

August 22, 2012 Addendum to:

**Air Program Support for Stage I and Stage II
Programs in Massachusetts**

Draft Final Report for Public Review

July 16, 2012

Prepared for:

Massachusetts Department of Environmental Protection

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Introduction

On August 7, 2012, subsequent to completion of the July 16, 2012 ERG Draft Final Report for Public Review (the Draft Report¹), EPA issued its final *Guidance on Removing Stage II Gasoline Vapor Recovery Programs for State Implementation Plans and Assessing Comparable Measures*.²

ERG has revised two sections of the Draft Report to incorporate EPA's final Guidance. The following revised Sections replace the corresponding Sections in the Draft Report:

Section 3.2 – Emission Reductions for Current Stage II Programs

Section 3.3 – Costs to Continue Stage II Systems.

All other Sections of the Draft Report are unchanged.

Section 3.2 - Emission Reductions for Current Stage II Program

In its August 7, 2012 Guidance, EPA provided equations to calculate incremental emission reductions from continuing Stage II. These equations include terms that account for the impact of incompatibility excess emissions³ (IEE). This Addendum provides calculated benefits of Stage II using EPA's recommended procedure.

EPA's primary equation is listed below:

Equation 1: $increment_i$ (% reduction in refueling emissions from Stage II) =

$(Q_{SII}) \times (1 - Q_{ORVRI}) \times (\eta_{iuSII}) - (Q_{SIIva}) \times (CF_i)$, Where:

Q_{SII} = Fraction of gasoline throughput covered by Stage II VRS

Q_{ORVRI} = Fraction of annual gallons of highway motor gasoline dispensed to ORVR

η_{iuSII} = Stage II VRS in-use control efficiency

Q_{SIIva} = Fraction of gasoline throughput dispensed through vacuum-assist type systems

CF_i = Compatibility Factor (IEE), $CF_i = (0.0777) \times (Q_{ORVRI})$

ERG used EPA's recommended procedure but with Massachusetts-specific parameters. The differences between EPA default and Massachusetts specific parameters are shown below in Addendum Table A.

¹ The Draft Final Report is available at <http://www.mass.gov/dep/air/community/stageii.htm> - Stage II Program Changes.

² EPA's Guidance is at: <http://www.epa.gov/ozonpollution/pdfs/20120807guidance.pdf>

³ The increased emissions that occur due to the dilution of the storage tank with air from ORVR vehicles are termed incompatibility excess emissions (IEE). IEE is limited to vacuum assist systems without ORVR compatible nozzles. In Massachusetts, 81 percent of the fuel is dispensed at GDFs with incompatible Stage II systems.

AddendumTable A. Comparison of EPA Default and Massachusetts-Specific Parameters (This is a new table; there is no comparable table in the Draft Report.)

Parameter	2013 MA	2013 EPA	2015 MA	2015 EPA	2018 MA	2018 EPA
Q_{SII}: % Gasoline Dispensed to GDFs with Stage II	99%	90%	99%	90%	99%	90%
Q_{ORVRi}: % Gasoline Dispensed to ORVR equipped vehicles	84.9%	81.0%	90.3%	86.5%	94.3%	91.9%
η_{iuSII} = Stage II efficiency⁴	75%	60-75%	75%	60-75%	75%	60-75%
Q_{SIIva} = % dispensed through vacuum-assist type systems	81%	Varies by State	81%	Varies by State	81%	Varies by State
CF_i = Compatibility Factor, CF_i = (0.0777) x (Q_{ORVRi})⁵	0.0659	0.0629	0.0702	0.0672	0.0733	0.0714

ERG used EPA’s latest mobile source emissions factor model, MOVES 2010a, to derive Massachusetts-specific ORVR gasoline fractions (Q_{ORVRi}) and Compatibility Factors (CF_i). ERG ran MOVES for Middlesex and Hampden Counties for calendar year 2013, 2015, and 2018 for the following cases:

- Uncontrolled baseline (no ORVR or Stage II)
- ORVR Only

Middlesex and Hampden counties were chosen by MassDEP to represent eastern and western Massachusetts, respectively. These two counties can be used to approximate statewide Stage II refueling emissions without the need to model all 14 counties.⁶

Using MOVES output, ERG estimated percent emissions reductions from ORVR for calendar years 2013, 2015, and 2018. ERG estimated the fraction of gasoline dispensed to ORVR equipped vehicles by dividing the ORVR emission reductions (in percent) by 0.98, which is the assumed control efficiency for ORVR in MOVES. MOVES results are shown on Table 3-2.

⁴ According to EPA’s Guidance, data suggests a typical current Stage II in-use control efficiency of 60-75%. ERG is using 75% in light of annual Stage II testing requirements in Massachusetts, which increases the effectiveness of the program. The Draft Report was based on a Stage II efficiency of 84%, the number used in the Massachusetts SIP.

⁵ In the Draft Report, ERG evaluated two IEE values: 0.0 and 0.86 pounds per thousand gallons.

⁶ Analyses performed by MassDEP have shown that MOVES runs performed using these two representative counties and extrapolated statewide using county VMT fractions are within 1% of the results obtained by totaling the MOVES results from 14 individual counties. The Middlesex emission factors are weighted by 64% and Hampden emission factors are weighted by 36%. This weighting was determined by MassDEP based on the fraction of vehicle miles travelled from eastern counties (represented by Middlesex) compared to the western counties (represented by Hampden.)

Table 3-2. Percent Reduction in MA VOC Refueling Emissions from ORVR Based on MOVES (Replaces Table 3-2 in Draft Report

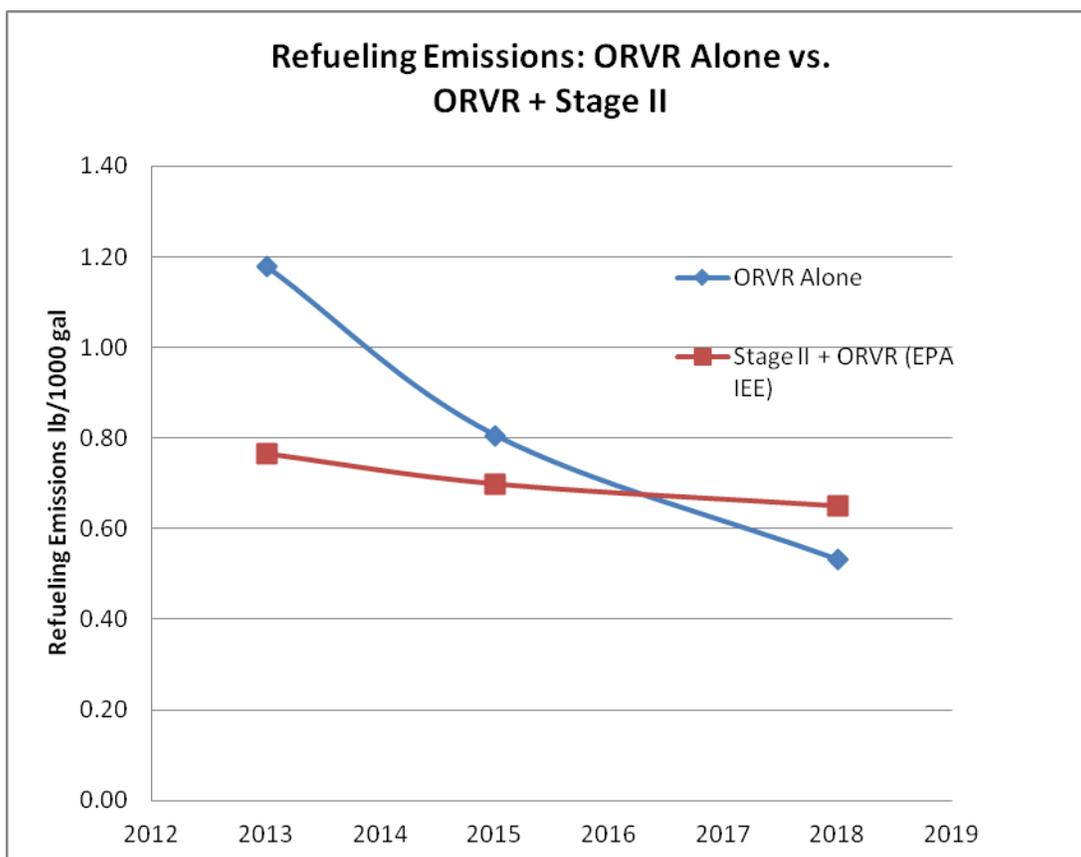
Year	% Reduction from Stage II Alone	% Reduction from ORVR Alone		ORVR Penetration (% of Gasoline)	
		Hampden	Middlesex	Hampden	Middlesex
2013	84%	83%	83%	85%	85%
2015	84%	88%	89%	90%	90%
2018	84%	92%	92%	94%	94%

Addendum Table B shows the increment calculated for Stage II in 2013, 2015, and 2018. Stage II is estimated to reduce refueling emissions by 5.9% in 2013 and 1.5% in 2015. Stage II is projected to increase refueling emissions by 1.7% in 2018, due to IEE. Results are shown graphically on Figure 3-2. Around July 1, 2016, Stage II starts to increase emissions.

Addendum Table B. Percent Reduction in MA VOC Refueling Emissions from Stage II (This is a new table; there is no comparable table in the Draft Report.)

Year	Qorvr (ORVR Fraction)	CFi	Qstii	1-Qorvr	Eff(stii)	Qstiiva	Increment (% reduction in refueling emissions)
2013	84.87%	0.065947	0.99	0.15	75%	81%	5.92%
2015	90.31%	0.070171	0.99	0.10	75%	81%	1.54%
2018	94.31%	0.073283	0.99	0.06	75%	81%	-1.69%

Figure 3.2 (Replaces Figure 3.2 in Draft Report.)



To estimate statewide mass reductions for the current Stage II program, ERG first used MOVES to calculate the uncontrolled refueling emissions in terms of lbs./1,000 gallons of gasoline dispensed. The uncontrolled refueling emission factor (7.01 lbs./1,000 gal) was then multiplied by statewide annual fuel consumption (2,916,370,000 gallons) and the Stage II increment to calculate the annual reduction from Stage II. Annual reductions were converted to tons per summer day by multiplying the total by 0.256 and dividing by 78. Estimated mass reductions from Stage II and ORVR alone are shown on Table 3-3.

Table 3-3. Statewide VOC Mass Emission Reductions for Stage II⁷
(Replaces Table 3.3 in Draft Report.)

Year	Increment (% reduction in refueling emissions)	Tons per Year Stage II	Tons per Day Stage II	Tons per Day ORVR Alone
2013	5.92%	604.57	1.98	27.90
2015	1.54%	157.29	0.52	29.69
2018	-1.69%	-172.26	-0.57	31.00

⁷ Stage II reductions are incremental to reductions achieved through ORVR alone.

ERG also estimated the impacts of removing Stage II on the emissions of hazardous air pollutants (HAPs). The HAPs found in greatest quantities in refueling emissions are n-hexane, toluene, and benzene. N-hexane and toluene account for the highest amounts of HAPs in GDF refueling emissions but benzene is considerably more toxic and is, therefore, considered the “risk driver” for the HAPs in refueling vapors. Benzene is a known carcinogen and is the first HAP that would be expected to have air concentrations greater than any health-based screening value, whether for acute or chronic exposure durations. Table 3-4 shows the estimated reductions of benzene with ORVR alone and Stage II.

Table 3-4. Statewide Benzene Emission Reductions (lbs per Summer Day) for Continuing Current Stage II Controls⁸ (Replaces Table 3-4 in Draft Report)

Year	Stage II	ORVR Alone
2013	15.48	217.62
2015	4.03	231.56
2018	-4.41	241.83

Section 3.3 - Costs to Continue Stage II Systems

Table 3.5 presents estimated costs for continuing Stage II systems based on publicly available studies. EPA’s study is the most recent and the assumptions are well documented, so ERG selected it as the basis for evaluating the costs of continuing Stage II in Massachusetts. EPA accounted for costs for hardware replacement, operating and maintenance, and vapor recovery fuel credit. The model station that was the basis for EPA’s estimate pumped 120,000 gallons per month, and had 10 nozzles and three underground storage tanks. Note that EPA’s annual cost estimate of \$2,977 includes a \$1,230 credit per GDF for fuel recovery. An annual cost per GDF of \$4,207 was used in the calculations of the cost per ton of VOC reduced and then a fuel credit specific to Massachusetts was applied to this cost. This credit assumed a gasoline cost of \$4.00/gallon.

Table 3.5. Annual Costs to GDFs for Continuing Current Stage II Program
Replaces Table 3.5 in Draft Report.

Source	Annual Cost (with fuel savings)
Low: New York State ⁹	\$2,000
High: API ¹⁰	\$4,410
EPA ¹¹	\$2,977 (\$4,207 without fuel credit)

⁸ Stage II reductions are incremental to reductions achieved through ORVR alone.

⁹ Part 230 -- Gasoline Dispensing Sites and Transport Vehicles, Stakeholder Meeting; New York Department of Environmental Protection, December 7, 2010.

¹⁰ Refueling Emission Controls at Retail Gasoline Dispensing Stations and Cost-Benefit Analysis of Stage II in Connecticut, Tech Environmental, Inc., September 24, 2007

¹¹ Widespread Use for Onboard Refueling Vapor Recovery and Stage II Waiver; USEPA, July 8, 2011. Costs include fuel savings of \$930/yr.

Tables 3-6 and 3-7 show the cost per ton for continuing Stage II in 2013 and 2015, by gasoline throughput category. (These replace Tables 3-6 and 3-7 in the Draft Report. Table 3-8 in the Draft Report showing costs in 2018 is omitted.)

Table 3-6. Cost per Ton of VOC Reduced for Continuing Stage II: 2013

Throughput Category (gal/yr)	(Stage II Benefit tons/yr)	\$/ton
Less than 120,000	7	\$255,074
120,000 to 240,000	4	\$87,783
240,001 to 500,000	28	\$44,830
500,001 to 1,000,000	127	\$24,212
1,000,001 to 2,000,000	278	\$14,175
Greater than 2,000,000	160	\$8,842
ALL	604	\$19,790

Table 3-7. Cost per Ton of VOC Reduced for Continuing Stage II: 2015

Throughput Category (gal/yr)	(Stage II Benefit tons/yr)	\$/ton
Less than 120,000	2	\$985,572
120,000 to 240,000	1	\$341,644
240,001 to 500,000	7	\$176,311
500,001 to 1,000,000	33	\$96,951
1,000,001 to 2,000,000	72	\$58,315
Greater than 2,000,000	42	\$37,790
ALL	157	\$79,931