

4.0 NO_x ANALYSIS METHODS

6 Aftermarket Catalytic Converters

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Catalytic converters reduce emissions through chemical reactions formed in the engine during combustion but prior to the exhaust leaving the tailpipe. Several precious metals, most notably platinum, palladium and rhodium, help to convert harmful pollution into carbon dioxide, as well as the non-toxic gasses of water and nitrogen. As the catalytic converter ages, reactions occur with sulfur dioxide, which results in buildup on the surfaces of the catalyst, in effect, “poisoning” it and making it less effective.

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. These types of catalytic converters are known as two-way catalysts. 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. The converters that reduce NO_x are commonly known as a three-way catalyst.

Many states have programs to inspect vehicles for malfunctioning catalytic converters called Inspections and Maintenance (I/M) programs. When a catalytic converter fails the emissions tests from an I/M program there are three options for replacement, a converter manufactured by the original manufacturer of the car (OEM), a still functional converter taken from another car (used), and a converter manufactured by a third party (aftermarket). To ensure that aftermarket converters meet standards there exists two certification regimes, one headed by USEPA and one by the California Air Resources Board (CARB).

The anti-tampering provisions of section 203(a)(3) of the Clean Air Act prohibits against the removal, or rendering inoperative, of emission control devices such as the catalytic converter. Therefore, replacement of a malfunctioning catalytic converter should take place using one of the three aforementioned options, even within states, or areas, without an I/M program.

4.6.1 Existing Standards

A federal policy was put in place in 1986. The standard is efficiency based (70% HC -70% CO - 30% NO_x) and must meet one of these options:

- Option 1: aftermarket catalytic converters that meet the requirements of the current USEPA aftermarket catalytic converters policy, provided the aftermarket catalytic converter warranty is honored when the OBDII system indicates a catalyst malfunction during the 25,000 mile warranty period or;
- Option 2: aftermarket catalytic converters that meet the requirements of the California aftermarket catalytic converter/OBDII procedures provided the aftermarket catalytic converters 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.

Two states (Maine and New York) in the Ozone Transport Region (OTR) already require CARB Executive Orders for aftermarket catalytic converters sold in their respective states to be installed on CA LEV vehicles.

4.6.2 The OTC Measure

After adoption by a member state, the OTC model rule would apply to all sales of aftermarket catalytic converters in the state. The measure would in no way impact the sale of OEM converters. Only aftermarket catalytic converters meeting CARB performance standards are permitted to be sold and installed. When a converter meets the performance standards CARB signs an Executive Order (EO) allowing for its sale. The measure provides optional language for a state to allow used converters to be sold if they are compatible with and installed on an OBD II vehicle.

4.6.3 Emissions Reduction Benefit

Estimated emission benefits from the OTC's recommended catalytic converter program were projected for 2015. This year was chosen because it would reflect lead time until rule adoption.

Tailpipe tests conducted by the Manufacturers of Emissions Control Association (MECA) were used to determine the benefits of installing CARB converters in lieu of federal converters¹. CARB and EPA catalytic converters were tested for three classes of light duty vehicles and two classes of light duty trucks in the study. The light duty vehicle and light duty truck emission rates were averaged separately. Different deterioration rates were observed in the study between 0 -25,000 miles and 25,000-50,000 miles so two sets of emission reductions were calculated. We assumed that the difference in emissions from installing a CARB certified catalyst in lieu of an EPA certified catalyst would be the same across all vehicle make and model years.

Linearly interpolated MOVES inputs for vehicle miles traveled and vehicle population were developed for each year from 2011-2015, for cars and trucks separately 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 counties in Northern Virginia in the OTR were 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 were excluded from the analysis since it was assumed that older vehicles would be the most likely to be scrapped if the owner is facing a major repair. Since several states have model year limits on testing, many of these vehicles would not have been tested anyway. Also model years more recent than 2011 were excluded since newer vehicles would mostly likely be under the federal warranty (8 years or 80,000 miles) and thus owners would replace their catalytic converters with OEM converters. The mileage accumulation calculation was conducted by multiplying the average annual VMT (for cars 10,600 miles, for trucks 14,700 miles), separately

¹ Manufacturers of Emissions Control Association (2013) "Emission Performance of California and Federal Aftermarket TWC Converters." *SAE 2013 World Congress & Exhibition Technical Papers*. <http://papers.sae.org/2013-01-1298/> (Accessed January 7, 2013).

for cars and trucks, by the number of years.² In the case that the threshold was crossed midway through the year, it was assumed that accumulation was at a steady daily rate so the results were multiplied by the ratio of miles traveled out of the warranty over average annual VMT.

Secondly, it was assumed that vehicle owners that installed converters would not scrap their cars before the end of the analysis period.

Thirdly, we assumed that converters would not fail while still under their warranty period. Since EPA certified catalysts only have a 25,000 mile warranty; the replacements would begin to go out of warranty halfway through the 2011-2015 period (for those that were replaced in 2011). Since the converter still could function for longer we provided two sets of estimates, one assuming that the EPA converters were replaced after two and a half years and one assuming they lasted a full five years.

Finally, it was assumed that the age distributions from 2011-2015 would remain consistent and could be based on the 2007 age distributions, which were the best available data. Given that the prolonged economic downturn of 2008 that likely has resulted in depressed fleet turn over in subsequent years this analysis will show less of an emission reductions benefit since the vehicles fleet on the road currently is older and dirtier than our estimates. Though the Car Allowance Rebate System (“Cash for Clunkers”) program of 2009 would have had a slight counteracting effect it should be minor.

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 that occurred under the federal warranty (cars that are less than 8 years old or have driven less than 80,000 miles) 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 warranty, with the exception of people with specialty vehicles that have a very low market share for which aftermarket converters are not manufactured, as CARB assumed in their analysis³. We also assumed that people would opt for aftermarket converters over used converters given the risk factor associated with purchasing a used converter with no warranty. Additionally, for the few instances where vehicle owners would purchase a used converter, the converter would still have to pass regular emission tests and we assume would still result in emission reductions over a failing converter.

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).

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).

An additional level of uncertainty that is introduced for the emission estimates involves potential regulations affecting vehicle emissions that have not yet been adopted. Some examples of these are state adoption of CARB ZEV provisions, EPA promulgation of Tier 3, or state adoption of “boutique” fuels. We have chosen to only consider on-the-book regulations that would affect the vehicle fleet in the OTR for 2015 in this analysis.

Table 1: NO_x Emission Reduction Estimates from an updated Aftermarket Catalytic Converter Program in the OTR in 2015

	Range of Reductions in NO _x	
Annual Reductions (tons per year)	13,000	20,000
Daily Reductions (tons per day)	34	56

4.6.4 Control Cost Estimate

OTC employed the cost estimates presented in the 2011 recommendation “OTC Mobile Source Committee Recommended Federal Aftermarket Catalytic Converter Program (FACCP)” for each class of converter, \$100 for EPA certified converters, \$200-\$300 for non-OBD updated converters and \$350-\$500 for OBD updated converters. OBD converters cost more since more metals are necessary to meet the more stringent emission standards, making them more expensive. Projected replacements were divided into categories for pre-1996 and 1996 and after model years so that the separate cost estimates could be used. Given that a range was presented for the updated converters a high and low estimate were calculated.

Given our assumptions on the length of time aftermarket converters would last, differing time periods were used calculating the levels of depreciation. All CARB certified converters were depreciated for five years and EPA certified converters were depreciated for two and half and five years to match the range of emission reductions estimated earlier. The straight line method was employed to calculate the amount of annual depreciation. The result was an estimate that the benefits from reducing NO_x would be between \$2,200 and \$4,500.

4.6.5 Emissions Reduction Benefits for Other Pollutants

Updating the aftermarket catalytic converter standards brings with it benefits from reducing other pollutants as well. The same technique was used to calculate these reductions as was used to calculate the benefits from reducing NO_x and the benefits are listed in Table 2.

Table 2: Other Emission Reduction Estimates from an updated Aftermarket Catalytic Converter Program in the OTR in 2015

	Range of Reductions in NMHC		Range of Reductions in CO	
Annual Reductions (tons per year)	3,000	4,000	28,000	44,000
Daily Reductions (tons per day)	7	12	76	120
Cost Benefit (2010 dollars)	\$9,600	\$20,000	\$1,000	\$2,000