

Emissions Impact of OTC's Recommended Federal Aftermarket Catalytic Converter Program

Discussion Paper

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Executive Summary

Following a 2009 OTC annual meeting, the OTC issued a statement calling for EPA to update its policy towards motor vehicle aftermarket catalytic converter. In 2011, OTC submitted to EPA its own recommendations for an updated federal aftermarket catalytic converter program. OTC's recommended program is similar to the program established by the California Air Resource Board's program in 2007. This paper demonstrates the benefits of a federal program by showing a substantial reduction in ozone precursors in the Ozone Transport Region.

The results of the OTC study found that the current EPA policy towards catalytic converters is failing to adequately reduce emissions. OTC conducted an analysis to determine the frequency of catalytic converter failure and catalytic converter tampering. The catalytic converter failures were estimated to occur in 0.6% of vehicles tested and catalytic converter tampering were estimated to occur 0.21% of vehicles tested. Additionally, OTC's study showed that by implementing its recommendations, its estimate emission reduction in 2014 is a 30 tons per day ("tpd") reduction of NO_x; a 6 tpd reduction in NMHC; and a 74 tpd reduction in CO. Based on the forgoing OTC concluded that that it was appropriate for EPA to update its motor vehicle aftermarket catalytic converter policy.

Background

At the June 2009 OTC Annual Meeting OTC issued a statement calling for EPA to update its policy toward motor vehicle aftermarket catalytic converters. EPA's program has not been updated since 1986 so it does not consider the technological advances that have occurred in the ensuing 25 years. The OTC has since submitted its own recommendation for an updated federal aftermarket catalytic converter program to EPA in April of 2011¹. This analysis supports the need for the recommended updated program by examining the extent of catalytic converter failures and the emissions impacts of their replacements in the Ozone Transport Region (OTR).

OTC's Recommended Program

The OTC's recommended program is based on a similar program by the California Air Resource Board (CARB) that went into effect in 2009. Like CARB's program, aftermarket catalytic converters would now have a 50,000 mile/5 year warranty, which is an increase from the current federal warranty length of 25,000 miles. The recommended program would rely on a mass based standard rather than the current 70% HC, 70% CO, 30% NO_x emission reduction based standard to become certified that would substantially decrease emissions over the five year period. The type of vehicles that would be used for certification would also be changed for certification of OBD equipped vehicles, but would remain largely unchanged for non-OBD equipped vehicles. One difference between CARB's program and OTC's recommendation is that CARB would not allow used Original Engine Manufacturer (OEM) converters to be certified and sold, but OTC does recommend that any properly certified used OEM converter could be sold. A full breakdown of OTC's recommended program can be found in Appendix 1.

Other Policy Options

Since CARB has an updated aftermarket catalyst program in place, OTC as a whole, or the individual states within the OTR could implement the California program. If the entirety of the OTC were to adopt the CARB program the emissions estimates in this paper are expected to be similar. Additionally, if states within the OTR, were to implement the California program it could prompt increased consideration of the recommended federal program by EPA. New York State has recently proposed to adopt CARB's aftermarket catalyst program.

Emissions

Catalytic converters first obtained wide-spread use in 1975 in the United States and reduced pollution from unburned hydrocarbons and carbon monoxide (CO), the former of which acts as an ozone precursor. Technological advances in the early 1980s allowed for catalytic converters to also reduce oxides of nitrogen (NO_x) which are also precursors to ozone pollution. Several precious metals, most notably platinum, help to convert harmful pollution into less harmful gasses. As the catalytic converter

¹ OTC (2011) "OTC Mobile Source Committee Recommended Federal Aftermarket Catalytic Converter Program (FACCP)."

ages, reactions occur with sulfur dioxide, which results in buildups on the surfaces of the converter, “poisoning” it and making it less effective.

I/M Programs in the OTR

The Clean Air Act requires that all areas in Metropolitan Statistical Areas in the OTR with populations greater than 100,000 implement an Inspection/Maintenance (I/M) program. Some of these states have implemented programs state wide. I/M programs implemented in the region vary slightly, but are very similar. Every state in the OTR has different vehicle age requirements, visual catalyst check standards, and requirements for vehicles to return on either an annual or biennial basis. Many states allow private certified automotive shops to conduct tests, but others have centralized facilities to conduct tests. A full list of all of the program variations is in Table 1.

Table 1: I/M Program Traits by OTC State

State	Centralized?	Model Years	Regularity	Visual Catalyst Check?	# of Counties
CT	No	Up to 25 years old	Biennial	Yes	8
DE	Yes	1968+, <5 exempt	Biennial	Yes	3
DC	Yes	1968+, <5 exempt	Biennial	Yes	1
ME	No	1974+	Annual	Yes	1
MD	Yes	1977+, <2 exempt	Biennial	Yes	14
MA	No	1984+, <2 exempt	Annual	No	14
NH	No	> 20 years exempt	Annual	Yes	10
NJ	Yes*	<5 exempt	Biennial	Yes	21
NY	No	2-25 years old	Annual	Yes	62
PA	No	1975+	Annual	Yes	25
RI	No	2-25 years old	Biennial	No	5
VT	No	1968+	Annual	Yes	14
VA (OTR Only)	No	2-24 years old	Biennial	Yes	9

* New Jersey’s system is a hybrid system, but the vast majority of vehicles are tested at centralized facilities so New Jersey’s I/M program was considered centralized

Technical Analysis

Catalysts Failures in the OTR

In order to calculate failures in the OTR a regression analysis was conducted to develop a model for how catalyst failures and catalyst tampering vary by model year for vehicles with on board diagnostic (OBD) equipment. OBD catalyst failure data by model year were provided by MA, MD, NJ, NH, NY, and VA and catalyst tamperings by model year were provided by NJ, NH, NY, and VA. The analysis also looked at whether each state’s program was centralized or not (Table 1). The equations 1 and 2, shown below, were used for evaluation and the regression results are shown in Table 2.

Equation 1: OBD Catalyst Failure Percentage Regression Equation

$$\text{OBD Catalyst Failure Percentage} = \beta_1 * \text{Centralized System} + \beta_2 * \text{Age} + \beta_0$$

Equation 2: Catalyst Tampering Percentage Regression Equation

$$\text{Catalyst Tampering Percentage} = \beta_1 * \text{Centralized System} + \beta_2 * \text{Age} + \beta_3 * \text{Age}^2 + \beta_0$$

Table 2: Catalytic Failure/Tamperings Percentage Regression Results

	OBD Catalyst Failure			Catalyst Tampering		
	Coefficient	StdError	P-Value	Coefficient	StdError	P-Value
Intercept (β_0)	-5.04E-03	1.10E-03	1.43e-05 ***	2.84E-03	1.47E-03	0.05735
Centralized (β_1)	6.80E-03	1.09E-03	1.37e-08 ***	-1.01E-03	1.21E-03	0.40768
Age (β_2)	1.40E-03	1.15E-04	< 2e-16 ***	-1.04E-03	3.49E-04	0.00421 **
Age ² (β_3)	n/a	n/a	n/a	9.52E-05	1.87E-05	3.56e-06 ***
R ²	0.6776			0.5387		
statistically significant at the *** 0.1% level, ** 1% level,						

It was also necessary to develop an estimate of vehicle population by model year. 2010 Federal Highway Administration vehicle registrations by state were used as a starting point for total vehicle population. A state level 2007 to 2010 growth rate was calculated from state level totals used as inputs for OTC's 2007 MOVES runs. These growth rates were then applied to 2007 county level vehicle populations from OTC's MOVES inputs to estimate 2010 county level vehicle populations.

County level vehicle age distributions from OTC's 2007 MOVES inputs were used to estimate the vehicle totals by model year. The age fractions were multiplied with the 2010 county level vehicle population estimates to perform this calculation. Given the way in which vehicles that are 30 years and older are summed in the distribution, these populations were removed from the estimation. However, a variety of factors to be discussed later should result in little impact on emission estimates.

Using the regression results, OBD catalyst code failure and catalyst tamperings rates were estimated for each model year (1981-2010) with separate results for states with centralized and decentralized I/M programs. These percentages were applied to the estimates of vehicle totals by model year to develop an estimate for total OBD catalytic code failures and catalyst tamperings. These results are in Table 3.

Table 3: 2010 Estimates of Tests and Failures in I/M Programs in the OTR

Vehicles	OBD Tests	OBD Catalyst Code Failures	Visual Inspections	Catalyst Tamperings
47,000,000	32,000,000	200,000 (.6%)	32,000,000	78,000 (.2%)

Emissions Estimates

Estimated emission benefits from the OTC's recommended catalytic converter program were forecasted for 2014. This year was chosen because it would allow for several years of fleet turnover and replacement catalysts installations to occur. Additionally, using the assumption that an average vehicle travels 10,649 miles annually, the warranties for a CARB certified catalyst would expire in that particular year².

However, the fleet average annual mileage assumption was only used for determining which year to conduct the analysis for, linearly interpolated MOVES inputs for vehicle miles traveled and vehicle population were developed for each year from 2010-2014, for cars and trucks separate and for each state, except Pennsylvania and Virginia. These interpolations were based on 2007 and 2020 MOVES inputs. 2020 MOVES inputs were not available for NY so 2007 values were held across the entire time period. Since only NOVA was analyzed for Virginia, it was assumed that vehicle miles traveled to vehicle population were more similar to DC than to VA as a whole so DC's ratios were used.

To simplify this analysis several additional assumptions were made. First, model years prior to 1981 and after 2010 were excluded from the analysis. Since several states have age limits and model year limits, many of these vehicles would not have been tested anyway. Pre-1981 vehicles would be the mostly likely to be scrapped if the owner is facing a major repair. Newer vehicles would be under the eight year federal warranty and thus would replace their catalytic converters with OEM converters.

Second, it was assumed that vehicle owners that installed converters would not scrap their cars before the end of the analysis period. Third, despite the fact that EPA certified catalysts only have a 25,000 mile warranty; they would not be replaced again during the period.

Finally it was assumed that the age distributions from 2010-2014 would remain consistent and could be based on the 2007 age distributions, which were the best available data. This could result in the analysis showing less of a benefit given that the economic downturn of 2008 and the Car Allowance Rebate System ("Cash for Clunkers") program of 2009 that may have resulted in depressed fleet turn over in 2010 and 2011.

One uncertainty was how many people would purchase an OEM catalyst (either new or used since both are allowed in OTC's proposed program). OTC assumed that all failures in the eight most recent MY cars would be addressed by replacing the catalyst through the dealer using a new OEM catalyst, and thus would not fall under the universe impacted by this program. When considering vehicles that are no longer under warranty, owners have the options of purchasing a new or used OEM or an aftermarket catalyst. We assumed that the vast majority of owners would replace their catalysts with aftermarket converters if their vehicle was no longer under warrant, with the exception of vehicles with a very low

² Federal Highway Administration (2010) "Annual Vehicle Distance Traveled in Miles and Related Data - 2010 By Highway Category and Vehicle Type." <http://www.fhwa.dot.gov/policyinformation/statistics/2010/vm1.cfm> (Accessed August 14, 2012).

market share making aftermarket converters unprofitable, as CARB assumed in their analysis³. The calculated emissions benefits are in Table 4.

Table 4: Emission Reduction Estimates from OTC's Recommended Federal Aftermarket Catalyst Program in the OTR

	NO_x	THC	NMHC	CO
Annual Reductions (tons per year)	10,000	2,000	2,000	27,000
Daily Reductions (tons per day)	30	6	6	74

Conclusions

The results of the OTC study found that the current EPA policy towards catalytic converters is failing to adequately reduce emissions. OTC's study showed that by implementing its recommendations, its estimate emission reduction in 2014, based on a 80% aftermarket catalytic converter rate is a 10,000 tons per year reduction of NO_x; a 2,000 tpy year reduction in THC; a 2,000 tpy reduction in NMHC; and a 27,000 tpy reduction in CO. Based on the forgoing OTC concluded that that it was appropriate for EPA to update its motor vehicle aftermarket catalytic converter policy.

³ California Air Resources Board (2007). "Public Hearing to Consider Amendments to Regulations Regarding New. Aftermarket Catalytic Converters and Used Catalytic Converters Offered for Sale and Use in California," <http://www.arb.ca.gov/regact/2007/amcat07/isor.pdf> (Accessed July 30, 2012).

Appendix 1: Summary of a Recommended Revisions to the Federal Aftermarket Catalytic Converter (FACC) Program

Proposed Requirements for Non – OBD Equipped Vehicles		
<i>Criteria</i>	<i>Current Federal Program⁴</i>	<i>Recommended Federal Program</i>
Performance	Efficiency based: 70%, 70%, 30% conversion efficiencies (HC, CO & NOx) must be maintained at end of 25k miles or 5 years.	Mass Based (grams/mile): Performance Standards based on meeting the vehicle certification tailpipe emission levels for vehicle being tested for 50k, 5 yrs.
Warranty	25K, 5yrs.	50K, 5yrs.
Used or remanufactured converters permitted?	Yes	Yes, a reseller would be able to certify a used OEM converter using an approved emissions testing protocol that can evaluate whether the used converter meets the applicable standards.
Certification Procedure	Must demonstrate compliance with the <u>worst case vehicle</u> in the application category, i.e., the vehicle with the highest weight and largest engine in the category to which the converter is intended to apply.	Must demonstrate compliance with the worst case vehicles within <u>four general classes</u> of vehicles, i.e., passenger cars and light-duty trucks each with single and dual exhaust configurations
FAMCC Aging Procedure	On-vehicle mileage accumulation	Would allow for the use of accelerated aging of converters using a RAT-A engine dynamometer cycle rather than actual on-vehicle mileage accumulation for durability demonstration (RAT-A refers to a defined engine dynamometer-based converter aging cycle)
Estimated Price	\$100	\$200 - \$300

⁴ Based on the USEPA's 8/5/86 policy document

Recommended Requirements for OBD Equipped Vehicles

<i>Criteria</i>	<i>Current Federal Program</i> ⁵	<i>Recommended Federal Program</i>
Performance	<p>Efficiency based (70-70-30) and must meet 1 of these 2 Options:</p> <p>Option 1: AMCCs that meet the requirements of the current USEPA AMCC policy, provided the AMCC warranty is honored when the OBDII system indicates a catalyst malfunction during the 25000 mile warranty period or;</p> <p>Option 2: AMCCs that meet the requirements of the California AMCC/OBDII procedures provided the AMCC warranty is honored when the OBDII system indicates a catalyst malfunction during the 25,000 mile warranty period, and provided that the information described above is submitted to the USEPA.</p>	<p>Mass Based (grams/mile) Performance Standards based on meeting the vehicle certification tailpipe emission levels for vehicle being tested for 50k, 5 yrs. <u>with full OBD compliance.</u></p>
Warranty	25K, 5yrs	5yrs or 50,000miles & 50,000 miles emissions performance warranty
Used or remanufactured converters permitted?	Yes	Yes, a reseller would be able to certify a used OEM converter using an approved emissions testing protocol that can evaluate whether the used converter meets the applicable standards.
Certification/Applicability Procedures	Worst case vehicle	Aggregation of similar vehicles permitted for a limited worst case AMCC certification process for OBD-equipped vehicles. Criteria for worst case vehicle aggregation to be defined based on vehicle engine and emissions

⁵ Based on 8/2/00 and 9/30/04 letters from the USEPA to MECA

		<p>control similarities (note: this provision is not part of California’s AMCC rules).</p> <p>2 Proposed Options for certifying an AMCC in the FAMCC Program:</p> <ol style="list-style-type: none"> 1. AMCC must have a CARB Executive Order for the analogous California-certified vehicle with the AMCC manufacturer providing full OBD warranty on the Federally certified equivalent vehicle model or; 2. AMCC must meet California’s AMCC/OBDII standards including durability and warranty requirements for the applicable federally emissions certified vehicle. The AMCC manufacturer must submit to the USEPA the same information that they would send to the CARB under their procedures.⁶
AMCC Aging Procedure	On-vehicle mileage accumulation	Would allow for the use of accelerated aging of converters using a RAT-A engine dynamometer cycle rather than actual on-vehicle mileage accumulation for durability demonstration (RAT-A refers to a defined engine dynamometer-based converter aging cycle) .
Estimated Price	\$100	\$350 - \$550

⁶ The information to be submitted to the USEPA would include a list of applicable vehicles for each new converter; the USEPA would select vehicles from the list for the manufacturer’s compliance determination.

Also, the AMCC manufacturer must conduct an OBDII compliance check, ie, aging of converter with demonstration that during emissions testing the converter will cause the MIL to illuminate while not exceeding the emissions limit (2.6 times the certification emission limit).