Simple Methodology to Determine Whether EPA GHG and NHSTA CAFE Standards Are Equivalent to Applying California's Program Nationwide

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Background

California has established emission standards for a basket of four greenhouse gases (GHGs) emitted by motor vehicles – carbon dioxide, methane, nitrous oxide, and hydrofluorocarbons – measured on a CO_2-equivalent basis. Thirteen other states and the District of Columbia have adopted those standards and more states are considering doing the same. These standards will take effect upon the issuance of a waiver to California under Section 209(b) of the Clean Air Act.

Responding to the Supreme Court's decision in *Massachusetts v. EPA*, the Environmental Protection Agency (EPA) is considering establishing federal GHG emission standards for the same four GHGs. A methodology is needed to determine whether potential EPA GHG standards would deliver emission reductions equal to or greater than the California standards if applied to the nationwide fleet. In addition, though GHG and CAFE standards are clearly distinguishable, it is useful for comparison purposes to understand what impact potential EPA GHG emission standard would have on combined fleet average fuel economy levels when measured under the current CAFE system.

EPA Greenhouse Gas Standard Level Equivalent to Applying California Standards Nationwide

We describe here a simple methodology for deriving from California's standards the equivalent grams of CO_2 per mile for the combined average of the national new car and light truck fleets in any model year. Although the pollutants covered are the same, there are several key differences between the California standards and potential EPA GHG emission standards. These are as follows:

- The California classification system for cars and light trucks differs from the federal one. California divides the light truck category into two weight categories and adds the lighter category to the passenger car class.[1]
- The current California fleet mix differs from the national mix in that a higher percentage of cars is sold in California than nationwide.
- EPA can set standards on a different basis using an "attribute-based" or "size-based" like the federal fuel economy program rather than California's class-based standards.[2]

The California program has separate fleet average standards for cars and smaller light trucks (PC/T1), and for larger light trucks (T2). For example, in model year 2015, the fleet average standard for the PC/T1 class is 213 grams of CO_2-equivalent per mile, and the fleet average standard for the T2 class is 341 grams per mile (see Table 1).[3]

The equivalent value for the combined national fleet can be derived by taking a simple arithmetic average of the California PC/T1 and T2 standards, each one weighted for the proportion of PC/T1 and T2 vehicles forecast to be sold nationwide. As an example, for model year 2015 (MY2015), the calculation is as follows:

$$((59.45\%) \times (213 \text{ g/mile})) + ((40.55\ \%) \times (341 \text{ g/mile})) = 264.9 \text{ g/mile}$$

We adopt the market shares from the US DOE, Energy Information Administration's official forecast (*Annual Energy Outlook 2009*) which estimates 59.45 percent cars and 40.55 percent

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light trucks by calendar year 2016.[4] We also assume that EIA's car shares forecast include T1s, which are mostly car-like small crossovers. Recent sales trends and the official US DOE forecast show a pronounced long-term trend away from truck-based vehicles (pickups and SUVs) and towards cars and crossovers, due to higher fuel prices. This trend is likely to continue, despite a recent temporary drop in fuel prices, because of changing consumer demographics (i.e., truck-based SUVs are less desirable for aging population) and the widespread expectation that higher fuel prices will rebound as the economy recovers. Since the model year starts much earlier than the calendar year, we use the calendar year 2016 split for model year 2015.

Table 1. National GHG Emission Level Equivalent to Applying California Standards Nationwide (MY2015)

Class*	Estimated Market Share**	**CA Standard***** grams of CO_2-equivalent per mile
PC/T1	59.45%	213
T2	40.55%	341
Combined Fleet	100%	**264.9**

* California GHG program classification definitions are: PC = passenger cars; T1 = light trucks that weigh less than 3750 lbs loaded vehicle weight; T2 = heavier light trucks that weigh more than 3750 lbs, but less than 8500 lbs gross vehicle weight rated (GVWR).

** Source: NRDC calculation based on sales forecast from the US Department of Energy, Energy Information Agency, *Annual Energy Outlook 2009*, table 57. For MY2015, we assume that the EIA forecast for the PC category includes T1's, since these are mostly car-like light crossover vehicles.

*** PC/T1 and T2 standards are directly from the California Air Resources Board GHG regulations.

California GHG Compliance Methodology

To understand how the conversion from a GHG target to a MPG target can be done, it is important to first review the methodology for which automakers would certify their emission levels to a fleet average GHG level under the California system.

As discussed earlier, the California standard regulates a basket of GHGs; consequently, manufacturers must account for emissions from all four gases, not just CO_2. The emissions components can be broken down into three main categories: 1) the official test cycle (called the federal test procedure or "FTP") CO_2 emissions from the tailpipe;[5] 2) additional GHG emissions from CH_4 and N_2O; and 3) emission reduction credits earned from improved air conditioning systems.[6] To show compliance, automakers would use the following formula:

(FTP CO_2 Emissions) + (CH_4+N_20) – (Air Conditioning Credits) = Emission Level for Compliance Purposes

For MY2015, the calculation is as follows and is also illustrated in Figure 1:

(271.4 grams CO_2/mile) + (1.9 grams CO_2-eq/mile) – (8.4 grams CO_2-eq/mile) = 264.9 grams CO_2-eq/mile

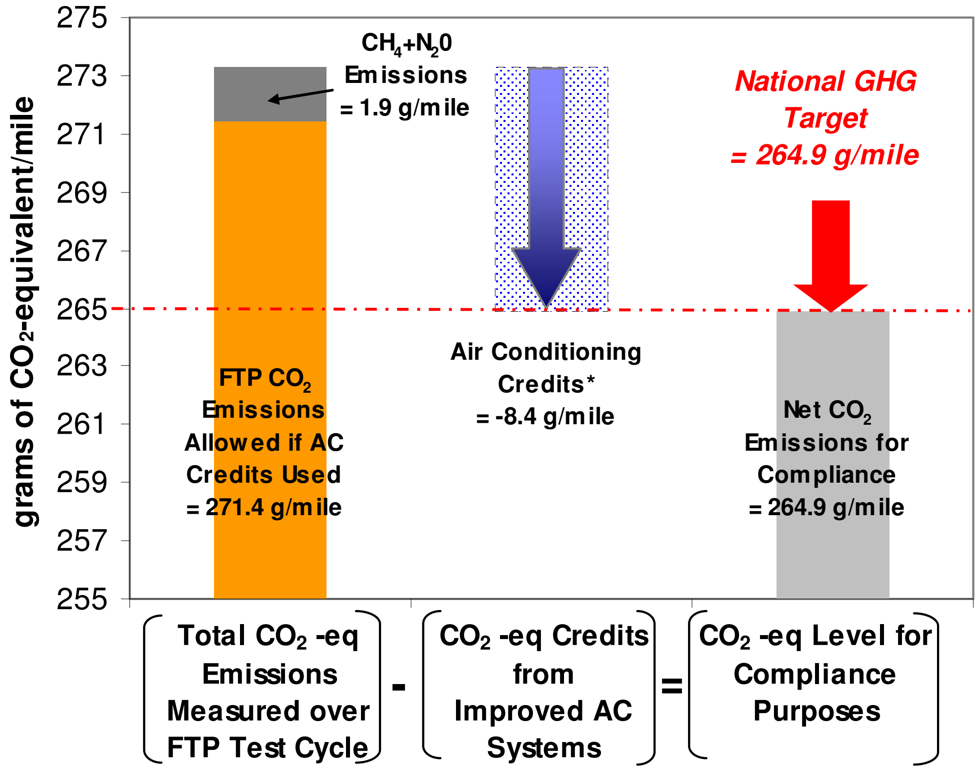
where:

271.4 grams CO_2/mile = the measured tailpipe CO_2 emissions level tested over the standard Federal Test Procedure cycle.

1.9 grams CO_2-eq/mile = the measured amount of tailpipe CH_4 and N_20 emissions tested over the Federal Test Procedure cycle, converted to CO_2-equivalent terms using standard IPCC global warming potential factors. CARB 2008 assumes this level will be 1.9 g/mile.[7]

8.4 grams CO_2-eq/mile = the amount of GHG reduction credits CARB 2008 assumes automakers will achieve in MY2015, assuming they use just 50 percent of the total credits available to them.[8]

Figure 1. Illustration of Compliance with a EPA GHG Standard in MY2015 using CARB Methodology



Conversion to NHSTA CAFE Standard Levels in MPG Terms

The national combined fleet GHG target can also be converted to miles per gallon (MPG) equivalency terms for facilitating comparison to Corporate Average Fuel Economy (CAFE) standards. The FTP CO_2 tailpipe emission components of the GHG emissions shown in Figure 1 can be directly correlated to a MPG level achieved under a CAFE program for two key reasons: first, the FTP test cycle used for CARB GHG standard compliance is identical to the test cycle used for CAFE compliance; and second, there is an accepted conversion factor for emissions of CO_2 from burning a gallon of gasoline or diesel fuel.[9] There are four key assumptions that are also needed:

- Base conversion factor: Burning one gallon of gasoline results in 8,887 grams of CO_2 emissions, based on CARB 2008.

- Emission rate of CH_4 and N_2O. As noted above, CARB 2008 estimates the level to be 1.9 grams of CO_2 equivalent per mile. This level is unlikely to be exceeded since CH_4 and N_2O emission levels are closely correlated to emission levels of currently regulated pollutants, namely hydrocarbons (HC or NMOG) and nitrogen oxides (NO_x), under the CARB LEV II and the US EPA Tier 2 programs.

- Level of air conditioning system improvements. CARB 2008 assumes that by MY2015, automakers will only be able to achieve 50 percent of the credits available to them. This assumption looks very reasonable, especially in light of new developments in replacement refrigerants (HFO 1234-yf with GWP of 4)) that appears to be superior to the original CARB analysis that assumed a switch to a different, more expensive refrigerant (HFC-152a with GWP of 140).

- Adjustment for FFV credits. Automakers can use flex-fuel vehicle (FFV) CAFE credits as allowed by federal law (1.2 mpg for MY2012-14, 1.0 mpg in MY2015, and 0.8 mpg in MY2016). FFV credits result in *higher* GHG emissions because the actual usage rate of ethanol is systematically overestimated in the credit calculation (vehicles *capable* of running on ethanol are given credit for doing so 50 percent of the time when they actually run on gasoline 95 percent of the time[10]). To achieve equivalent GHG performance when FFV credits are used, the MPG target needs to be raised by 1.0 MPG in MY2015.

We present two illustrative calculations. The first assumes automakers do not make use of the air conditioning credits under the EPA GHG program or the FFV credits under the CAFE program. For this calculation, the equivalent level in MPG terms is:

[(8,887 g/gallon) / ((264.9 g/mile) – (1.9 g/mile))] = 33.8 mpg

However, we believe this scenario is highly unlikely. Both air conditioning credits and FFV credits are very inexpensive compliance options.[11] The calculation to convert the MY2015 national GHG equivalency level of 264.9 g/mile to a corresponding CAFE level would then be:

[(8,887 g/gal) / ((264.9 g/mile)-(1.9 g/mile)+(8.4 g/mile))] + (1.0 mpg) = 33.7 mpg

Table 2. Fuel Economy Levels Corresponding to EPA GHG Standards Levels (MY2015, Combined Fleet)

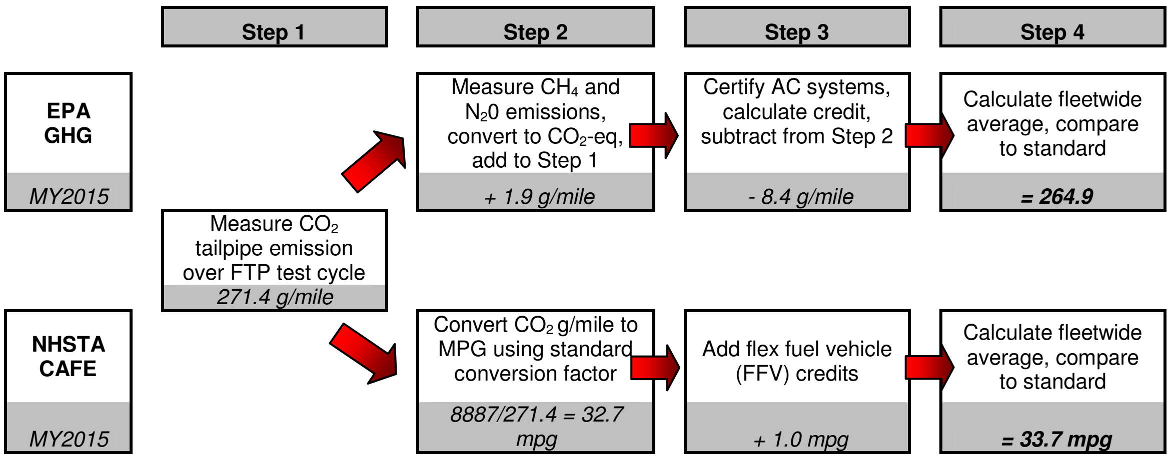
Scenario	**Fuel Economy** miles per gallon	**Description**
MPG Simple Equivalence	33.8	Assumes manufacturers do not use any AC or FFV credits.
Corresponding CAFE Level*	**33.7**	Assumes manufacturers choose a least cost compliance strategy by using 50% of the AC credits available under an EPA GHG standard and 100% of FFV credits available under the NHSTA CAFE Program.

* The Corresponding CAFE Level by itself does not ensure GHG emission equivalency with a national GHG program. The EPA GHG standards are necessary to ensure that the AC GHG reductions are achieved. Without a companion EPA GHG standard, the CAFE target would have to be further increased by 1.1 mpg to 34.8 mpg to ensure that the FTP CO_2 standards deliver equivalent GHG reductions.

Example of How Manufacturers Would Demonstrate Dual Compliance

Demonstrating compliance with both EPA GHG and NHSTA CAFE standards is straightforward. The key to note is that Step 1, measuring the CO_2 tailpipe emissions over the FTP test cycle, is common to both programs. That is, to comply with a minimum national stringency, the manufacturers' internal plans have to target just a single combined fleet CO_2 emissions or MPG target (in the case of MY2015, 271.4 g/mile or 32.7 mpg in MY2015). Converting this target value to emission or fuel economy compliance values is then done as shown in Figure 2 below.

Figure 2. Illustration of Dual EPA GHG and NHSTA CAFE Compliance Demonstration



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[1] The California program combines the passenger cars and T1's (light trucks that weigh less than 3750 lbs loaded vehicle weight) and creates a separate category for T2's (heavier light trucks that weight more than 3750 lbs, but less than 8500 lbs gross vehicle weight).

[2] Adoption of an attribute-based system, however, does not impact the calculation in this paper of industry-wide GHG targets. It would impact the target which individual manufacturers would need to meet. The analysis of such is beyond the scope of this paper.

[3] The California Program has different standards for "Intermediate Volume Manufacturers" (manufacturers that sell less than 60,000 vehicles per year in California which is roughly 0.3% of total annual vehicles). Since it's not clear how an EPA GHG program would treat such manufacturers and because they are likely to make up a very small fraction of the national fleet, for simplicity we assume that all manufacturers are included in a national program.

[4] US Department of Energy, Energy Information Agency, *Annual Energy Outlook 2009*, table 57.

[5] For alternative fuel vehicles that have tailpipe CO_2 emissions (natural gas, LPG and dedicated E85), CARB provides a "fuel adjustment factor" to account for the difference in production emissions. For vehicles that have not tailpipe emissions (battery electric, hydrogen internal combustion engine, and hydrogen fuel cells), CARB provides an emissions factor that represents the net emissions benefit over the entire fuel cycle of displacing gasoline. Note this full fuel cycle, GHG credit system is different from how the CAFE system credits alternative fuels for fuel economy purposes.

[6] It is important to not that the FTP test cycle (sometimes called the "2 cycle test" since it contains a city and highway drive cycle) does not account for the fuel burned by air conditioning operation (air conditioners use a compressor that is connected to the engine by a belt). Because there is no accepted air conditioning test cycle for fuel economy or CO_2 purposes, CARB has chosen to not add these emissions to its standards, but instead incentivize improved AC systems by providing GHG credits against the FTP cycle GHG emission levels. AC emission reductions include both direct reductions in HFC-134a refrigerant emissions (either through low leak systems or replacing with a lower GWP refrigerant) and indirect CO_2 emission reductions through more efficient compressors.

[7] CARB 2008, *Comparison of Greenhouse Gas Reductions for the United States and Canada Under U.S. CAFE Standards and California Air Resources Board Greenhouse Gas Regulations*, an Enhanced Technical Assessment, February 25, 2008, http://www.climatechange.ca.gov/publications/arb/ARB-1000-2008-012/ARB-1000-2008-012.PDF.)

[8] This value accounts for reduction in HFC leakage and efficiency improvements that reduce tailpipe CO_2 emissions. Air conditioning system changes allow manufacturers to meet GHG targets with less reduction in tailpipe CO_2 emissions through drive-train improvements. Recent developments (the imminent commercialization of a new refrigerant, HFO-1234yf with a global warming potential less than 1/300th that of the current refrigerant) suggest even larger reductions could be feasible by model year 2015.

[9] For this calculation, we simply assume that the fleet is composed of gasoline vehicles. Since diesel fuel has higher CO2-equivalent emissions per gallon of fuel than gasoline, the MPG target will be slightly underestimated using this assumption.

[10] According to the Energy Information Agency of the US DOE, of the over 6 million FFVs on the road, only about 300,000 (about 5 percent) actually run on E85. These are almost all centrally refueled fleet vehicles.

[11] Air conditioning improvements at the 50 percent level does not assume refrigerant change. Rather, it simply assumes, low leak systems through tighter seals and more efficient compressors (known as "variable displacement compressors and are common on cars in Europe). FFVs are estimated to cost automakers $50 per vehicle and the Detroit based manufacturers all have committed to building large volumes of FFVs.