi})(\eta_{iuSII}) - (Q_{SIIva})(CF_i)$$
$$= (0.95)(1-0.794)(0.60)- (0)$$
$$= 0.1176$$

Table 6: Increment$_i$ by Area in Year

Year	BPA	DFW	ELP	HGB
2012	0.1176	0.0934	0.1150	0.0987
2014	0.0811	0.0610	0.0811	0.0639
2016	0.0528	0.0384	0.0557	0.0391
2018	0.0385	0.0277	0.0413	0.0280
2020	0.0294	0.0216	0.0319	0.0215
2022	0.0242	0.0185	0.0263	0.0182
2024	0.0210	0.0166	0.0226	0.0163
2026	0.0194	0.0155	0.0201	0.0152
2028	0.0175	0.0138	0.0165	0.0137
2030	0.0166	0.0129	0.0144	0.0130

If the increment$_i$ value is greater than zero for the year under consideration there is still a remaining emission reduction benefit for Stage II for the year relative to ORVR. If it is zero there is no net difference in the inventory. If it is zero or negative, this would indicate that removing Stage II would not increase the refueling emissions inventory because the higher efficiency from ORVR and the incompatibility emissions offset the increment due to non-ORVR vehicles being refueled at Stage II GDFs.

1.3.1.1 Fraction of Gasoline Dispensed to ORVR Equipped Vehicles

To calculate the percentage of gasoline dispensed to ORVR equipped vehicles three variables are needed. The three variables are: the phase in schedule for ORVR by vehicle type; vehicle type specific age distributions; and vehicle fuel economy. Since these variables are dependent on age and vehicle type, the calculations need to be done using a matrix of variables by vehicle type and age. The ORVR phase in schedule was obtained from the Table A-1: *Projected Penetration of ORVR in the National Gasoline Fueled Vehicle Fleet by Year* from the EPA guidance, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012. The phase in schedule varies by vehicle type. Combining the ORVR phase in schedule with an age distribution by vehicle type and year allows for calculation of the percentage of vehicles equipped with ORVR. If area specific age distributions are used, the vehicle penetration percentage will be specific to the area. For this analysis 2011 county registrations by age and by vehicle type were obtained from the Texas Department of Motor Vehicles for the 16 Texas counties with Stage II control equipment. The county registrations were summed to obtain area total registration values. The 2011 area total registrations were used to calculate age distributions. The 2011 age distributions were used for all analysis years. Using vehicle type specific annual mileage accumulation rates by age in conjunction with the ORVR phase in schedule and the age distributions allows for calculation of the percentage of vehicles miles traveled attributed to ORVR equipped vehicles. National default annual miles accumulation rates were used to calculate the vehicles miles travelled (VMT) ORVR fractions for each area for each analysis year. If the fuel economy for vehicles by age is used, the VMT fractions can be converted into fuel fractions attributed to ORVR equipped vehicles. For this analysis national default fuel economy values were used to calculate the percentage of gasoline dispensed to vehicles equipped with ORVR, the Q_{ORVRi} values needed in Equation 1. A summary of the results are provided in Table 7*: ORVR Penetration Rates by Model Year and Vehicle Type* through Table 11*: Projected Penetration of ORVR in Houston-*

Galveston-Brazoria by Year. Because the process needed to calculate the ORVR penetration rates requires multiple matrices for each year and area, electronic documentation is more efficient and clearer, so the spreadsheet file has not been printed or added as an attachment. The spreadsheet used to perform the calculations is available upon request from the TCEQ Mobile Source Programs Team.

Table 7: ORVR Penetration Rates by Model Year and Vehicle Type

Model Year	Vehicle Type					
	LDGV	LDGT1	LDGT2	LDGT3	LDGT4	HDGV2b
2006 & Newer	100%	100%	100%	100%	100%	100%
2005	100%	100%	100%	80%	80%	80%
2004	100%	100%	100%	40%	40%	40%
2003	100%	100%	100%	0%	0%	0%
2002	100%	80%	80%	0%	0%	0%
2001	100%	40%	40%	0%	0%	0%
2000	100%	0%	0%	0%	0%	0%
1999	80%	0%	0%	0%	0%	0%
1998	40%	0%	0%	0%	0%	0%
1997 & Older	0%	0%	0%	0%	0%	0%

Table 8: Projected Penetration of ORVR in Beaumont-Port Arthur by Year

Area	End of Calendar Year	Vehicle Population Percentage	VMT Percentage	Gasoline Dispensed Percentage
BPA	2012	0.732	0.790	0.794
BPA	2014	0.807	0.856	0.858
BPA	2016	0.871	0.907	0.907
BPA	2018	0.905	0.932	0.932
BPA	2020	0.928	0.947	0.948
BPA	2022	0.943	0.956	0.958
BPA	2024	0.952	0.961	0.963
BPA	2026	0.958	0.965	0.966
BPA	2028	0.965	0.968	0.969
BPA	2030	0.969	0.970	0.971

Table 9: Projected Penetration of ORVR in Dallas-Fort Worth by Year

Area	End of Calendar Year	Vehicle Population Percentage	VMT Percentage	Gasoline Dispensed Percentage
DFW	2012	0.785	0.833	0.836
DFW	2014	0.853	0.891	0.893
DFW	2016	0.904	0.931	0.933
DFW	2018	0.931	0.950	0.951
DFW	2020	0.946	0.961	0.962
DFW	2022	0.955	0.966	0.968
DFW	2024	0.961	0.969	0.971
DFW	2026	0.965	0.971	0.973
DFW	2028	0.972	0.975	0.976
DFW	2030	0.976	0.977	0.977

Table 10: Projected Penetration of ORVR in El Paso by Year

Area	End of Calendar Year	Vehicle Population Percentage	VMT Percentage	Gasoline Dispensed Percentage
ELP	2012	0.729	0.794	0.798
ELP	2014	0.798	0.854	0.858
ELP	2016	0.855	0.899	0.902
ELP	2018	0.889	0.924	0.928
ELP	2020	0.913	0.940	0.944
ELP	2022	0.928	0.950	0.954
ELP	2024	0.939	0.956	0.960
ELP	2026	0.947	0.961	0.965
ELP	2028	0.962	0.968	0.971
ELP	2030	0.970	0.973	0.975

Table 11: Projected Penetration of ORVR in Houston-Galveston-Brazoria by Year

Area	End of Calendar Year	Vehicle Population Percentage	VMT Percentage	Gasoline Dispensed Percentage
HGB	2012	0.774	0.824	0.827
HGB	2014	0.847	0.886	0.888
HGB	2016	0.903	0.931	0.931
HGB	2018	0.931	0.950	0.951
HGB	2020	0.947	0.961	0.962

Area	End of Calendar Year	Vehicle Population Percentage	VMT Percentage	Gasoline Dispensed Percentage
HGB	2022	0.957	0.967	0.968
HGB	2024	0.963	0.970	0.971
HGB	2026	0.966	0.972	0.973
HGB	2028	0.973	0.975	0.976
HGB	2030	0.976	0.977	0.977

1.3.2 Area Specific Fuel Consumption

In order to determine gasoline consumption for each area for each analysis year national consumption values for the most recent data year, 2011, were adjusted for each area, projected to each analysis year and reduced from annual to ozone season daily consumption. Section 1.3.2.1, *Gasoline Consumption Growth Factors*, through Section 1.3.2.3, *Nonattainment Area Ozone Season Daily Gasoline Consumption*, document the calculation of the area specific fuel consumption values for each analysis year.

1.3.2.1 Gasoline Consumption Growth Factors

The data source for 2011 to projected year growth are based on values from the United States Energy Information Administration, Annual Energy Outlook (AEO) 2011, Motor Gasoline Production for year 2011 and all projection analysis years. The values were posted at: http://www.eia.gov/oiaf/aeo/tablebrowser/#release=AEO2011&subject=0-AEO2011&table=11-AEO2011&region=0-0&cases=ref2011-d020911a.

A summary of the values from the AEO and the resulting growth factors are summarized in Table 12: *Motor Gasoline Growth from 2011 to Projected Years*.

Table 12: Motor Gasoline Growth from 2011 to Projected Years

Year	Motor Gasoline Supply (million barrels per day)	Growth Factor
2011	9.09	N/A
2012	9.33	1.026
2014	9.39	1.033
2016	9.42	1.036
2018	9.29	1.022
2020	9.19	
2022	9.13	
2024	8.90	
2026	8.89	
2028	8.92	
2030	8.95	

1.3.2.2 Projected Fuel Consumption

The projected values for national fuel consumption are calculated by multiplying base year data by year specific growth factors. National fuel consumption values by month for 2011 were obtained from the Federal Highway Administration, National Totals from Monthly Motor Fuel Reported by States
available: http://www.fhwa.dot.gov/policyinformation/motorfuelhwy_trustfund.cfm. The 2011 values were multiplied by the 2011 to projected year growth factors, Equation 4. The projections are done for each month. The monthly information will be needed to determine the consumption for the ozone season in the last step of the consumption calculation. A summary of the results for a sample year, 2012, is provided in Table 13: *National Gallons Motor Fuel Projected from 2011 to 2012*.

Equation 3: GC_{iMonth} (gallons) = $GC_{2011Month}$*($GrowthFactor_{2011toi}$)

Where:

GC_{iMonth} = gallons consumption for year i for each Month

$GC_{2011Month}$ = gallons consumption for year 2011 for each Month

GrowthFactor2011toi = consumption growth between data year 2011 and projected year i

Month = each calendar month, January to December

Table 13: National Gallons Motor Fuel Projected from 2011 to 2012

Month	2011 Fuel Consumption (Gallons)	Growth Factor 2011 to 2012	2012 Projected Fuel Consumption
January	10,693,040,761	1.026	10,975,365,270
February	10,354,644,164	1.026	10,628,034,109
March	11,246,844,342	1.026	11,543,790,727
April	11,031,804,745	1.026	11,323,073,517
May	11,572,850,469	1.026	11,878,404,277
June	11,655,070,334	1.026	11,962,794,963
July	11,599,045,109	1.026	11,905,290,524
August	11,680,938,682	1.026	11,989,346,304
September	11,548,346,074	1.026	11,853,252,901
October	11,327,553,992	1.026	11,626,631,325
November	11,173,161,223	1.026	11,468,162,179
December	11,331,538,330	1.026	11,630,720,860
Total	135,214,838,225		138,784,866,957

1.3.2.3 Nonattainment Area Ozone Season Daily Gasoline Consumption

The fuel consumption values for each nonattainment area can be calculated from the national value if the percent attributed to each nonattainment area or county is known. In the EPA

guidance document, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012, EPA provides values for determining the gasoline consumption each nonattainment area from the national fuel consumption value. The values for all nonattainment areas are provided in Table A-4 - *Percent of 50 State Gasoline Consumption for Areas Covered by FCAA Sections 182(b)(3) or 184(b)(2)* of the EPA guidance document, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012. The values for the four Texas nonattainment areas were taken from the table and are summarized in Table 14: *Percent of 50 State Gasoline Consumption for Areas Covered by FCAA Sections 182(b)(3) or 184(b)(2)*.

Table 14: Percent of 50 State Gasoline Consumption for Areas Covered by FCAA Sections 182(b)(3) or 184(b)(2)[1]

Area Name	% of 50 State Gasoline Consumption
Houston-Galveston-Brazoria	0.016460
El Paso	0.001841
Dallas-Ft. Worth	0.017860
Beaumont-Port Arthur	0.001230

Note 1: Excerpt from Table A-4 - Percent of 50 State Gasoline Consumption for Areas Covered by CAA Sections 182(b)(3) or 184(b)(2) of the EPA guidance document, Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures

The gasoline consumption for any nonattainment area can be calculated by multiplying the national total fuel consumption by the nonattainment percent of national total value. The projected fuel consumption for each analysis year is multiplied by the nonattainment area percent to obtain values for each nonattainment area for each year. A sample of the nonattainment area results are provided for the year 2012 in Table 15: *2012 Texas Monthly Ozone Season Total and Ozone Per Day Gasoline Consumption for Four Texas Nonattainment Areas*. The calculations are done for each month because the monthly values are needed to calculate the ozone season total and daily consumption values.

Table 15: 2012 Monthly, Ozone Season Total and Ozone Per Day Gasoline Consumption for Four Texas Nonattainment Areas

Month	2012 Projected	BPA 2012 Projected	DFW 2012 Projected	ELP 2012 Projected	HGB 2012 Projected
January	10,975,365,270	13,499,699	196,020,024	20,205,647	180,654,512
February	10,628,034,109	13,072,482	189,816,689	19,566,211	174,937,441
March	11,543,790,727	14,198,863	206,172,102	21,252,119	190,010,795
April	11,323,073,517	13,927,380	202,230,093	20,845,778	186,377,790

Month	2012 Projected	BPA 2012 Projected	DFW 2012 Projected	ELP 2012 Projected	HGB 2012 Projected
May	11,878,404,277	14,610,437	212,148,300	21,868,142	195,518,534
June	11,962,794,963	14,714,238	213,655,518	22,023,506	196,907,605
July	11,905,290,524	14,643,507	212,628,489	21,917,640	195,961,082
August	11,989,346,304	14,746,896	214,129,725	22,072,387	197,344,640
September	11,853,252,901	14,579,501	211,699,097	21,821,839	195,104,543
October	11,626,631,325	14,300,757	207,651,635	21,404,628	191,374,352
November	11,468,162,179	14,105,839	204,821,377	21,112,887	188,765,949
December	11,630,720,860	14,305,787	207,724,675	21,412,157	191,441,665
Total	138,784,866,957	170,705,386	2,478,697,724	255,502,940	2,284,398,910
Ozone Season Total[1]	N/A	73,294,579	1,064,261,129	109,703,513	980,836,404
Ozone Season Per Day[2]	N/A	479,050	6,955,955	717,016	6,410,695

Note 1: Ozone season is May through September. The total for the five months is the ozone season total.
Note 2: There are 153 days in the five month ozone season. The ozone season day value is obtained by dividing the ozone season total by 153.

In order to calculate the ozone season daily gasoline consumption, the fuel consumption for the five ozone seasons months is summed to obtain an ozone season total, and then the ozone season total is divided by 153, the number of days in the ozone season, Equation 5. Table 15: *2012 Texas Monthly Ozone Season Total and Ozone Pre Day Gasoline Consumption for Four Texas Nonattainment Areas* has a sample of the ozone season daily result for analysis year 2012. A summary of the values for all nonattainment areas and years is provided in Table 16: *Ozone Season Daily Gasoline Consumption by Years and Areas*. The ozone season daily gasoline consumption for each nonattainment, for each year is the GC_i value used in *Equation 1*.

Equation 4: $GC_i \text{ (gallons)} = (GCi_{May} + GCi_{June} + GCi_{July} + GCi_{August} + GCi_{September})/153$

Where:

GC_i = ozone season daily gasoline consumption for year i

GC_{iMonth} = gallons consumption for year I, for each ozone season Month

153 = number of days in the five month ozone season

Table 16: Ozone Season Daily Gasoline Consumption by Years and Areas

Year	BPA	DFW	ELP	HGB
2012	479,050	6,955,955	717,016	6,410,695
2014	482,130	7,000,688	721,627	6,451,922

Year	BPA	DFW	ELP	HGB
2016	483,671	7,023,054	723,933	6,472,535
2018	476,996	6,926,133	713,942	6,383,211

1.3.3 Area Specific Emission Factor

The term emissions factor (EF) in Equation 1 is the uncontrolled displacement refueling emission factor in grams per gallon (g/gal). The value of EF depends on: the Reid vapor pressure (RVP); the dispensed fuel temperature, T_d, in degrees Fahrenheit(˚F); and the difference between tank fuel temperature and the dispensed fuel temperature, ΔT, in ˚F. The equation presented in EPA's ORVR widespread use determination final rule was used for the calculations presented here, Equation 5.

Equation 5: $EF\ (g/gal) = \exp[-1.2798 - 0.0049(\Delta T) + 0.0203(Td) + 0.1315(RVP)]$

Where:

EF = uncontrolled displacement refueling emission factor in grams per gallon

ΔT = the difference between tank fuel temperature and the dispensed fuel temperature in °F

T_d = dispensed fuel temperature in °F

RVP = Reid vapor pressure in pounds per square inch (psi)

The three terms used in Equation 10 vary by region/state by month or season. Values used by the EPA for ΔT and T_d are contained in the Appendix Table A-2: *Monthly Average Dispensed Liquid Temperature* and Table A-3: *Seasonal Variation in Temperature Difference Between Vehicle Fuel Tank and Dispensed Fuel* of the EPA guidance document, *Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures*, August 7, 2012. The regulated values for RVP derived from 40 CFR 80.27: 7.8 for BPA; 7.0 for ELP; and for DFW and HGB the lower value of 7.0 psi RVP gasoline needed to meet the RFG VOC performance standard. A summary of RVP, ΔT, T_d, and the resulting exp factor and EF values are provided in Table 17: *Uncontrolled Displacement Refueling Emission Factor by Area*.

Table 17: Uncontrolled Displacement Refueling Emission Factor by Area

Area	EF (grams/gallons)	RVP	ΔT	Td	exp factor
BPA	3.86	7.8	7.1	80.8	1.35135
DFW	3.39	6.8	7.1	80.8	1.21985
ELP	3.48	7.0	7.1	80.8	1.24615
HGB	3.39	6.8	7.1	80.8	1.21985

1.4 LIST OF REFERENCES

Guidance on Removing Stage II Gasoline Vapor Control Programs from State Implementation Plans and Assessing Comparable Measures, EPA-457/B-12-001 August 7, 2012, U. S. Environmental Protection Agency, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711

Federal Register, Vol. 77, No. 95, Wednesday, May 16, 2012, Rules and Regulations, Agency: Environmental Protection Agency (EPA), 40 CFR Part 51 [EPA–HQ–OAR–2010–1076; FRL–9671–3] RIN 2060–AQ97, Air Quality: Widespread Use for Onboard Refueling Vapor Recovery and Stage II Waiver, Action: Final Rule

Motor Vehicle Emission Simulator (MOVES) User Guide for MOVES2010b, U.S. Environmental Protection Agency, Assessment and Standards Division, Office of Transportation and Air Quality, EPA-420-B-12-001b, June 2012

Beaumont-Port Arthur (BPA) Attainment Area On-Road Mobile Source Emissions Inventory and Motor Vehicle Emissions Budget (MVEB) Update State Implementation Plan (SIP) Revision, SIP Project No. 2012-005-SIP-NR, October 26, 2012

Dallas-Fort Worth Reasonable Further Progress State Implementation Plan Revision For The 1997 Eight-Hour Ozone Standard, Project Number 2010-023-SIP-NR, Adoption December 7, 2011

El Paso County 8-Hour Ozone Maintenance State Implementation Plan Revision, Project Number 2005-027-SIP-NR, Adopted on January 11, 2006

Houston-Galveston-Brazoria Reasonable Further Progress State Implementation Plan Revision for the1997 Eight-Hour Ozone Standard, Project No. 2009-018-SIP-NR, Adopted March 10, 2010