Appendix B

Review of the Agencies' Technical Analysis Supporting the SAFE Vehicle NPRM

Supporting Report for Environmental Defense Fund Comment on Environmental Protection Agency and National Highway Traffic Safety Administration Proposed Rule, *The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule for Model Years 2021–2026 Passenger Cars and Light Trucks*, 83 Fed. Reg. 42986 (Aug. 24, 2018)

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I. Introduction

This Report reviews key aspects of the technical analysis that purportedly supports the National Highway Traffic Safety Administration's (NHTSA) and the Environmental Protection Agency's (EPA) recent proposal to flatline vehicle greenhouse gas emission and fuel economy standards for model years 2021 - 2026, published in the Federal Register (FR) on August 24, 2018. (Hereafter, we will refer to NHTSA rather than "the Agencies", as it is clear that NHTSA staff performed the technical analysis on behalf of both NHTSA and EPA). We discovered a large number of major problems with NHTSA's technical analysis supporting their proposal, including substantial bias reflected in many decisions and assumptions made relating to these analyses. Taken together, these problems are serious and render the current proposal unlawful -- both because the analysis is fatally flawed and arbitrary and because, by seeking to bury these flaws in a series of otherwise opaque models, NHTSA fails to satisfy it legal obligations to provide for adequate notice and public opportunity to comment. As we demonstrate in the last section of this Report, correcting these deficiencies demonstrates that the proposal, if finalized, will result in substantial societal costs, including major adverse health impacts. The only conclusion which can be drawn from this Report, and similar reviews by others, is that the proposal should be completely withdrawn.

The remainder of this Report addresses the key flaws in NHTSA's technical analysis. The final section presents our own technical analysis of the proposal using NHTSA's CAFE Compliance and Effects Model (hereafter referred to as the Volpe Model) and many of the inputs to this model developed by NHTSA. Before delving into the details, we present a short summary of our findings concerning 1) the utter lack of transparency in the Volpe Model and 2) the substantive flaws with NHTSA's modeling.

This report makes numerous references to the review and use of outputs of the Volpe Model, both runs performed by NHTSA and runs performed by us. The spreadsheets containing the relevant output from the Volpe Model and all of the calculations involved in processing these outputs into the result presented here are being submitted to NHTSA as part of these comments on the proposal. These spreadsheets, along with modified Volpe Model input files are described in a Readme file included along with the spreadsheets.

II. The Volpe Model is Not Transparent

NHTSA nowhere describes (and It is nearly impossible to understand) exactly how the "Volpe Model" operates and the key assumptions and constraints that drive the model's outputs. (For readability, we will sometimes refer to the Volpe Model in this section simply as "the model". References to other models or modules within the Volpe Model, such as the scrappage model will be made explicitly (e.g., the scrappage model or module)). This was true for the version of the model used for the Technical Assessment Review (TAR). It is far more true today.

The fundamental purpose of the Volpe Model, the reason it was developed in the first place, is to simulate the application of technology to enable manufacturer's compliance with CAFE standards. Yet the way that the Volpe model navigates through its maze of individual technologies is almost entirely opaque, despite numerous versions of model documentation and general descriptions of model operation in previous rulemakings and the TAR. The model follows assigned paths when it evaluates the effective cost of various technologies when it is attempting to find the least cost approach for a manufacturer to meet a CAFE standard. The model has been designed to "skip over" technologies which are not as cost effective as technologies further down the path. But how does the model exactly do this? When the model looks further down a particular technology path in case there is a more cost effective technology, is it also looking further down other technology paths, or can it only perform this "skipping" on one path at a time? Does it evaluate changes to two technologies at a time, as synergies between technologies are usually present? This does not appear to be the case.

As we describe in detail below, the model in its current configuration does not accomplish this fundamental task well. By examining model outputs, a user can surmise that some individual technologies are not cost effective. However, simply eliminating these technologies from the options that the model has to choose from reduces the model's projected compliance costs. This should not be possible if the model was accomplishing its fundamental task, and it is not clear why technologies that are not cost-effective are even included in the list of available technologies in the first instance. Though it is clear the model produces irrational results, identifying the root cause of this irrationality requires labor-intensive and highly-technical examination of the model's source code. At the same time, it is not clear whether forcing the model to skip over cost ineffective technologies produces appropriate cost projections. NHTSA never discusses this option and never describes how such technologies can be appropriately removed from the model's list of available technologies and how this cannot be done. Yet NHTSA itself does this in a sensitivity case when they enable the application of HCR2 technology for all manufacturers, but continue to force the model to skip over the previous HCR technology for most of the 2016 vehicle fleet. Can this be done be for other technologies? As is obvious from the work done by other reviewers (e.g., the National Resource Defense Council (NRDC)), one has to examine the source code of the model, try to understand what NHTSA is actually doing inside the model, recode the model to correct errors, and then rerun the model, etc.

It is likewise difficult, if not impossible at a practical level, to evaluate NHTSA's specific estimates of the effectiveness of particular control technologies. These values were previously contained in the Technology file, though now appear in a file located in an unspecified directory on the user's hard drive. This FC1_Improvements.csv file contains estimates of the overall effectiveness of more than 145,000 combinations of technologies for each of 10 vehicle sub-groups modeled separately in the Volpe Model. Accordingly, to identify the effectiveness of any particular individual technology, a user needs to isolate two of these 145,000 combinations that are in all ways identical other than with respect to application of the particular technology. The incremental benefit of this technology must then be calculated and compared to other estimates of its effectiveness. While some of NHTSA's costs assumptions are more readily accessible, others (including battery costs) are similarly difficult to discern. Accordingly, the process for identifying these key inputs related to cost and effectiveness is laborious, and in many cases, practically impossible, preventing meaningful comment on NHTSA's proposal.

NHTSA modified the Volpe Model to simulate manufacturers' compliance with EPA's CO2 emission standards. However, many of the restrictions on compliance options related to CAFE compliance remain. NHTSA does not describe the CAFE-related restrictions which have been removed and which remain. NHTSA does not describe how the remaining restrictions affect the costs projected by the model. Accordingly, the public cannot easily evaluate whether and how NHTSA has accomplished these stated goals, including finding the lowest cost compliance option for each manufacturer. However, the results presented below along with the extensive reviews by others demonstrates that the model fails in this regard.

For example, both NHTSA and EPA have enabled manufacturers to generate substantial amounts of credits which can be used for compliance against the CAFE and CO2 standards, respectively. There is no way to determine how the Volpe Model allows or disallows manufacturers' use of these credits from the documents provided by NHTSA for public review. The public must again examine the model code, find where in a set of hundreds of files the model is performing the task of interest, understand what this particular subroutine is doing, as well as how it interacts with the rest of model, and then determine if its operation is consistent with the model's stated purpose and any statutory requirements imposed by the Clean Air Act or EPCA.

The addition of the sales response, fleet share and scrappage modules to the most recent version of the Volpe Model work to obscure the bases for NHTSA's results in several additional lawyers of modeling opaqueness. For example, the sales-response module ostensibly predicts the effects of varying CAFE and CO2 standards on the sales volumes of new vehicles. However, the sales response module also controls (and thus, affects) new vehicle sales even when there are no CAFE or CO2 standards being applied (i.e., NHTSA's typical 1.0 mile per gallon (mpg) scenario, which obviously every manufacturer already meets with its 2016 baseline fleet). When the sales-response module is disabled, the Volpe Model no longer refers to sales projections which are explicitly listed in the Parameters file and/or the Market file. There appears to be no way around this. Thus, the user (and reviewer) is forced to enable the sales response module in order to include any growth in new vehicle sales over time.

The scrappage model was ostensibly developed to address the impact of a change in new vehicle prices on the scrappage (and therefore use) of used vehicles. However, we found that the scrappage model is disconnected from the sales model and also affects the level of vehicle miles travelled (VMT) of used vehicles even in the case where no future CAFE or CO2 standards were being applied. The scrappage model is addressed below in both the section dealing with NHTSA's 1977-2029 MY analysis and the section on the scrappage model itself. There was one reference to the scrappage model under NHTSA's description of its new mileage accumulation schedules, but no detailed description of this interaction. Again, disabling the scrappage module had more effects on the operation of the Volpe Model than simply eliminating the difference in vehicle scrappage between various control scenarios--interactive effects which NHTSA nowhere describes and are difficult to discern absent examination of the models underlying source code.

The new NHTSA scrappage model also contains statistical terms relating to the fuel cost per 100 miles for new and used vehicles. The sign (directionality) of these terms are opposite for cars/vans/SUVs and pickups. NHTSA never discusses this fact. One set of terms is likely consistent with NHTSA's theory that the higher the new vehicle fuel economy, the higher the odds that used vehicles will be scrapped. Presumably the other set reflects the opposite effect and is inconsistent with NHTSA's own economic theory. As with other aspects of the models, NHTSA does not plainly describe this anywhere, nor can the scrappage model be disabled without affecting other aspects of the models, so these effects cannot be easily disentangled by the user.

The Volpe Model evaluates manufacturers' compliance with the standards through model year 2032. The Volpe Model then extends this 2032 fleet into the future to allow for further evaluation of costs and benefits. NHTSA does not describe exactly how this 2032 fleet is extended into the future. One might have thought that the 2032 vehicle fleet would be held constant, maybe with some shifts in car and truck sales based on an external source, like EIA's Annual Energy Outlook. Possibly the continued application of learning would be applied to continue to reduce technology costs, consistent with what was done up to 2032. What we found, again from reviewing the detailed Volpe Model output, was very different. NHTSA stopped applying learning to technology costs after 2032. Instead of holding fuel economy constant given no change in the CAFE or CO2 standards, NHTSA assumed that fuel economy would improve at no cost. These assumptions are inconsistent with the trends prior to 2032, where costs would decrease and fuel economy would stay constant. Instead, costs stay constant and fuel economy increases. Both inconsistencies inaccurately minimize the true impacts of the proposal, which is in fact the one consistent finding of our review. And importantly, all of this is completely non-transparent to the reader of the proposal.

The application of CO2 credits in NHTSA's analyses is also not transparent. NHTSA generally describes it application of CAFE credits in the proposal. However, since NHTSA believes that it cannot use these credits when assessing the feasibility of future standards, it largely doesn't use them in its analyses. While NHTSA claims to have modified the Volpe Model to simulate compliance with the CO2 standards, and accordingly claims that it can be used to fulfill the requirements of the Clean Air Act, it did not modify its application of credits when the Volpe Model is being used to model CO2 standards.[1] There was no way to understand how the Volpe Model applied credits under either the CAFE or CO2 standards without deciphering the source code of the model itself.

NHTSA's use of the Volpe Model for the proposal includes two assumptions which dramatically affect NHTSA's projection of the effect of the proposal on national fuel consumption. One is the assumption that manufacturers will apply "cost effective" technology to their vehicles whether this technology is required to meet the standards or not. This causes the Volpe Model to predict that manufacturers will over-comply with the proposed CO2 standards by 11 grams per mile (g/mi). This over-compliance drops to 1 g/mi for the current CO2 standards. This assumption is addressed in detail below. For our purposes here, NHTSA does describe this assumption in the proposal, conducts a sensitivity analysis around this assumption and presents some very condensed results of these

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[1] See comments on the proposal by NRDC for a detailed discussion of this issue.

sensitivity analyses. What NHTSA does not do is point out that changing this payback period affects the model's determination of the most "cost effective" technology needed to meet the standards being analyzed. While the sensitivity analyses affect the degree of over-compliance with the proposed standards, they also reduce the efficiency at which the Volpe Model complies with both the current and proposed standards. Thus, the sensitivity analyses do not actually reflect what they are designed to indicate.

The other assumption regarding over-compliance is NHTSA's projection that fuel economy will continue to improve in the years after the Volpe Model stops evaluating compliance with the CAFE or CO2 standards. This is also addressed in more detail below. However, for our purposes here, it is important to point out that NHTSA does not mention this anywhere in its proposal and we were only able to identify this feature by running the model ourselves and cross referencing the model documentation (which includes no justification for the specific numbers cited for the growth of passenger car and light truck fuel economy (0.76% and 1.29%, respectively)). The documentation only referred to an assumption that currently unknown and unidentified technology would be developed in the future. This assumption reduces the impacts of the proposal and, importantly, was completely hidden.

There are many other instances of this pervasive lack of transparency throughout the rulemaking--failure to disclose assumption, shielding key aspects of the model's operations, and obscuring the interactive effects of various of the individual modules. Commenters cannot meaningfully comment (and therefore the agencies cannot satisfy their administrative law obligations to provide for notice and comment) if the agencies simply provide model outputs without explaining, evaluating, and opening to public scrutiny the key assumptions and processes that led to those conclusions. These are fatal defects in the proposal, and accordingly, the agencies should immediately withdraw it.

III. There is Clear Bias in the Technical Analysis Behind the SAFE Vehicle Rule

Notwithstanding these difficulties in simply understanding the model's operation, our review found numerous aspects of NHTSA's technical analysis to be severely biased and fundamentally flawed.

First, NHTSA altered a typical analysis of the costs and benefits motor vehicle standards over a set of model years (MYs) so that it fully assessed the purported impacts of these standards on the used vehicle fleet (where NHTSA's analysis shows that the costs of these standards exceed their benefits), but only very partially assesses the impacts of the standards on the new vehicle fleet in these same years (where benefits would exceed costs). This approach arbitrarily fails to assess all impacts of the standards in the model years that NHTSA purports to evaluate and likewise deeply distorts the true impacts of the standards.

Second, NHTSA developed an entirely new scrappage model without presenting the underlying data used to develop the model, nor any substantive detail regarding the statistical analyses performed. While NHTSA argued that increased new vehicle sales would increase the scrappage of used vehicles, NHTSA's scrappage model removed 2-10 times as much national VMT as was added by new vehicle sales. This reduced national vehicle miles travelled (VMT) under the proposed standards runs contrary to the economic theory presented by NHTSA as undergirding the model (which we and others have elsewhere critiqued as flawed). This completely irrational reduction in VMT alone produces roughly half of the benefits of the proposal. NHTSA tries to explain this irrational result by indicating that reviewers new to this concept will find it difficult to accept. But the argument that they present still violates their own economic theory.

Third, NHTSA developed entirely new "sales response" and "fleet share" models. The sales response model predicts the impact of macroeconomic factors and new vehicle prices on the sales volume of new passenger cars and light trucks. The fleet share model predicts the share of new vehicle sales which are cars and light trucks, respectively. NHTSA did not provide the data underlying either of these models for review and comment. NHTSA did not disclose the statistical analyses used to develop either model. The sales response model only responds to vehicle prices, not vehicle fuel economy. The fleet share model only responds to vehicle fuel economy and not prices. The proposal affects both vehicle prices and fuel economy. NHTSA's decision to base the sales response model on prices and the fleet share model on fuel economy both minimize the harmful impacts associated with the proposal, reflecting similar biases that run throughout NHTSA's analyses.

Fourth, NHTSA revised its mileage accumulation schedules (the level of annual VMT versus age) for cars and light trucks using data which could not be released for review and thus, could not be commented on. These new schedules reduced the lifetime VMT for cars and light trucks by one-third, reducing the cost of the less stringent proposal proportionately. NHTSA did not make any effort to confirm if the new mileage schedules were consistent with national gasoline consumption based on tax receipts. In fact, the new mileage schedules under-predict national gasoline consumption to the same degree or more that they reduced lifetime mileage using the previous mileage accumulation schedules. These biased and unfounded assumptions again work to reduce the costs of the proposal and its effect on national fuel consumption and CO2 emissions and all types of emissions from refineries (which have a substantial impact on public health, as will be quantified below).

Fifth, NHTSA assumes that manufacturers will apply “cost-effective” technology to reduce fuel consumption and CO2 emissions beyond that needed to meet CAFE and CO2 standards, contrary to their historical practice. NHTSA refers to historical data which reflect such application of technology. However, NHTSA does not discuss the price of fuel during this time frame. During periods of low, steady fuel prices, which NHTSA predicts will be the case in its analyses, manufacturers do not improve fuel economy. It again works to reduce the impact of the proposal on national fuel consumption and CO2 emissions and all types of refinery emissions.

Sixth, NHTSA projects continuous fuel economy improvements beyond 2032 based on unknown and unidentified technology at no cost under all scenarios. This increased fuel economy has no effect on the relative cost of the alternatives being considered. Again, this assumption was not identified in the proposal and is not supported by any analysis. It again serves to reduce the impact of the proposal on national fuel consumption and CO2 emissions and all types of refinery emissions.

Seventh, NHTSA assumes that most of the crude oil needed to provide additional fuel required under the proposal will be produced overseas and half of this fuel will be refined overseas. NHTSA makes these assumptions despite identifying the energy independence of the U.S. as a rationale supporting the proposal. Again, this serves to substantially reduce all types of refinery emissions.

Eight, NHTSA increased its estimate of the rebound effect from negative 10% to negative 20%. This further reduces national VMT under the proposal, which again reduces the impact of the proposal on national fuel consumption and CO2 emissions and all types of refinery emissions. While the proposal affects both vehicle price and fuel economy, NHTSA’s analysis of the rebound effect focused primarily on fuel price. Changes in fuel economy were not considered in most of the rebound studies cited by NHTSA. Changes in vehicle price were never addressed. Again, this was directionally favorable to the proposal. While NHTSA assumes equal, offsetting benefits for the costs of fatalities and non-fatal crash costs and the value of this additional driving NHTSA still counts all of the above positive, physical impacts in its total of impacts associated with the proposal. It’s 20% rebound estimate was responsible for fully half of the reduction in fatalities touted by the proposal.

Ninth, NHTSA used flawed logic to determine the most cost effective approach to complying with the CAFE and CO2 standards. We demonstrated that eliminating less cost efficient technology from the Volpe Model lowered the model’s projected compliance cost. Other reviewers found severe problems with NHTSA’s estimates of the costs and effectiveness of individual technologies. NHTSA also unreasonably restricted the use of several highly effective technologies from use. These deficiencies doubled NHTSA’s projected compliance costs compared to its own analysis performed only two years ago for the Technical Analysis Review (TAR), which was still based on an inefficient application of technology.

We show that correcting only some of these biased assumptions changes the proposal from producing a net societal benefit to producing sizeable net societal costs. We also show that instead of saving thousands of lives by getting less safe vehicles off of the road, the proposal is likely to increase thousands of deaths from increased ambient levels of fine particulate matter (PM). Thus, the very title of the proposal, “SAFE”, is biased and misleading. This bias is directly at odds with the objectives of EPCA and the Clean Air Act to improve fuel economy and to reduce emissions of air pollutants which contribute to endangerment of public health and welfare, respectively. The net result of these findings makes it imperative that the proposal be withdrawn.

The bulk of the remainder of this review describes the flaws we found in NHTSA’s analysis . The review concludes by developing alternative projections of the costs and benefits of the proposal based on justifiable assumptions.

IV. The 1977-2029 Model Year Lifetime Analysis

One of the many new aspects of NHTSA's modeling of vehicle use introduced in the NPRM is an analytical concept of how to evaluate various CAFE and CO2 control scenarios. This concept is a comparison of the costs and benefits of the various control scenarios across the vehicle lifetimes of 53 model years: 1977-2029. While a model-year lifetime analysis is not new, as we discuss below, the way NHTSA combines the vehicle operation of used and new vehicles in a model year analysis is new and extremely biased. Before delving into the details, it is worth reviewing the basic way that NHTSA's Volpe Model works and how its output was used in this 1977-2029 MY analysis.

The Volpe Model and the 1977-2029 Analysis

NHTSA developed the Volpe Model to simulate manufacturers' application of technology to meet CAFE standards.[2] Regarding its application supporting this proposal, the model starts out with a 2016 model year fleet including sales, the fuel economy and CO2 emission levels of each vehicle, a description of the engine and transmission utilized by each vehicle and the fuel saving technology already utilized. The model then determines each manufacturer's CAFE (or CO2) emission target for MYs 2017-2032 based on the sales and footprint of each vehicle model. The model then purports to determine the technology best suited to enable compliance in each model year by each manufacturer at the least cost. The model then calculates the cost per vehicle for each manufacturer and model year, the total application of each technology, and the final fuel economy (or CO2 emission) level. The Volpe Model repeats this procedure for each set of CAFE (or CO2) standards being evaluated in that run.

The user has the option of having the Volpe Model evaluate model years beyond 2032 and calculating various factors on a calendar year basis, such as VMT, fuel consumption, CO2 emissions, criteria pollutant emissions, air toxic emissions, traffic fatalities and other economic impacts. If this is done, the Volpe Model assumes that the 2032 MY standards are continued through MY 2050. The model no longer evaluates manufacturers' compliance with the CAFE or CO2 standards, but the 2032 MY fleet is extended into the future *en masse*. One might assume that the 2032 MY fleet is projected into the future without change. However, this is not true. Thus, it is not simply an exact repetition of MY 2032 vehicles. One feature of this post-2033 fleet that is assumed to remain constant into the future is its average cost of compliance. In contrast, the fuel economy of post-2032 vehicles is projected to improve, as already mentioned. While the model stops modeling "new" vehicles with the 2050 MY, it continues modeling their use until the last one is scrapped, which is assumed to occur in CY 2089.

The Volpe Model produces about 10 output files. One file contains detailed descriptions of each vehicle model as it is modified by the addition of technology. Another file describes manufacturer level projections, such as fuel economy and CO2 emission levels, average technology costs, etc. Another file contains fleetwide estimates of VMT, fuel consumption, emissions, traffic related fatalities, etc. for each model year of vehicles in each calendar year. A fourth file contains fleetwide estimates of the economic

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[2] This presentation should be considered an overview focusing on the features of the Volpe Model most relevant to the proposal and our review of the proposal. The reader desiring a more in depth understanding of the Volpe Model should refer to the NHTSA website which provides information on various versions of the model, as well as documentation on how to use the model: https://www.nhtsa.gov/corporate-average-fuel-economy/compliance-and-effects-modeling-system.

value of technology, fuel use, emissions, traffic related fatalities, non-fatal accidents, etc. for each model year of vehicles in each calendar year.

The 1977-2029 MY lifetime analysis draws most of its relevant information from these last two files: the Annual_Societal_Effects_Report.csv file and the Annual_Societal_Costs_Report.csv file. In particular, it selects projections of all the relevant factors for MY 1977-2029 vehicles. This runs from 1977 MY vehicles operated in calendar year (CY) 1977 to MY 2029 vehicles operated in CY 2068.

NHTSA performed a 2016-2028 MY lifetime analysis for the TAR.[3] Starting with MY 2016 made some sense at that time, since NHTSA was utilizing a 2015 MY baseline fleet. Thus, 2016 represented the first model year in which technology was added. NHTSA does mention in the TAR why it chose to end the analysis with the 2028 MY (TAR, page 13-102 where the results of this analysis are presented).

At that time, the application of technology to one model year's vehicles had absolutely no impact on the operation of vehicles of other model years. For that analysis, NHTSA would have selected relevant information from the same two files mentioned above for MY 2016-2028 vehicles. These projections would have run from 2016 MY vehicles operated in CY 2016 to MY 2028 vehicles operated in CY 2067. Overall, the analysis showed the Augural CAFE standards produced net benefits over this range of model years, discounted at 3% per year. As this was consistent with the findings of the final rule establishing the Augural standards, this was not surprising and garnered little attention.

For the NPRM, as already mentioned, NHTSA developed a scrappage model which created a connection between any one future model year and the 39 previous model years of vehicles. This introduced a connection between 2017 MY vehicles and vehicles as old as 1978 MY vehicles, which is ostensibly why NHTSA changed its MY analysis from 2016-2028 MY to 1977-2029 MY. Of course, it is impossible for a change in standards in the 2021 MY to affect vehicle operation in 1977, especially for an analysis conducted in 2018. So labeling the inclusion of 1977 MY vehicles as an extension of the "model years" covered by the analysis is misleading. As it turns out, 1977 MY vehicles were not affected at all. The inclusion of their operation simply added to the total of any factor addressed by the analysis (VMT, fuel consumption, etc.). Model year 1978 vehicles were the earliest vehicles affected and then only affected in calendar year (CY) 2017. Model year 1979 vehicles were only affected in CY 2017 and 2018, and so on, which we discuss more fully below.

This extension of the included model years into the past represented NHTSA's belief that sales in the near future (e.g., 2017 MY) could affect older vehicles still on the road. However, the design of the Volpe Model meant that sales of vehicles from the 2030-2068 MYs affected the operation of 1977-2029 MY vehicles (i.e., those vehicles included in the analysis). This last feature of the analysis was not mentioned by NHTSA in the proposal. Yet this effect of vehicles ostensibly excluded from the analysis on vehicles included in the analysis has a large impact on the results of the 1977-2029 MY analysis. Once again, this approach makes the costs and benefits of the proposal look more favorable than is actually the case.

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[3] Unlike the proposal, this MY lifetime analysis did not receive much billing. It was described on the very last page of a 1200 page document.

As will be discussed below, analyzing a range of model years which primarily includes the transition to an assumed long term standard is unreasonable, as it give little weight to that final standard level.

NHTSA's 1977-2029 MY Lifetime Analysis

NHTSA's model year analysis in the TAR covered MYs 2016-2028. As NHTSA changed its "baseline" fleet from 2015 MY in the TAR to 2016 in the proposal, it would have been consistent for NHTSA to shift this MY analysis to begin with MY 2017.

NHTSA chose model year 1977 as the first year of this analysis presumably because it ostensibly represents the oldest vehicles affected by MY 2017 vehicles using NHTSA's new scrappage model.[4] NHTSA never actually describes why MY 2029 was chosen as the final year in this 53 model-year analysis. On page 43254 of the preamble to the rule, NHTSA states that the impact of the 2021-2025 standards on manufacturers and their vehicles standards "stabilizes" in the 2030 MY. Thus, ending the 1977-2029 MY analysis in MY 2029 does not even include the first year of the complete effect of the CAFE and CO2 standards being evaluated. At best, this 1977-2029 MY analytical concept can be described as an analysis of the introduction or ramp-up of the various control alternatives. It certainly cannot reflect, as NHTSA purports, a thorough analysis of the long term effects of the various control alternatives.

Simply extending the model year analysis to MY 2030 would not address the fundamental inappropriateness of this multi-"model year" analysis. Absent the more severe problems discussed below, it would still be an analysis of the initial implementation of the various regulatory alternatives.[5] A legitimate analysis would ascertain the effects of the proposal over the lifetime of the vehicles directly affected by that proposal, as both agencies have done in the past rulemakings, which is described further below. It is noteworthy that NHTSA ends its new analytical concept with the model year where the standards are nearly stabilized, as opposed to starting with this year. The MY analysis for the TAR ended with the 2028 MY. However, at that time, there were no scrappage effects on older vehicles. This should make it clear, even at the outset of this review, that NHTSA's purpose in developing the concept of a 1977-2029 MY analysis is not on a thorough assessment of the various alternatives.

Uncertainty in projecting the impacts of CAFE and CO2 standards into the future cannot be a reason for excluding the impacts of the standards on model years after 2029. NHTSA's 1977-2029 MY

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[4] Actually, in the Volpe Model analyses used to support the NPRM, there are no MY 1977 vehicles on the road in 2017 when the 2017 MY vehicles are first sold. (MY 2017 is the first year that technology applied in NHTSA's analysis, so 2017 is the first year that these sales can affect the use of used vehicles.) The Volpe Model only tracks vehicles through their 39th year of use, with the first year of use labeled as year 0, versus year 1. Thus, MY 1978 vehicles are actually the first vehicles affected by scrappage. The person or group at NHTSA who came up with this approach to evaluating the standards was apparently not familiar with the Volpe Model. They were not aware that the "40 year" life over which the Volpe Model tracks is inclusive and includes the first year of operation (i.e., runs from 1977 to 2016.) The inclusion of the 1977 MY in the analysis causes no error, as the operation of MY 1977 vehicles is completely unaffected by any of the CAFE or CO2 control scenarios evaluated by NHTSA. However, its inclusion in dozens of tables describing the impacts of the various control scenarios analyzed by NHTSA shows the lack of accuracy and inattention to detail which permeates analyses underlying the proposal.

[5] See, e.g. 77 FR at 62920 (Oct. 15, 2012) (estimating costs of MY 2017-2025 GHG standards through 2050); id. at 63060 (estimating fuel use impacts of augural standards through 2060)

analysis is based on vehicle use through calendar year (CY) 2068, the last year that MY 2029 vehicles are projected to be on the road. As will be discussed in detail below, the scrappage impacts modeled by NHTSA and included in the 1977-2029 MY analysis are based on the price and fuel economy of 2030-2068 MY new vehicles. Thus, NHTSA's 1977-2029 MY analysis assumes that they can accurately predict the future out to at least 2068. Again, the only reason for excluding 2030 and later MY vehicles appears to be that this decision makes the proposal look better, as is spelled out in great detail below.

Overview of the Rationale for a "Model Year" Analysis

People live and drive in real time. Vehicle standards introduced in a particular model year begin affecting vehicles on the road in roughly the analogous calendar year. (The model year typically begins a few months earlier than the analogous calendar year and some of "new" vehicles continue to be sold in the next calendar year.) Thus, changing CAFE and CO2 standards beginning in the 2021 model year only begins to affect sales in late calendar year 2020 and primarily during CY 2021. Regulatory analyses therefore typically evaluate the costs and benefits over a series of calendar years starting with the introduction of the regulatory change. The number of calendar years evaluated typically is large, as the technological changes involved in compliance often involve capital improvements. These improvements entail an upfront cost, which provides benefits for many years into the future. This is true of vehicle regulation, as the cost of redesigning a vehicle are felt at the time of vehicle purchase, but affect operation over the next 30-40 years. One weakness of the calendar year analysis is that it always ends with a substantial set of vehicles which have received a capital investment in the form of new technology, but which have not yet completed their useful lives and provided the benefit of this technology on the environment.

An alternative to the "calendar year" analysis was developed to appropriately compare the upfront investment with the ensuing benefits without extending the number of calendar years to an unwieldy number. This was the "model year" lifetime analysis. The model year analysis begins with the sale of vehicles in a particular model year and tracks the impacts of vehicle design changes over its lifetime, be these changes in traffic fatalities or emissions. It is simpler than conducting a calendar year analysis over 30-40 calendar years. It also avoids the problem that even after 30 years, a calendar year analysis excludes the benefits already paid for in the last years of the analysis. With a model year analysis, both the upfront capital cost is included, as well as all of the vehicle use which is affected by this technology.

NHTSA has performed model year analyses in the past, like that done for the TAR, but only for the model years of vehicles to which the new standards applied.[6] In this NPRM, NHTSA extended this analysis back to earlier model years, due to its new scrappage model. The unreasonable impacts of NHTSA's scrappage model is discussed below. Here, we focus solely on the appropriateness, or even-handedness, of NHTSA's 1977-2029 model year analysis in theory, even assuming that there is an effect of new vehicle standards on new vehicle sales and used vehicle operation.

The appropriateness of any model year analysis hinges on the premise that the operation of the vintage of vehicles included in the analysis is independent of the operation of both older and newer vehicles. We are not aware of a single previous "model year" analysis that included the impact of those vehicles on vehicles with another model year's vintage, nor vice versa. It is likely that this is the first time

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[6] 77 fr at 63060 is an instance.

that anyone has tried to conduct such an analysis. The inclusion of this effect of new vehicle prices on older vehicles should have been preceded by a thorough evaluation of the whether such an analysis was both feasible and appropriate. Instead, NHTSA simply introduces this new concept and focuses it evaluation of the various control scenarios on it.

NHTSA's unarticulated reasoning is that 2017-2029 MY vehicles affect the use of vehicles on the road during CY 2017-2029. Thus, it included all used vehicles on the road during this time period in their assessment of the standards. Again, leaving the numerous technical problems with the way that NHTSA projected these impacts on older vehicles, the fundamental analytical problem is that NHTSA portrays such changes in older vehicle operation as "model year" effects when they are really effects which occur during calendar years when the 2017-2029 vehicles are sold. NHTSA hides the fact that the operation of 1991-2029 MY vehicles in its analysis (the vast majority of vehicle operation included in the analysis) is being affected by the Volpe Model's projection of the changing prices and fuel economy of 2030 and later model year vehicles. In other words, the Volpe Model is applying scrappage impacts in CY 2030 and beyond according to their nature: calendar year effects. In order to do so, it requires (and provides) vehicle prices and fuel economy levels for 2030 and later MY vehicles which differ across scenarios. But NHTSA's model year analysis ends with the 2029 MY. Thus, the benefits of 2030 and later MY vehicles are excluded from the analysis, but the scrappage effects of these vehicles are allowed to have a major impact on the results of the analysis. Nowhere does NHTSA mention this fact, which is obfuscated by labeling the analysis a "model year" analysis and selecting projections of vehicle operation from the Volpe Model output on this basis. The result was the inclusion of 38 years of post-2029 scrappage effects which reduce fuel consumption, CO2, criteria pollutant and air toxic emissions, accidents, noise, and fatalities under the proposed freeze without including the vehicles with higher fuel consumption and emissions which purportedly cause this increased scrappage of older vehicles. This is simply cherry-picking the results and reflects an extremely biased analysis.

Reviewing how scrappage actually works according to NHTSA's theory is essential to understanding how its existence should and should not be analyzed. The next step in demonstrating the inappropriateness of the NHTSA multi-model year analysis is to review how scrappage works in the Volpe Model.

NHTSA Scrappage Model

In their description of scrappage, NHTSA says that an increase in new vehicle prices will lead to a decrease in new vehicle sales. (Note that the direction here is from less stringent standards to more stringent standards, or the opposite of the direction of the proposal.) Since new and used vehicles are substitute goods, demand for used vehicles will then increase. Since the supply of used vehicles is limited, their prices will increase. This in turn will cause used vehicle owners to repair and continue to operate their used vehicles when they otherwise would have scrapped them. NHTSA argues that this effect of higher new vehicle prices propagates quickly due to the large number of used vehicle transactions occurring every year relative to the number of new vehicle transactions. In its statistical form, the likelihood of a used vehicle's survival in a particulate calendar year is predicted by its fuel cost per mile and the price and fuel cost per mile of new vehicles sold in that calendar year.

The first thing to note about this process is that it is the increase in price of new vehicles that starts this chain of events. For example, a change in the price of new 2021 MY vehicles under the current CAFE and CO2 standards affects the scrappage of used vehicles while this price increase is in effect, which is essentially CY 2021, plus and minus a few months. Should the price increase go away for any reason, the scrappage effect would presumably go away. There might be a lingering impact of previous scrappage changes for a year or two. But given how little documentation the agencies have provided on how the scrappage model works (in addition to the short comment period), we are currently not able to determine precisely how long the impact would last. In any event, without a recurring increase in vehicle prices, scrappage effects only occur in the calendar year over which the vehicle prices change. Since new vehicles of 20XX model year are basically sold in calendar year 20XX, this makes the scrappage effect a calendar year effect.

This temporary aspect of the scrappage effect can perhaps be more easily seen by considering a temporary imposition of a tax on new vehicle purchases of $1000. If such a tax were imposed, the cost of a new vehicle would presumably increase by $1000, as manufacturers would be reluctant to absorb the cost of the tax. The tax would apply to all manufacturers, so it would not affect competition at least within market segments. Consumers would receive no direct benefit from the higher vehicle price. Thus, one would expect new vehicle sales to decrease. If the tax was revoked at some later date, new vehicle sales would presumably rise to previous levels. The increase in sales might even be a bit larger, as demand for new vehicles had been "pent up" for a time. Still, no one would expect future new vehicles sales to remain at their lower, tax-induced levels forever once the tax was removed.

The same thing was true for the Cash for Clunkers programs described by NHTSA in the PRIA. Offering people a cash payment for an older, but still operational vehicle could entice them to sell their vehicle and buy a new, more efficient one. But no one talks about or analyzes the long term effect of such temporary programs on vehicle scrappage or sales. NHTSA certainly does not when they analyze the effect of this program. These programs have an effect while they exist and have no effect once they end.

This is analogous to the situation with NHTSA's understanding of the effect of an increase in new vehicle prices on scrappage. There are differences at the appearance level, of course. Regulatory standards do not usually come and go, though some programs have been rescinded of late, as this proposal is attempting to do. Normal expectations are that once implemented, standards will remain in place. This masks the fact that the scrappage of used vehicles in CY 2030 and beyond in NHTSA's MY analysis is being affected by the price impacts on 2030 and later MY new vehicles. The CAFE and CO2 standards are not changing, so it might seem reasonable to assign any scrappage impacts in the future to "the 2025 standards". However, like the vehicle tax or scrappage incentive, any scrappage effect related to the CAFE and CO2 standards only continues as long as the program is affecting new vehicles. At a very fundamental, common sense level, it is only appropriate to include the scrappage effect of vehicles which are included in the analysis (i.e., 1977-2029 MY vehicles).

The following diagram attempts to show this relationship.

CY 2025		CY 2026 and beyond
Added Technology Increase in New Vehicle Price in 2025	→	Reduced fuel consumption, CO2 emissions, changes in safety, reduced upstream emissions, etc. over the useful life of the vehicle
↓		No effect
Reduced Scrappage and increased use of used vehicles in CY 2025 Leading to increased fuel consumption, CO2 emissions, changes in safety, reduced upstream emissions, etc. during CY 2025		

As is depicted in the diagram, the change to the design of new 2025 MY vehicles along with its cost affects the operation of 2025 MY vehicles over their entire lifetime. However, the effect of the increased price of these new vehicles only affects the use of used vehicles in the calendar year during which these new vehicles are sold. In order for there to be a scrappage effect in CY 2026, new vehicle prices must be increasing (relative to MY 2024 levels) in that year, as well.

Given their belief in an effect of new vehicle prices on used vehicles, NHTSA could have returned to a multi-calendar year analysis which is commonly used in regulatory analyses. All of the necessary information is made available in a run of the current Volpe Model, which we will demonstrate below. While the Volpe Model tracks vehicle usage beginning with the 1975 model year in CY 1975, the Volpe Model is not a time machine. Future standards cannot affect the past.[7] Thus, any vehicle usage occurring prior to CY 2017 shown in the model output is the same for every control scenario. Thus, the inclusion of the model years 1977-2016 in the title of the 1977-2029 MY analysis is highly misleading, intentionally or not. First, it implies that all of the operation of these vehicles is included in the analysis. While this is technically true, the vast majority of this operation is irrelevant to the analysis as it can't be affected by any future control scenario. Second, it also implies that what is going on has to do with "model years", which is incorrect and misleading. By characterizing the phenomena presumably occurring as relating to "model years", NHTSA increases its justification for ending the analysis early (i.e., MY 2029), as can often be justified with model year analyses. In reality, the higher prices of 2017-2029 MY vehicles simply did not and could not affect the operation of 1978-2016 MY vehicles over their lifetimes. The higher prices could not begin earlier than 2017 and could only affect used vehicle operation beginning in CY 2017.

Table 1 is a simple chart which describes the first 34 model years of vehicles potentially affected by NHTSA's proposal (2017-2050 MY) and the older model years of vehicles potentially affected by "scrappage". The Volpe Model tracks new vehicle designs and sales through MY 2050 and the operation

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[7] NHTSA, through the Volpe Model, does attempt to be time machine in that it projects technology which will be added to vehicles starting in MY 2017 and allows this technology to vary based on future CAFE and CO2 standards. This obviously cannot be realistic, since the 2017 fleet has already been completely sold. The vast majority of 2018 MY vehicles have also been already sold. The technology for the 2019 vehicles is already set and many vehicle models are already in production. To pretend otherwise is simply another way to reduce costs for the proposal relative to the current standards.

of these vehicles through CY 2089. The NHTSA MY 1977-2029 analysis simply focuses on select outputs from this broader simulation. Therefore, the model years shown in Table 1 go through 2050 simply for the sake of completeness. Its relevance will be discussed later below.

Table 1: Used Vehicles Affected by Potential Changes in the Sale of New Vehicles		
MY of New Vehicle Sales	Used Vehicles Affected	
	Newest	Oldest
2017	2016	1978
2018	2017	1979
2019	2018	1980
2020	2019	1981
2021	2020	1982
2022	2021	1983
2023	2022	1984
2024	2023	1985
2025	2024	1986
2026	2025	1987
2027	2026	1988
2028	2027	1989
2029	2028	1990
2030	**2029**	**1989**
2031	2030	**1990**
…	…	**…**
2050	2049	**2011**

According to NHTSA’s theory about the effect of new vehicle prices on scrappage, Table 1 shows that prices of new 2017 vehicles will affect the scrappage of 1978-2016 vehicles. However, this impact only occurs in the 2017 calendar year. (As mentioned above, NHTSA argues that the scrappage effect will respond to changes in new vehicle prices and fuel economy quickly, so there is no assumed lag in the timing of the response. However, there are “lag” variables in the scrappage model which NHTSA did not describe or justify in any detail.) Thus, while 1978 MY vehicles are affected, they are not affected over their entire lifetime. Their use can at most be affected in their 39th year of life. Similarly, the operation of 1979 MY vehicles are only affected by the sale of vehicles in calendar years 2017 and 2018, or for the final two years of their life.[8] This reflects the fact that scrappage occurs in specific calendar years and can potentially affect all vehicles on the road, regardless of model year.

The problem arises as we move to the bottom of Table 1, highlighted in bold and yellow. According to NHTSA’s scrappage model, changes to new 2030 MY vehicle prices affect the operation of 1991-2029 MY vehicles. Changes to new 2031 MY vehicle prices affect the operation of 1992-2030 MY vehicles. Changes to new 2032 MY vehicle sales affect the operation of 1993-2031 MY vehicles, and so on. The Volpe Model assumes that the final CAFE or CO2 standards continue on infinitum (i.e., the 2025 MY standards under the current standards and the 2020 standards under the proposed freeze). The

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[8] The inclusion of the operation of used vehicles prior to its being affected by new vehicle sales is not the problem. This operation, by definition is the same under all the control scenarios evaluated by NHTSA since any decision made in this rule cannot affect the past.

model stops adding technology and evaluating compliance after the 2032 MY. After the 2032 MY, vehicle design is assumed to remain constant[9] and only absolute sales projections are changed. In other words, any changes in new vehicle price are. projected for 2032 is continued through the end of the modeling of the fleet (MY 2050 and CY 2089). [10] This happens whenever the Volpe Model is run in fleet analysis mode, which was used by NHTSA in their runs. The model output from which NHTSA then selects its “relevant” data reflects these assumptions. The model is not designed to cease applying an earlier standard and remove all of the technology added previously.[11] Thus, as late as MY 2050, the model is still assuming that new vehicle sales increase and used vehicle operation decreases under the proposal. In fact, this scrappage effect might continue even beyond the 2050 MY, as the operation of MY 2029 vehicles continues as late as 2068, when the last MY 2029 vehicles are assumed to be scrapped. This implies that the Volpe Model is actually assuming that the decrease in new vehicles prices is continuing until the last calendar year that vehicle operation is tracked, or 2089.

This inclusion of the scrappage effects of 2030-2068 MY vehicles in the 1977-2029 MY analysis is completely hidden in NHTSA’s description of the analytical tool, since MYs 2030-2069 do not appear in the label. The primary (and presumably desired) effect of this inclusion is the addition of an enormous amount of decreased operation of 1991-2029 MY vehicles in CYs 2030-2068 under the proposal. This reduces fuel consumption, CO2 and criteria pollutant emissions, accidents and fatalities to any standard which is projected to decrease vehicle prices. As will be demonstrated below, it creates a hurdle for any future regulation that appears to be impossible to overcome.

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[9] We will see below that NHTSA actually assumes that vehicle fuel economy will increase at a compounded rate of about 1% per year at no cost.

[10] We end with the 2050 MY, as this is the last year that the Volpe Model analysis includes. However, NHTSA is actually including scrappage effects due to the sale of new 2068 MY vehicles in their model year analysis, almost 40 years after ceasing to include the impacts of the control scenarios on new vehicles. This is demonstrated by the fact that the VMT per year of 2050 MY vehicles reflects the effect of NHTSA’s scrappage model even though no 2050 and later MY vehicles are included in the model.

[11] That is why the Volpe Model cannot model the present situation in a realistic manner. It cannot model manufacturers’ decisions for MY 2017-2019 assuming the current standards are in place and then begin assessing potential differences between standard scenarios. It looks like the Volpe Model can do this, as the standards which are fed to the model are consistent with the various control scenarios. However, the Volpe Model adds technology to 2017-2019 MY vehicles based on standards in effect in later model years. Thus, the model actually pretends that it can change history, when no model obviously can.

Table 2 compares the years of operation of various vehicles included in NHTSA's 1977-2029 MY analysis versus those years actually affected by changes in new vehicle prices of 2017-2029 MY vehicles.

Table 2: Used Vehicle Operation Included in the 1977-2029 MY Analysis Versus That Affected by the Sale of 2017-2029 MY Vehicles						
Used Vehicle Model Year	CYs of Operation Included in NHTSA MY Analysis		CYs of Operation Affected by Sale of New 2017-2029 MY Vehicles		CYs of Operation Affected by Sale of New 2030 and later MY Vehicles	
	Model Years	No. of MYs	Model Years	No. of MYs	Model Years	No. of MYs
Pre-2089	Pre-2089	1-11	Pre-2089	1-11		0
1989	2017-2028	12	2017-2028	12	2030-2028	0
1990	2017-2029	13	2017-2029	13	2030-2029	0
1991	2017-2030	14	2017-2029	13	2030-2030	1
1992	2017-2031	15	2017-2029	13	2030-2031	2
1993	2017-2032	16	2017-2029	13	2030-2032	3
1994	2017-2033	17	2017-2029	13	2030-2033	4
1995	2017-2034	18	2017-2029	13	2030-2034	5
1996	2017-2035	19	2017-2029	13	2030-2035	6
…..						
2017	2017-2055	39	2017-2029	13	2030-2056	26
2017	2018-2056	39	2018-2029	12	2030-2056	27
2018	2019-2057	39	2019-2029	11	2030-2057	28
2019	2020-2058	39	2020-2029	10	2030-2058	29
….						
2025	2026-2064	39	2026-2029	4	2030-2064	35
2026	2027-2065	39	2027-2029	3	2030-2065	36
2027	2028-2066	39	2028-2029	2	2030-2066	37
2028	2029-2067	39	2029-2029	1	2030-2067	38
2029	2030-2068	39	2029-2029	0	2030-2068	39

As shown in Table 2, all of the operation of 1991 MY vehicles occurs prior to 2030. Thus, any changes to the operation of 1991 MY vehicles which might occur is related to the sale of new 2017-2029 MY vehicles which are included in the analysis. However, starting with the 1992 MY, some of the operation of these vehicles included in NHTSA's MY analysis is modified because of changed scrappage patterns caused by 2030 and later MY vehicles. At the extreme end of the list, all of the assumed changes in the operation of 2029 MY vehicles are caused by the prices and fuel economy of 2030 and later MY vehicles.

This impact is reinforced by a comparison of the 1977-2029 MY analysis to that of either a 2017-2029 CY analysis or a 2017-2050 CY analysis. We choose this comparison as it is difficult to argue that an indefinite calendar year analysis would not be the best basis for comparing various regulatory alternatives. As mentioned above, we live in real time. Future standards cannot affect the past. Thus, it is appropriate to begin any regulatory comparison with its effective start date. Continuing the projection of regulatory impacts forever would include all of the potential impacts of the various regulatory options. Of course, in practice, there are both limits to the number of years which can be modeled, though with computers, this is not a large burden to absorb. Practically, one can simply continue to add calendar years to the analysis and find a point in time when the results cease to change significantly due to the repeated application of a finite discount rate.

A greater issue is uncertainty, as no one can predict the future. However, given that the Volpe Model is already being used in this way, extending this approach is not a hurdle to performing a more complete and fair analysis. Thus, we chose two multi-calendar year analyses for comparison. The first, which includes CYs 2017-2029, was chosen as this stops the analysis with the same model year selected by NHTSA as the end of their multi-"model year" analysis. The second, which includes CYs 2017-2050, was chosen as the Volpe Model does not model the operation of 2051 and later new vehicles.[12] Thus, including CY 2051 or later years would not be including a complete fleet of vehicles expected to be on the road in those years. Table 3 shows the relevant model years and calendar years of vehicle operation included in each case.

Table 3: Inclusion of Model Year/Calendar Year Combinations in Three Regulatory Analysis			
	1977-2029 MY Analysis	2017-2029 CY Analysis	2017-2050 CY Analysis
Operation of 1975-2016 MY Vehicles			
Prior to CY 2017	Included, but irrelevant, as operation unaffected by future standards	Operation excluded	Operation excluded
After CY 2016	Completely included	Included through CY 2029	Included through CY 2050
Operation of 2017-2029 Vehicles			
Prior to CY 2030	Completely included	Included through CY 2029	Included through CY 2050
After CY 2029	Completely included	Operation excluded	Included through CY 2050
Operation of 2030 and later MY Vehicles			
From CY 2030-2068	Scrappage effects included; operation of 2030 MY and later vehicles excluded	Completely excluded	Included through CY 2050
After CY 2069	Completely excluded	Completely excluded	Included through CY 2050

The table is broken down into three sections vertically. The first section addresses MY 1978-2016 vehicles, or those vehicles whose design is not affected by the proposal. The second section addresses MY 2017-2029 vehicles, or those vehicles whose design is affected by the proposal and which are included in NHTSA's 1977-2029 MY analysis. The third section addresses 2030-2050 MY vehicles, or those vehicles whose operation is excluded from NHTSA's analysis, but whose scrappage effects are included. In each section, we identify one or two groups of calendar years that show how these three different approaches affect analytical outcomes.

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[12] We would have chosen CY 2068, as NHTSA's MY 1977-2029 analysis included operation of MY 2029 vehicles out to this calendar year. However, the current Volpe Model stops tracking new vehicle operation with the 2050 MY, making CY 2050 the last year with a complete vehicle fleet aged from zero to 39 years.

Starting at the top, as mentioned above, the operation of pre-2017 vehicles prior to CY 2017 cannot be affected by any future regulation. NHTSA's 1977-2029 MY analysis includes this operation, but to no real purpose other than labelling. The two calendar year analyses exclude this vehicle operation for the same reason: it doesn't matter. This vehicle operation should not be included in the analysis nor its title as it simply confuses the public about what is really going on.

Regarding the operation of pre-2017 vehicles after CY 2016, NHTSA's 1977-2029 MY analysis completely includes the operation of these vehicles, until the last vehicle is scrapped in CY 2055. A 2017-2029 CY analysis would only include the operation of these vehicles until CY 2029. As the design of these vehicles is unaffected by future regulation, only scrappage effects can change their operation. The 2017-2029 CY analysis would automatically cease to consider any post-2029 scrappage effects on pre-2017 vehicles, consistent with the exclusion of 2030 and later MY vehicles from the analysis. A 2017-2050 CY analysis would include the bulk of the operation of these vehicles, as the last of these vehicles are scrapped in 2055. Again, the operation which would be excluded (CY 2051-2055) would be consistent with the exclusion of 2051 and later MY vehicles from the analysis.

Regarding the operation 2017-2029 vehicles prior to CY 2030, all three analytical approaches include this operation.

After CY 2029, NHTSA's 1977-2029 MY analysis completely includes the operation of these vehicles until the last vehicle is scrapped in CY 2068. A 2017-2029 CY analysis would include the operation of these vehicles only until CY 2029. In such an analysis, the post-CY 2029 benefits which will result from technology already paid for would be excluded. A multi-calendar year analysis of such a short duration would not generally be acceptable for this reason. However, this analysis would also avoid including any post-CY 2029 differences in the scrappage and VMT of these vehicles across various control scenarios, as these scrappage effects are due to the sale of 2030 and later MY vehicles. Finally, a 2017-50 CY analysis would include the operation of 2017-2029 MY vehicles through CY 2050. This would include the any scrappage effects on these vehicles through 2050, consistent with the inclusion of new 2050 MY vehicles in the analysis. Some of the operation of all of the 2017-2029 MY vehicles would be excluded from the analysis, as these vehicles are not assumed to be scrapped in the Volpe Model until CY 2052-2068. Such an analysis would include the benefits over the vast majority of the operation of 2017-2029 MY vehicles compared to both the shorter calendar year analysis and NHTSA's 1977-2029 MY analysis. It would also include the scrappage effects caused by 2017-2050 MY vehicles through CY 2050. Any scrappage effects would be applied to 2030-2050 MY vehicles, as well as 2017-2029 MY vehicles. Thus, there would be both greater and lesser scrappage effects being applied in this analysis than in NHTSA's 1977-2029 MY analysis. However, the 2017-2050 CY analysis would add the operation of 2030-2050 MY vehicles through CY 2050. This operation would not be included in the shorter multi-calendar year analysis.

The third and final section of Table 3 pertains to 2030 and later MY vehicles operated in CY 2030 and beyond. NHTSA's 1977-2029 MY analysis includes the scrappage effects of these vehicles, but excludes the operation of the vehicles themselves. A 2017-2029 CY analysis would completely exclude these vehicles, operation and scrappage effects. The 2017-2050 CY analysis would include most of the scrappage effects as included in NHTSA's 1977-2029 MY analysis and add the operation of 2030-2068 MY vehicles through CY 2068. Again, the 2017-2050 CY analysis would still leave off the post-2050 operation of the 2030 and later MY vehicles, which is the typical problem with any calendar year analysis.

Limiting further discussion to just the NHTSA 1977-2029 MY analysis and a 2017-2050 CY analysis, Table 3 shows that there are only two differences between the two. First, NHTSA's 1977-2029 MY analysis excludes the operation of 2030-2050 MY vehicles, while a 2017-2050 CY analysis would include this operation through CY 2050, including any scrappage effects experienced by these vehicles. Second, the 2017-2050 CY analysis would exclude any scrappage effects after CY 2050, while the NHTSA 1977-2029 MY analysis includes these effects through CY 2068. A 2017-2050 CY analysis would meet the guidelines normally used in designing any multi-calendar year analysis. Given that NHTSA's 1977-2029 MY analysis excludes the cost and benefits of operating 2030 and later MY vehicles, but includes their impact on the scrappage of older vehicles, it is difficult to see how this analysis can be justified once this bias has been understood and publicized. It is not easy to understand how such an analysis became the backbone of a proposed Federal regulation.

An alternative that keeps the model year structure of NHTSA's 1977-2029 MY analysis would be to modify it by removing any scrappage effects occurring in 2030 CY and beyond. This analysis would still have the disadvantage of barely including any vehicles which reflect full compliance with the current and proposed standards in 2025. However, it would at least remove the primary problem with NHTSA's current MY analysis. The impact of including the scrappage effects caused by 2030 and later MY vehicles simply and straightforwardly increases the VMT of used vehicles under the current standards. This increases fuel consumption, CO2 emissions, fatalities, and criteria pollutant emissions associated with the current standard or reduces them under the proposal, depending on your point of view. Since NHTSA ignores any value associated with scrappage-related increase in VMT (i.e., personal transportation), the inclusion of scrappage VMT in CY 2030 and later increases the costs associated with the current standard or reduces them under the proposal, which significantly affects the cost-benefit comparisons of the proposal and other alternatives evaluated by NHTSA. Even if NHTSA added the value of this additional scrappage induced driving, this would only address private costs. Public impacts, like emissions, noise and congestion would still be inappropriately modeled and considered. We now estimate the degree that this inappropriate analytical tool affected the regulatory impacts presented by NHTSA in the proposal.

Impact of the Inclusion of Post-2029 Scrappage

As mentioned above, the Volpe Model cannot simulate the removal of technology and its impact on vehicle prices, fuel economy, CO2 and safety. However, it is possible to remove scrappage impacts starting in CY 2030 from the information contained in the output files of the Volpe Model. With such an adjustment, the operation of 2016 and earlier MY vehicles in CY 2030 and beyond would be the same under all control scenarios, as the design of these vehicles cannot be affected by future regulation. The VMT of 2017-2029 MY vehicles in CY 2030 and beyond would be the same under all scenarios. However, their fuel consumption per mile, CO2 emission factor, safety, etc. would change according to the scenario under which they were certified.

The diagram at the beginning of this section depicts the impact of added technology on the lifetime of operation of the vehicle receiving the new technology, plus the possible impact of this technology on the operation of used vehicles in the year in which the new vehicles were sold. Looked at this way, NHTSA's 1977-2029 MY analysis is really just a string of 13 individual model year analysis running from 2017 through 2029. New vehicles receive new technology over this time period, which is used for 40 years to modify the impacts of their operation. The cost of this added technology affects the scrappage of used vehicles during CYs 2017-2029, but not beyond this date.

Removing the impact of scrappage in CY 2030 and beyond required two runs of the Volpe Model. The first run was identical to that performed by NHTSA to evaluate the effects of the proposed CO2 emission standards. This run included 20% rebound, the scrappage module, the dynamic fleet share (DFS) module and the sales response module all enabled. The second run was the same, but with the scrappage module disabled. We use the Volpe Model's estimates of various effects due to the proposal from the annual_societal_effects_report.csv files of each run. For calendar years 2029 and earlier, VMT (and all "effects" related to VMT, such as fuel consumption, emissions and fatalities) is taken from the first run, that used by NHTSA in the proposal. For calendar years 2030 and later, VMT is taken from the second run, as this run does not have any impact of scrappage. Without any scrappage impacts, the Volpe Model's projections for vehicle operation after 2029 do not include any effects from scrappage in CY 2030 and beyond. Looking back to the last line of Table 1, the VMT for 2010 MY vehicles would include the scrappage effects associated with changes in vehicle prices of 2029 and earlier MY vehicles, but not those for 2030 and later MY vehicles. In this way, the effect of scrappage truncates consistently with the truncation of the inclusion of new vehicles: MY 2029.

Table 4 summarizes the impact of this change in accounting on several key impacts of the proposal.

Table 4: Effect of Consistent treatment of New and Used Vehicles on the Impact of the Proposed Freeze versus the Current CO2 Standards

Fleetwide Parameter Total for 1977-2029 MY	NHTSA Analysis	Scrappage effects truncated in CY 2029
VMT (billion miles)	(1,787)	(888)
Fuel Consumption (billion gallons)	79	98
CO2 Emissions (million metric tons	713	885
Fatalities	(15,644)	(7,905)

As Table 4 shows, the effects of the proposal on total VMT and fatalities over these 53 model years decreases by roughly 60%. The proposal's effect on fuel consumption and CO2 emissions increases by 34%. These figures show the degree to which NHTSA "new" 1977-2029 MY analysis skews the projected impacts of the proposal. This occurs assuming that NHTSA's scrappage model is reasonable for MY 2017-2029.

We performed a second comparison using conditions which address some of the purported problems with the current standards, namely safety. This time, we ran the Volpe model with two additional modifications: 1) we set the rebound rate to zero, and 2) we limited mass reduction to vehicles which fell into either the light truck or van/SUV safety classes. Eliminating rebound simply eliminates one source of change in VMT between CO2 control scenarios which is independent of the interaction between the scrappage model and the 1977-2029 MY lifetime analysis. Plus, NHTSA admits (and its cost-benefit analysis reflects) that the additional VMT due to rebound has been voluntarily chosen by consumers and its value should more than outweigh the private costs of this driving. Limiting mass reduction to only those vehicles where lighter mass reduces fatalities creates a comparison which highlights the impact of older vehicle VMT since the proposed freeze reduces VMT from older vehicles (and thus, their associated fatalities), but increases fatalities from new vehicles due to less mass reduction.

Table 5 incorporates the above described changes and shows the total fatality impact using two analytical approaches: 1) the 1977-2029 MY lifetime approach and 2) total fatalities over calendar years 2017-2050.

Table 5: Impacts of the Proposal on Fatalities Using Two Analytical Methods

	Total Fatalities		
	Current CO2 Standards	Proposed Freeze at 2020 Levels	Impact of the Freeze on Fatalities
1977-2029 MY lifetimes	492,210	484,453	(7,557)
Calendar Years 2017-2050	845,442	840,439	(5,003)

As can be seen, NHTSA's model year lifetime approach indicates that the proposal will reduce total fatalities by 7,557 over the model years considered. This is roughly a 1.5% increase in total fatalities. The total change in fatalities over calendar years 2017-2050 is only 5,003 (a decrease of 33% compared to the NHTSA analysis) and represents only a 0.6% increase in total fatalities. As the new vehicles being produced under the current CO2 standards are safer on a per mile basis than those produced under the proposed standards, and rebound was set to zero, the entire impact on fatalities is due to scrappage. As discussed elsewhere in these comments, we believe that NHTSA's scrappage model is not reasonable and should be discarded. However, the MY analytical approach introduced by NHTSA in this rulemaking contributes significantly to the problem and should also be discarded. While the number of fatalities projected to be reduced by the proposal is still substantial, this level of 5,003 still includes the scrappage module through CY 2029, the fleet share module and the sales response module. All of these aspects of NHTSA's analysis are flawed. With more reasonable estimates of these effects, the number of fatalities saved by the proposal decreases to very low levels or even turns into an increase in fatalities. One such scenario is described below.

In this final comparison, we ran the Volpe Model in CO2 emission compliance mode using input files published by NHTSA in support of the NPRM with a few modifications. One, rebound was changed to zero so that the VMT added due to the more stringent current CO2 standards did not confound the comparison. Two, we replaced NHTSA's scrappage model with one which held total car plus truck VMT constant across CO2 control scenarios in each calendar year. In other words, the increase in used vehicle VMT matched the decrease in new vehicle VMT arising from the sales response module and fleet share module. Three, we restricted vehicle mass reduction to limits used by NHTSA in the Technical Assessment Review (i.e., limits of 5% for small cars and 7.5% for medium cars). This was done to hold the fatality rate per mile the same or better as CO2 standard stringency increased. Otherwise, all inputs were the same as those used by NHTSA in their assessments of the CO2 standards.

Table 6 shows the impact of the proposal on the VMT for the three MY groups of vehicles used by NHTSA in the preamble.

Table 6: Impact of NHTSA’s Proposal on Fleetwide VMT – Sales Response and Fleet Share Modules Enabled, No Rebound, VMT Neutral Scrappage, TAR Limits on Mass Reduction (billion miles)

Model Years	Current CO2 Standards	Proposed Freeze	Effect of Proposal
Includes Post-CY 2029 Scrappage Effects			
1977-2016	14,420	14,391	(30)
2017-2020	11,155	11,118	(37)
2021-2029	25,872	25,855	(17)
1977-2029	51,447	51,364	(84)
Excludes Post-CY 2029 Scrappage Effects			
1977-2016	14,403	14,391	(12)
2017-2020	11,133	11,118	(14)
2021-2029	25,745	25,855	109
1977-2029	51,281	51,364	83

As can be seen, when the effect of the scrappage model is allowed to run through CY 2089, the proposal reduces VMT by 84 billion miles over these model years. When the scrappage effect is eliminated starting in calendar year 2030, VMT increases by 83 billion miles. This difference of 167 billion miles represents mileage by 1991-2029 vehicles in CY 2030 and beyond which has been increased due to higher vehicle prices for model year 2030 and later MY vehicles, whose operation is excluded from this analysis. When examined on a calendar year basis, VMT is the same under either set of CO2 standards in any particular calendar year.

Table 7 shows the impact of the proposal on total projected fatalities.

Table 7: Impact of NHTSA’s Proposal on Fatalities – Sales Response and Fleet Share Modules Enabled, No Rebound, VMT Neutral Scrappage, TAR Limits on Mass Reduction

Model Years	Current CO2 Standards	Proposed Freeze	Effect of Proposal
Includes Post-CY 2029 Scrappage Effects			
1977-2016	136,353	136,079	(274)
2017-2020	96,014	95,702	(312)
2021-2029	211,085	210,992	(93)
1977-2029	443,452	442,773	(679)
Excludes Post-CY 2029 Scrappage Effects			
1977-2016	136,193	136,079	(114)
2017-2020	95,823	95,702	(121)
2021-2029	210,057	210,992	936
1977-2029	442,072	442,773	701

The fatality projections shown in Table 7 show the same trends as those in Table 6. With post-2030 CY scrappage included, the proposal reduces fatalities. Without this scrappage, the proposal increases fatalities. While the elimination of post-2029 scrappage affects the fatalities for each of the three MY groups, the change is most notable for the vehicles directly affected by the proposal, 2021-2029 MY vehicles. (Note that rebound is assumed to be zero in this analysis.) The VMT of the 2021-2029

MY vehicles are affected the most by the exclusion of 2030 and later CY scrappage, as these vehicles have the highest annual mileages in the post 2030 CY timeframe. Despite scrappage being set to be VMT-neutral on a calendar year basis, VMT by model year can shift. It is this shift that causes most of the net increase in fatalities due to the proposal when post-2029 scrappage is excluded. Fatalities under the current standards are also slightly lower due to the slight improvement in safety, which we move to next.

Finally, Table 8 shows the impact of the proposal on the fatality rate per mile.

Table 8: Impact of NHTSA's Proposal on Fatalities per Mile– Sales Response and Fleet Share Modules Enabled, No Rebound, VMT Neutral Scrappage, TAR Limits on Mass Reduction

Model Years	Current CO2 Standards	Proposed Freeze	Effect of Proposal
Includes Post-CY 2029 Scrappage Effects			
1977-2016	9.456	9.456	0.000
2017-2020	8.607	8.608	0.000
2021-2029	8.159	8.161	0.002
1977-2029	8.620	8.620	0.001
Excludes Post-CY 2029 Scrappage Effects			
1977-2016	9.456	9.456	0.000
2017-2020	8.607	8.608	0.000
2021-2029	8.159	8.161	0.002
1977-2029	8.621	8.620	0.000

As can be seen, the proposal increases the fatality rate per mile for 2021-2029 MY vehicles, regardless of the treatment of scrappage. (Vehicle technology is independent of scrappage.) While the fatality rate per mile for pre-2017 vehicles is shown to be the same under both approaches to post-2029 scrappage, the level under the current standards is very slightly lower with either NHTSA's scrappage model or VMT-neutral scrappage. With either approach to post-2029 scrappage, differences in the overall fatality rate per mile are in the fourth decimal point and beyond any realistic difference given the uncertainty of the safety-related inputs to the analysis. This analysis indicates that there need not be any significant worsening of vehicle safety with the retention of the current CO2 standards.

The extremely biased and misleading nature of the 1977-2029 MY analysis is finally demonstrated by evaluating the level of net benefits that the 2020 standards produce when compared to the 1 mpg scenario which NHTSA always includes in their Volpe Model runs. Using the Volpe Model output from NHTSA's evaluation of the proposed and alternative CO2 standards, we calculated the net benefits of the proposal compared to the 1 mpg scenario. Using either a 3% or 7% discount rate, net benefits were negative for the 2020 standards. In other words, if NHTSA had evaluated the proposal using their own Volpe Model run, they could not even justify the proposed 2020 standards using their 1977-2029 MY analysis. We performed the same comparison, only against the 2017 standards. Again, the 2017 standards produced a net cost relative to the 1 mpg. These additional runs show that the inclusion of scrappage related VMT due to vehicle sales over 52 model years produces simply too high a level of artificial costs for the benefits of just 13 model years' of new technology to overcome, especially when the vehicle fleet has not even reached equilibrium compliance with the 2025 standards. Standards which are producing no problems for the industry are projected to be problematic, due to the inappropriateness of the MY 1977-2029 analytical concept being used. We have every reason to believe that this would be true for any future safety standards which might be considered by NHTSA, as well.

In short, labeling the scrappage impacts on used vehicle operation as “model year” effects and allowing this to justify the exclusion of the operation of 2030 and later MY vehicles is clearly biased: this increases the net benefits of the proposal and under-estimates the negative impacts of the proposal on the key aspects of the relevant regulations: fuel consumption CO2 and criteria pollutant emissions, and safety. This concept hinges the safety impact of more stringent standards on vehicle scrappage. Improved safety is then touted as the primary goal of the proposal to roll back the current standards. As mentioned above, this new analytical tool should be discarded from any use in this or other regulatory area.

A much more straightforward approach would be to return to a multi-calendar year analysis, such as 2017-2050. We will present more reasonable projections of the impact of the proposal over this time period at the end of this review of the proposal.

V. Over-Compliance Under the Proposed 2020 Freeze

NHTSA's projection of the increased fuel consumption due to the proposed rollback standards is lower than what would be consistent with previous regulatory analyses.[13] In the NPRM, NHTSA did not present any comparisons of its current fuel impact projections to previous projections. We obtained NHTSA's projections for the CO2 levels of the new vehicle fleet and the CO2 levels required by the standards from the Compliance_Report.csv file for the run performed by NHTSA simulating compliance with the CO2 standards (published on the NHTSA-Volpe Model website in support of this rulemaking). Table 9 below shows both the CO2 emission levels required by both the current and proposed CO2 standards and the fleetwide average CO2 emission levels projected to result by the Volpe Model. These figures represent 2-cycle certification emission levels, not onroad levels. Onroad emission levels are essentially 25% higher due to the "gap" between 2-cycle emissions and onroad emissions.

Table 9: Fleetwide Average 2-Cycle CO2 Levels - NHTSA Run of the CO2 Standards (g/mi)

	Current Standards			Proposed Freeze		
Model Year	Required Fleetwide CO2 Levels	Projected CO2 Compliance Levels	Over-Compliance	Required Fleetwide CO2 Levels	Projected CO2 Compliance Levels	Over-Compliance
2021	212	198	15	241	236	4
2022	202	192	11	241	234	7
2023	193	187	5	241	233	8
2024	183	183	-	241	232	9
2025	175	182	(7)	240	232	9
2026	175	178	(3)	240	232	9
2027	175	176	(1)	240	230	10
2028	175	175	1	240	230	10
2029	175	174	1	240	230	11
2030	175	174	1	240	229	10
2031	175	174	1	240	229	10
2032	175	174	1	240	229	11

As Table 9 shows, in the 2028-2032 timeframe when the added technology needed to meet the standards has stabilized, NHTSA projects that manufacturers will over-comply with the 2020 standards by 11 g/mi. (This is equivalent to 14 g/mi CO2 on the road.) In contrast, as shown in Table 9, NHTSA projected that over-compliance under the current CO2 standards would be only 1 g/mi. We determined that this over-compliance was not related to NHTSA's projected refresh and redesign cadence for specific vehicle models. We ran the Volpe Model exactly as done by NHTSA, but allowing every vehicle model to be redesigned and refreshed every model year. The over-compliance seen in the NHTSA run did not decrease substantially. However, the over-compliance decreased dramatically to 3 g/mi when the payback period for fuel savings in the Effective Cost calculation was reduced from 30 months to zero.[14] In the Volpe Model, NHTSA assumes that manufacturers will add technology which provides fuel

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[13] See, TAR; EPA Final Determination; the 2016-2025 CAFE and CO2 rulemaking.

[14] NHTSA found that the over-compliance level was just under 3 g/mi with a payback period of 12 months (PRIA, Table 13-3). In the limited time provided for review of and comment on NHTSA's technical analysis, and due to the model's lack of transparency, we were not able to determine why the over-compliance did not decrease further

savings over the specified "payback period" whether the technology is needed to enable compliance or not.[15] Thirty months (two and a half years) is a small fraction of a vehicle's life. The fact that the model is finding technology beyond that required to meet the 2020 standards which pays for itself over such a short time period alone is a strong indication that this standard is too lenient. NHTSA does not address this obvious contradiction between the existence of this "cost effective" technology and its proposal to relax the standards. This also indicates that any analyses which indicate that the 2020 standards are not justified must be erroneous or biased in some way. This assumption simply appears to be a ploy to snatch the benefits of this technology for the proposal without actually ensuring that the manufacturers do in fact employ it in the future. This is made obvious by NHTSA's numerous observations that consumers will not buy something that they are not interested in.[16]

NHTSA describes that the Volpe Model used to support the proposal will add technology that pays for itself over two and a half years.[17] However, NHTSA does not mention the fact that this two and a half year payback period is two and a half times greater than the payback period used for the TAR.[18] The industry experience to which NHTSA points to justify this assumption (see below) was well prior to the time the TAR was conducted. NHTSA has failed to explain why it is now departing from its estimate of this payback period for the TAR.

NHTSA does perform three sensitivity analyses using two shorter payback periods and one longer one, which then shrinks or expands the amount of technology added beyond that needed for compliance.[19] NHTSA does present the effect these sensitivity analyses on projected fuel economy and CO2 levels in Section 13 of the PRIA. However, the projection of continued fuel economy improvements beyond 2032 diminish the impact of these reduced payback periods on the increased fuel costs projected for the proposal. Also, the impact of the reduced payback periods on the application of technology (via the Effective Cost metric) under both the proposal and the current standards makes the value of these sensitivity analyses questionable and the sensitivity case is causing more changes in model operation than meets the eye.

NHTSA states that the amount of technology added will vary with assumed fuel prices in the future and states that this is consistent with its observation of industry practice in the past.[20] However, when NHTSA examines this past experience, it points to a period of unusually high fuel prices (i.e., some over-compliance occurring after 2006 due to spikes in the price of crude oil and transportations fuels).[21]

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with a shorter compliance period. However, this 3 g/mi over-compliance may be due to the "inheritance" of technology applied to meet the proposed standard in an earlier model year by other vehicles sharing the same engine or transmission.

[15] See the definition of payback period, page 9 of the PRIA.

[16] For example, see FR, Vol 83, No. 165, August 24, 2018, p. 43191

[17] FR, Vol 83, No. 165, August 24, 2018, p. 43174, p. 43179.

[18] TAR, p. 13-10

[19] NHTSA does present average CO2 compliance levels for three alternative payback periods in Section 13 of the PRIA. However, there is no discussion of the significance of these values.

[20] *Ibid*.

[21] NHTSA states at FR, Vol 83, No. 165, August 24, 2018, p. 43179, that they base this assumption primarily on uncited statements made to NHTSA by automobile manufacturers. NHTSA mentions that they conducted sensitivity analyses using payback periods other than 30 months. NHTSA also states there that this assumption is consistent with historical fuel economy data, but does not describe this data, nor where to find it. We could not

However, there are no price "spikes" in NHTSA's central fuel price forecast. Fuel prices are generally low throughout most of the analysis (i.e., gasoline prices reach $3.19 in 3035 in today's dollars[22], hardly a "high" fuel price even today). Thus, the industry experience highlighted by NHTSA does not support their projection that manufacturers will apply this "cost-effective" technology under normal fuel pricing. Thus, while NHTSA presents a justification for this assumption, it is hollow.

Additionally, the majority of this unrequired, "cost-effective" technology being applied by the Volpe Model in 2017 and beyond under the rollback standards has been available for years and has not been extensively applied by manufacturers to date.[23] (Otherwise, it would already be in the 2016 baseline fleet.[24]) The fuel economy levels shown in Table 3.2 of the most recent EPA Trends Report show that car and pickup fuel economy was essentially constant over this entire period.[25] The fuel economy of truck-SUVs was constant from MY 1986-2006. Only the fuel economy of minivans improved over this time period and this improvement was 10% over a 20 year period. Engine technology developed dramatically over this time period. Figure 2-3 shows that instead of improving fuel economy, manufacturers choose instead to improve performance, as the horsepower-to-weight ratio of the average vehicle doubled between 1986 and 2006. A few manufacturers have historically over-complied with the standards (e.g., Honda, Toyota). However, overall, manufacturers have historically just complied with the standards or even paid CAFE fines due to under-compliance, offering no assurance that such over-compliance would indeed occur under the proposed standards. Further, this projection is in direct contradiction to NHTSA's new sales response model, which is reviewed in more detail below. NHTSA's sales response model projects the impact of changes to new vehicle characteristics on the sales volumes of these new vehicles. When developing this sales response model, NHTSA states that it could not find an effect of new vehicle fuel economy on sales.[26] In other words, new vehicle purchasers did not appear to value fuel economy in their purchase decisions. Yet here, NHTSA assumes that manufacturers believe that their customers value 30 months of fuel savings when they make their purchasing decisions and that manufacturers will devote development resources to adding fuel-saving technology.

NHTSA is making inconsistent assumptions which consistently favor the proposal. When it comes to new vehicle sales and fleet turnover to any more stringent standards, NHTSA assumes consumers do not value fuel economy and that sales will drop due to higher vehicle prices. When it

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find any reference to this data in the PRIA. NHTSA does present a chart (Figure 13-4) in the TAR which shows that manufacturers over-complies with the car and truck standards after CY 2000 (TAR, page 13-10).

[22] Taken from the Parameters file used by NHTSA in their Volpe Model runs.

[23] Vehicle_Report.csv file from NHTSA's simulation of the CO2 standards, total sales volume having specific technologies applied for technologies such as VVT, VVL, SGDI, DEAC, AT6, EPS, IACC, LDB, SAX, ROLL10, ROLL20, AERO5, AERO10, AERO15, MR1, MR2, and MR3, all of which have been available for a decade or more.

[24] Note that other reviewers, such as ICCT, have found that NHTSA changed its characterization of the 2016 baseline fleet for this rule to reflect the presence of more fuel-efficient technology than was justified. This likely reduced the level of over-compliance projected by the Volpe Model under the 2020 standards, but also avoided the possibility that one or more of the other alternative control scenarios could be met at little or not cost.

[25] Trends Report - Light-Duty Automotive Technology, Carbon Dioxide Emissions, and Fuel Economy Trends: 1975 Through 2017, U.S. EPA, January 2018, EPA-420-R-18-001.

[26] FR, Vol 83, No. 165, August 24, 2018, p.42993

comes to estimating the benefits of more stringent standards, NHTSA assumes that consumers value fuel economy, and so much so that fuel economy increases even in the absence of standards.

The projection of this over-compliance allows NHTSA to exclude the benefits of this "cost-effective" technology[27] from its calculation of the benefits of the current CO2 standards and all the other alternative standards considered. NHTSA does assign the cost of this technology to the 2020 standards. However, this in itself is not problematic to their cause, as this technology produces net benefits under any cost-benefit analysis (it pays for itself in two and a half years). At the same time, NHTSA is able to relax the CO2 standards to the greatest degree feasible at this point in time, providing manufacturers with the flexibility to ignore applying this technology for fuel-efficiency purposes, as they have done historically. This is consistent with NHTSA's emphasis on allowing manufacturers to use new technology to either improve fuel economy or performance.[28]

As we show below, eliminating this over-compliance and the over-compliance discussed in the next section appears to have been sufficient alone to cause the proposal to shift from producing net benefits to society to producing a net cost. This effect was not revealed in NHTSA's sensitivity analyses (which only addressed the payback period with its other effects on model operation) and thus, was not presented to stakeholders for adequate review and comment.

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[27] As noted elsewhere, NHTSA's definition of cost-effective technology with respect to ranking technology for its desirability to enable compliance is flawed. However, in this case, it is safe to say that any technology which pays for itself in 30 months is cost effective.

[28] See FR, Vol 83, No. 165, August 24, 2018, p 42991 regarding the use of downsized turbocharged engines.

VI. Post-2032 MY Fuel Economy Improvements

The Volpe Model only simulates the addition of technology to enable compliance with the CAFE and CO2 standards through MY 2032. The user of the Volpe Model can choose to extend the results of this simulation forward to the 2050 MY (and CY 2089) by clicking on “Perform Fleet Analysis Calculations” in the Runtime Settings of the graphical user interface (GUI) of the model. This option is useful and required when conducting analyses like NHTSA’s 1977-2029 MY lifetime analysis or the more appropriate 2017-2050 CY analysis. While neither the preamble to the proposal, nor the PRIA mention it, when NHTSA extended its Volpe Model analysis to 2033 and later MY vehicles, it assumed that manufacturers would increase fuel economy steadily each year. We were only able to discover this fact by reviewing the detailed output of the Volpe Model run used by NHTSA to analyze the CO2 standards and comparing onroad fuel economy and CO2 emissions after MY 2032 to that for MY 2032. Upon further investigation, we were able to find that NHTSA states on page 132 of the most recent documentation of the Volpe Model[29], that they automatically project that manufacturers will continue to “deploy emerging and previously unutilized cost-effective technologies on their fleets.” No justification is given for this assumption, nor are any levels of growth rates presented or discussed.

Table 10 presents average onroad CO2 emission levels for passenger cars and light trucks from NHTSA’s modeling of the CO2 standards. In contrast to the figures shown in Table 9 above, we have to show onroad emission levels here. Two-cycle CO2 emission levels, which are used in compliance calculations, are only provided by the Volpe Model up to MY 2032. The post-2032 MY growth in fuel economy (and shrinkage in CO2 emissions) is applied to the associated onroad fuel economy and CO2 emission levels. We calculated these fleetwide average CO2 emissions levels by dividing tailpipe CO2 emissions (column “AC” and converting million metric tons to grams) by the VMT (column “H”) for vehicles of age zero from the Annual_Effects_Report.csv file from NHTSA’s Volpe Model run simulating the CO2 standards. Also shown in Table 10 are the onroad CO2 emission levels equivalent to the final CO2 standards.[30]

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[29] Draft CAFE Model Documentation, NHTSA, U.S. DOT, July 2018. Published on the NHTSA.gov website for the Volpe CAFE Compliance Model.

[30] The onroad emission levels under the current standards include an adjustment for the use of A/C leakage credits under the current CO2 standards (14 g/mi for passenger cars and 17 g/mi for light trucks, as listed in the Market file for this same Volpe Model run performed by NHTSA). These credits are not available under the proposed standards after 2020. We used a “gap” of 0.799 for the proposed freeze and 0.798 for the current standards. The analogous Vehicle_Report file shows that electric vehicles constitute 2% under the current standards and 1% of the fleet under the proposed freeze and NHTSA uses a gap estimate of 0.3 for electric vehicles versus the usual gap of 0.8 for gasoline vehicles.

Table 10: Fleetwide Average CO2 Emissions from Passenger Cars and Light Trucks – NHTSA Run of the CO2 Standards (mpg)				
	Passenger Car		Light Truck	
Model Year	Current Standards	Proposed Freeze	Current Standards	Proposed Freeze
Onroad CO2 Equivalent of Standards *	203	255	276	355
	Volpe Model Projections of Onroad CO2 Emission Levels (g'mi)			
2025	213	249	295	343
2026	208	249	289	341
2027	206	248	286	340
2028	204	247	283	339
2029	204	247	281	339
2030	204	247	281	338
2031	204	247	281	338
2032	204	247	281	338
2033	202	245	277	334
2034	201	243	274	330
2035	199	241	270	325
2040	192	232	35.1	232
2045	185	224	37.4	224
2050	178	215	39.8	215

* Assumes onroad gap of 0.8, which is the gap applied by NHTSA to the vast majority of vehicles.

As can be seen, fleetwide CO2 emissions vary little between 2028 and 2032 for passenger cars and 2029 and 2032 for light trucks during the period of time when compliance is actually being modeled in the Volpe Model. By 2028-2029, even with the slow cadence of the application of technology in the Volpe Model, manufacturers have stopped adding technology and fuel economy is essentially constant. Even at these levels, however, the Volpe Model is already projecting significant levels of over-compliance with the CO2 standards. The 2020 CO2 standards for passenger cars and light trucks work out to onroad CO2 emission levels of 276 g/mi and 355 g/mi, respectively. The errors that this projected over-compliance creates are addressed in the previous section.

Then, beginning with MY 2033, for both cars and trucks and both CO2 control scenarios, fleetwide CO2 emissions start to decrease by 1-2g/mi per year for cars and 3-4 g/mi for trucks. We evaluated the year-over-year reduction in CO2 emissions occurring after 2032. (The same reduction applies to fuel consumption.) We found that CO2 emissions from passenger cars decreased by 0.76% annually on a compounded basis. CO2 emissions from light trucks decreased by 1.29% annually on a compounded basis. These reductions are consistent with the values entered in cells b5 and b6 of the Fleet Analysis Values worksheet of the Parameters input file for this Volpe Model run.[31]

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[31] While cells b5 and b6 contain fuel economy growth rates for the "baseline scenario", cells c5, and c6 of this worksheet and file contain the rate of fuel economy growth for the "action alternatives", or what are normally referred to as the control scenarios. Oddly, the parameters file used by NHTSA in their simulation of the CO2 standards contains higher fuel economy growth rates for the baseline scenario (0.76% to 1.29%) than the action alternative (0.25% to 0.87%). However, the output of the Volpe Model shows that the fuel economy growth rates

This projection is highly questionable given the industry's past practice, as discussed. Again, NHTSA presents no justification for the assumption. Worse, NHTSA does not even mention in the proposal that it is making this projection. It is buried in the model documentation, where the actual growth rates used are not mentioned.

There are further problems with this assumption. First, if such technology is expected to arise and be applied, we wonder why NHTSA is not adjusting the proposal to reflect its use. NHTSA might argue that it cannot base its or EPA's standards on unidentified technology. But NHTSA includes the benefits of such technology in its analyses as a basis for determining not to implement further technology, which is essentially the same thing. Second, it is arbitrary that NHTSA includes no cost for this technology. Third, NHTSA does not consider how this unknown, but cost-effective technology might shrink the difference in cost between various control scenarios. Fourth, this projection suddenly begins after the Volpe Model stops modeling compliance. Thus, while compliance is being modeled, no currently unexpected efficiency improvements are applied. However, as soon as NHTSA stops modeling compliance, such efficiency improvements appear and are free of charge. Fifth, this steady increase in fuel economy and reduction in CO2 emissions builds on the over-compliance projected by the Volpe Model under the proposed freeze. Thus, not only are CO2 levels unjustifiably low in the 2028-2032 timeframe, but they decrease further into the future. Finally, and most importantly, this improvement in fuel economy (and CO2 emissions) reduces the absolute difference in fuel consumption between the current standards and the proposed freeze. The assumption that this unknown technology is available to all control scenarios serves to diminish the benefit of further control by shrinking the difference between various control scenarios over time.

Since no justification is provided for this continual and free improvement, this reduction only serves to under-estimate the fuel savings associated with the current CAFE and CO2 standards. In contrast, the differences in cost between control scenarios for 2032 MY vehicles continue indefinitely. Thus, this seems to be one more way that NHTSA is actively working to ensure that its analyses support the relaxation of standards over the current program.

This is a serious problem for any appropriate and realistic analysis of future CAFE and CO2 standards. On the one hand, its impact on NHTSA's 1977-2029 MY lifetime analyses is indirect, as the 1977-2029 MY analysis excludes 2033 and later MY vehicles. However, fuel cost per 100 miles is a factor in the scrappage model and the scrappage effects of 2030 and later vehicles are included in NHTSA's 1977-2029 MY analyses.

With respect to more appropriate analyses, like a 2017-2050 calendar year analysis, this unjustified improvement in fuel economy after 2032 has major implications. While this improvement in fuel economy affects both control scenarios, it diminishes the increase in absolute fuel consumption resulting from the proposal. Based on the onroad CO2 levels associated with the standards themselves, the proposal increases fuel consumption over a typical year's driving of 15,000 miles by 137 gallons of gasoline. Using NHTSA's projections of fuel economy under the two control scenarios for 2050, this difference shrinks to 66 gallons. Thus, all of the impacts of the proposal on long-term fuel use in the U.S. are completely unrealistic and misleading. This problem extends to the effect of the proposal on all

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entered for the "baseline scenario" are used for all scenarios being evaluated by the Volpe Model. It is possible that the growth rates for "action alternatives" is disabled in the current version of the Volpe Model. Again, the model's lack of transparency hinders stakeholders' ability to meaningfully engage with NHTSA's projections.

upstream emissions of CO2, criteria pollutants, and air toxics, as well, as these emissions vary proportionately with the change in vehicle fuel consumption. The DEIA projects emission impacts out to CY 2050, meaning every projection contained in the DEIS after CY 2032 is affected by this unsubstantiated projection.[32]

To put this error into context, holding 2033 and later fuel economy at 2032 levels and eliminating over-compliance with the standard doubles the increase in fuel costs due to the proposal from $436 billion to $876 billion over calendar years 2017-2050 (discounted at 3%). This ignores the increased monetary cost of increased refinery emissions, though these too increase by a factor of two. Instead of technology costs exceeding fuel savings by $270 billion, when this error is corrected, fuel savings exceed technology costs by $100 billion. This accepts NHTSA's technology costs (which are reviewed below) and adjusts the technology cost of the proposal to account for removing over-compliance. It also includes NHTSA's scrappage model and 20% rebound. Thus, setting aside other major errors in NHTSA's analysis, correcting the two unjustified improvements relative to the 2020 standards almost single-handedly changes the proposal from providing net benefits on a societal basis to increasing net costs. This will be described in greater detail in the last section of this review when we develop and discuss the costs and benefits of the proposal.

This unjustified projection of free and unrequired improvement in fuel economy appears to be intended to reduce the benefits of any further regulation of fuel economy. It reduces the negative impacts of the proposal on the public (in terms of fuel costs) and the environment (in terms of all types of emissions). The projections of increased fuel use and emissions presented in the proposal stray so far from reality as to necessitate reproposal with defensible technical analysis before finalization of a regulation.

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[32] This is in addition to further problems with the emission projections contained in the DEIS. The emission impacts in the DEIS are not at all consistent with the output of the Volpe Model which NHTSA published on its website in support of the NPRM.

VII. Sales Response Module

The sales response module is described on pages 946ff of the PRIA. NHTSA describes how new vehicle sales have been basically stagnant for nearly 30 years. They also describe how vehicle sales are strongly affected by macroeconomic factors. NHTSA indicates that vehicle sales are likely the function of many vehicle attributes. Despite this, NHTSA's sales response module projects new vehicle sales on only one vehicle attribute: the average price of new cars and trucks combined. The model includes a number of macroeconomic factors which are believed to dominate the level of sales, but these factors do not differ with the level of CAFE or CO2 standard. It is important to note that no fuel-related factors (e.g., passenger car (hereafter referred to simply as "car") fuel economy, safety rating, performance level, etc.) are included in the model, despite the fact that differences in fuel economy can affect lifetime vehicle ownership costs which exceed changes in new vehicle purchase price. NHTSA says that it tried to include fuel economy in its analyses, but that these attempts did not improve the ability to predict sales.[33] As NHTSA provided neither the data nor its statistical analyses for review, we cannot determine if this inability is due to poor data, poor model structure, or some other reason. For example, NHTSA states that it shifted to modeling quarterly vehicle sales by versus annual sales in order to increase the amount of data available for statistical analysis.[34] However, there are likely to be strong seasonal trends in vehicle sales and in macroeconomic factors. How this move improved NHTSA's ability to find an effect of vehicle prices on sales needs to be described in detail so that these obvious questions, as well as others, can be answered. Thus, we have no ability to comment on the appropriateness of the inclusion of this one vehicle factor, whether it is truly significant, or whether its effect is essentially irrelevant compared to the macro-economic factors included.

NHTSA's inability to find a statistical effect of fuel economy on sales indicates a fundamental problem with their data or their model. Numerous studies cited in the NPRM and the TAR have found that consumers value fuel economy to at least some degree. NHTSA should reject any sales model which does not reflect the effect of fuel economy on sales. Similarly, we cannot even be sure that the form of the data used by NHTSA to develop the sales response model was of a form and precision to allow an effect of fuel economy to be quantified. If data are not available to allow the detection of the effect of fuel economy on sales, NHTSA should again reject any effort to develop a sales response model, given that it is inconsistent with studies which have found such an effect and which are cited by NHTSA elsewhere in the preamble.[35] Also, other relevant vehicle factors, such as safety features, luxury features, utility, and others were not described at all. While these factors were not included in the model, NHTSA does not describe whether or not it tried to include such factors.

NHTSA's use of a sales response model constitutes an unexplained reversal in the agency's position on the feasibility of doing so. In the TAR, EPA and NHTSA stated that developing such a model is "a difficult, if not impossible, task" and that "[i]t is difficult, if not impossible, to separate the effects of the standards on vehicle sales and other characteristics from the impacts of macroeconomic or other forces on the auto market"[36]. Now, NHTSA has apparently overcome this conclusion. However, none of

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[33] FR, Vol 83, No. 165, August 24, 2018, p 43075.

[34] FR, Vol 83, No. 165, August 24, 2018, pp 43074

[35] See TAR at 6-3 to 6-5 detailing factors besides vehicle cost which need to be accounted for in developing a consumer choice model which can be used to make reliable quantitative predictions.

[36] TAR p. 6-1.

the types of data that they are now analyzing appears to be different in nature than data which was available two years ago. It appears more likely that NHTSA's standard of quality changed. NHTSA must explain why this was appropriate.

It should also be noted that NHTSA only included average car+light truck costs in its statistical model. They make no mention of tracking changes in the prices of cars and trucks separately. NHTSA and EPA set differential fuel economy and CO2 standards for cars and light trucks and projected compliance costs for the two vehicle classes differ significantly. The overall cost and utility of the two vehicle classes are very different. The Volpe Model predicts changes in technology costs for the two classes separately. Thus, there seems to be little reason to combine their price increases in the sales response model. The result is that it obfuscates the greater decrease in the proposal's technology cost for trucks than cars and may have been projected to increase truck sales more than cars. NHTSA's new fleet share module is used to project relative car and light truck sales. However, while total sales are assumed to be solely a function of vehicle price, relative car and light truck sales are assumed to be solely a function of relative fuel costs. Given that CAFE and CO2 standards affect both vehicle costs and fuel economy, this is unjustifiably simplistic. At worst, it seems biased, as the result of both decisions is (yet again) in the direction of inflating the benefits of the proposal vis a vis the current standards.

Later in the description of the sales response model, NHTSA describes how it did not use data on vehicle prices from the Bureau of Labor Statistics (BLS).[37] The reason given was that BLS excluded price increases related to safety and fuel economy improvement, as these changes enhanced product quality. Yet NHTSA's sales response model explicitly ignores both safety and fuel economy improvements. NHTSA's model is therefore in conflict with the views of BLS that consumers value safety and fuel economy changes. It is important to note that NHTSA cites studies in the proposal that have found that purchasers of vehicles value fuel economy in their buying decisions.[38] NHTSA has offered no evidence that it worked as hard to find a fuel economy effect here as it did to find a statistical model which provided the "right" impact of mass reduction on fatalities. As described in Chapter 8 of the TAR, NHTSA worked for years to amass data, massage it, attempt dozens of statistical models and finally find effects of mass reduction which reflected its expectations. One can only surmise that the sales response model found for the proposal equally fit NHTSA's expectations.

NHTSA states that they used vehicle transaction price data obtained from the National Automotive Dealers Association (NADA) in lieu of the BLS data. However, we could not find a citation to the exact source of this data.[39] In addition to providing no description of their statistical analysis, we could not even perform a cursory review of the nature of the data used for vehicle pricing. One important aspect of vehicle pricing is the availability of rebates. Manufacturers often offer rebates, particularly during poorer economic periods. These rebates can affect the effective price of a new car by 20% or more.[40] If rebates have not been quantified and included, any resulting model would be of little value.

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[37] FR, Vol 83, No. 165, August 24, 2018, p 43095

[38] FR, Vol 83, No. 165, August 24, 2018, pp 43072

[39] There are no citations to any NADA publication or online source of data in NHTSA's discussion of its decision to use the NADA data (FR, Vol 83, No. 165, August 24, 2018, pp 43074 and PRIA pp. 1013 of the PRIA).

[40] https://www.gmc.com/incentives accessed on 10/25/2018. Rebates and price reductions below MSRP on 2018 GMC Sierra 1500 pickup total $10,948. Rebates and price reduction offered on 2019 Acadia of $6976.

Finally, while NHTSA shows that the overall fit of the sales response model is good,[41] they do not distinguish between the relative contribution of macroeconomic variables and vehicle price to the statistical fit. It is no surprise that vehicle sales are a function of the state of the economy, at least not to someone living in the state of Michigan. It would not be surprising if 90% of more of the explanatory power of NHTSA's sales response model was due to the macroeconomic terms, with the vehicle price terms have far less explanatory power. For example, Figure 8-5 of the PRIA shows total vehicle sales changing by plus or minus 4 million vehicles over the past 10 years. Since neither NHTSA nor anyone else is able to accurately predict future recessions more than a few months out, the presence of these factors in the model appear to be of little practical use. In fact, the sales response model basically predicts relatively high growth in car plus truck sales through 2021 (0.7-3.0% per year), low growth from 2021-2032 (0-0.3% per year), and then relatively steady growth of 0.7% per year through 2050, regardless of CO2 control scenario. These trends are present regardless of CO2 control scenario. The cause of the changes in growth rates over these broad periods are not clear.

NHTSA states that the sales response module predicts that a $1000 increase in the price of a new vehicle will reduce new vehicle sales by 160,000 units in the first year and 600,000 units over the next 10 years.[42] NHTSA is not clear whether this $1000 price increase occurs only in one year, or whether it is a step increase which continues indefinitely. If it is the former, then the statement and NHTSA's model seem unreasonable. As discussed above, an increase in price for a single year should have no negative impact on sales once the price increase disappears. If NHTSA's statement refers to a long term increase of $1000, their statement indicates that the effect of this price increase on sales should dissipate over the first 10 years and then essentially disappear or at least become very small. However, the Volpe Model outputs do not indicate a diminishing effect of a long term price increase. We find that the proposal is projected to have the same effect on sales in the late 2020's and in the 2040's. In fact, the impact of the proposal on total new vehicle sales is twice as high in 2050 (~200,000 units) compared to 2035 (~100,000 units). Given that the full cost difference of the proposal is reached in 2029, a diminishing effect on sales should have played out by 2040. Thus, there seems to be something about the form of the model input to the Volpe Model that is inconsistent with the findings of NHTSA's statistical analysis. It appears that regardless of what NHTSA meant by their statement, some correction to the model is needed.

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[41] Figure 8-5 of the PRIA.

[42] PRIA, p. 953.

VIII. Fleet Share Model

NHTSA's "fleet share" model projects the ratio of car and light truck sales by model year. NHTSA states that it used the EIA fleet share model, but modified its application.[43] EIA's model estimates the ratio of light-duty vehicle to light-duty truck sales. One of NHTSA's stated modifications was the conversion of the model to estimate the ratio of passenger car to light truck sales.[44] NHTSA does not provide any detail on how it accomplished this task, nor any other modifications which may have been made to EIA's fleet share model. NHTSA also has not provided any of the data used to construct this model. Thus, the model should be discarded or the proposal re-proposed with the information necessary for stakeholders to meaningfully comment on it.

At a more detailed level, the fleet share model predicts the relative sales of cars and trucks based solely on the difference between their cost per mile of fuel to operate, average horsepower and vehicle mass.[45] Based on NHTSA's own simulation of the CO2 standards, the difference between the cost of fuel during the first year of operation for a car and a truck was $460 under the 2020 standards and $600 under the 2025 standards in the 2032 model year (after the standards have completely phased in under NHTSA's slow cadence of vehicle redesign). These fuel costs are based on an annual mileage of 17,000 miles, which is the highest annual mileage for any year of vehicle operation. It ignores the fact that NHTSA projects that light trucks are driven more than passenger cars, even when the same buyer switched from a car to a truck.

NHTSA's fleet share model projects that this first year $140 difference will cause 450,000 consumers to purchase a truck in lieu of a car. This change in relative car-truck sales is 4 times the decrease in total car plus truck sales predicted to occur by NHTSA's sales response model for a $2200 price difference between the two CO2 standards. This change in relative car-truck sales also ignores the $360 difference in compliance costs between cars and trucks for the two CO2 standards.[46] This does not represent buyers of sedans switching to two wheel drive crossovers, which has already been occurring of late.[47] Two wheel drive crossovers are classified as passenger cars. Thus, NHTSA is projecting that buyers of either sedans or two wheel drive crossovers are switching to four wheel drive crossovers or much larger SUVs or pick-up trucks.

It appears that the premises behind the sales response and fleet share models are completely inconsistent. The former assumes that sales are solely a function of vehicle price and that consumers do not consider fuel economy. The latter assumes that fuel economy is consumers' sole determinative factor and that vehicle price does not impact a consumer's decision. The sensitivity of relative car-truck sales to fuel economy also appears to be extraordinary given the small annual savings involved. If

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[43] FR, Vol 83, No. 165, August 24, 2018, p 43076.

[44] *Ibid*.

[45] *Ibid.*

[46] Relative compliance costs for cars and trucks were taken from the Compliance_Report.csv file for the Volpe Model run of the CO2 standards which was posted by NHTSA to their website for the NPRM. Specifically, average technology cost for passenger cars and light trucks under the proposed freeze was $2019 less than the current standards (from cell AD4504) and $2382 less than the current standards (from cell AD4505), respectively).

[47] U.S. CFR Section 523.4 and 523.5

consumers valued fuel economy to this degree, one would think that NHTSA would not even bother with cost-benefit analysis for its CAFE standards. They would obviously be cost beneficial.

The fleet share model is not applied to changing fuel economy levels after 2032. As mentioned above, NHTSA projects continued fuel economy improvements for both cars and light trucks after 2032 through at least 2050. These improvements are greater for trucks on a percentage basis than for cars, and truck fuel consumption is higher than that of cars to begin with. Thus, the difference between the fuel cost per 100 miles for cars and trucks should be steadily shrinking. However, the more stringent the pre-2032 standards, the smaller this shrinkage would be. Thus, if the fleet share model was applied, truck sales would continue to increase under both the current standards and the proposal. However, the degree of increase in truck sales would be greater under the proposal than under the current standards. This would increase total fuel consumption under the proposal relative to the current standards, and increase upstream emissions as well.

When we looked at relative car and truck sales after 2032, however, we did not find a steadily increasing truck fraction of total sales. The truck fraction of total sales increased in 2033 compared to 2032, but then steadily decreased through 2050 at a very slow rate. Page 133 of the documentation to the Volpe Model states that total vehicle sales and the sales fractions of cars and light trucks for 2033 and beyond are an external input to the model, as listed in the Parameters.xls file. NHTSA's sales projections in the Parameters file show a slowly decreasing truck sales fraction. Notwithstanding the problems with the fleet share model, NHTSA does not offer any explanation as to why the fleet share model is not used beyond 2032. The use of external car-truck sales fractions would be consistent with a static vehicle fleet post-2032. However, given that NHTSA projects improving fuel economy for the next 28 years, it would seem only consistent to use its fleet share model to project steadily increasing truck sales fractions. The fact that the fleet share model is not applied after 2032 affects the analysis -- again in a direction in favor of the proposal.

The Parameters.xls file only provides for one set of car and truck sales. Given that sales after MY 2032 are taken from this list, this should mean that the same levels of sales are used for all control scenarios after 2032. However, when we examined sales after 2032, we found that sales under the current standards were lower than under the proposal. This is probably due to the sales response model. Thus, while NHTSA ceases to apply the fleet share module after 2032, it continues applying the sales response model. Enabling the sales response model after 2032 slows down the turnover of the fleet under more stringent standards. Thus, enabling the sales response model again makes the proposal appear more beneficial. The inconsistent, and apparently arbitrary disabling of the fleet share model after 2032 again helps the proposal. The only consistency in NHTSA's approaches is in bias toward the rollback of the standards.

IX. Mileage Accumulation Schedules

The Volpe Model uses estimates of the vehicle miles travelled per year by vehicle age in order to convert changes in the fuel economy and CO2 emission rate of new vehicles into both lifetime estimates of fuel consumption and emissions and calendar estimates of the same. Prior to the TAR, NHTSA obtained its estimates of VMT by vehicle age from the National Household Travel Survey (NHTS).[48] At the time of the TAR, the latest NHTS was from 2009. The mileage accumulation schedules used both prior to the TAR and for the TAR were assumed to be static; that is, they stayed the same regardless of the CAFE or CO2 scenario being evaluated. In the TAR, NHTSA simply stated that it developed new mileage accumulation schedules based on purchased data from Polk. No reason was given for the need to replace the NHTS-based schedules.[49]

In the NPRM, NHTSA provided several reasons for not using the 2009 NHTS data.[50] One, the survey was taken during the Great Recession. Two, it was based on a relatively small sample (113,000 households and 210,000 vehicles). Three, the results from the more recent 2017 NHTS were not yet available. Four, the Polk data applied to 2015, after the recovery from the Great Recession. Five, it represented a much larger sample of vehicles. Six, it was collected by a third party.

NHTSA describes the Polk data in general terms. However, presumably because it is proprietary, NHTSA did not publish the data. Thus, we have no ability to review it and comment upon it. NHTSA did state that they adjusted the Polk data for the cost of fuel using their recent 20% estimate of the rebound effect.[51] Thus, the mileage accumulation schedules are dependent on this questionable level of rebound.

Throughout several pages of discussion of its processing of the Polk data, NHTSA never mentions the development of "dynamic" mileage accumulation schedules.[52] Then, in Table II-42, NHTSA presents both static and dynamic lifetime mileage estimates using the 2009 NHTS and Polk data.[53] In a footnote NHTSA states that the particular dynamic mileages shown are based on their "central estimates" of GDP growth and fuel prices and apply to a 2016 vehicle with no further fuel economy or CO2 emission standards.[54] NHTSA goes on to state that the dynamic lifetimes mileage estimates were produced by the dynamic scrappage model, which is addressed below.[55] Based on the subsequent review of the scrappage model, we have no ability to review and comment upon their new dynamic mileage accumulation schedules, either. The mileages shown in Table II-42 indicate that the new schedules reduce the lifetime VMT of cars and light trucks compared to past schedules by 96,882 miles and 89,529-99,445 miles, respectively, on a "static" basis. These reductions represent 32% and 29-32% of lifetime car and light truck VMT, respectively. These are significant changes. The reductions range from 13-15% on the new, "dynamic" basis. NHTSA does not describe any attempt to reconcile either the

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[48] TAR, p. 13-11.

[49] *Ibid*.

[50] FR, Vol 83, No. 165, August 24, 2018, pp 43089.

[51] FR, Vol 83, No. 165, August 24, 2018, p 43090.

[52] FR, Vol 83, No. 165, August 24, 2018, pp 43089-92.

[53] FR, Vol 83, No. 165, August 24, 2018, p 43092

[54] *Ibid*.

[55] FR, Vol 83, No. 165, August 24, 2018, p 43092-93.

previous or new schedules at a fleetwide level with any independent data sources. It simply claims that the data used to generate the new schedules are better than the old data.

One obvious way to assess the accuracy of the schedules is to compare the projections of the Volpe Model of total fleetwide fuel consumption in a recent calendar year with actual gasoline sales. Gasoline is by far the predominant fuel used by cars and light trucks. Gasoline sales are tracked several ways, but one is the collection of Federal excise taxes. Since it is unlikely that people are paying taxes on fuel that wasn't sold, tax collections represent a lower bound of actual gasoline sales.

The EIA collects data on gasoline consumption. Its Annual Energy Outlooks contains gasoline consumption for the most recent couple of years of historical data and also projects gasoline consumption into the future. Table 11 presents car plus light truck VMT, fleet-wide fuel economy and fleetwide gasoline consumption from the Volpe Model run in CO2 mode for current CO2 standards. Table 11 also presents the analogous information from the 2018 Annual Energy Outlook.[56] We selected the Volpe Model output for the current CO2 standards as these were assumed to be in place by EIA in their projections.

Table 11: Fleet-wide Light-Duty Gasoline Consumption in the Volpe Model and the 2018 EIA Annual Energy Outlook

Calendar Year	Volpe Model: Current CO2 Standards with NHTSA Inputs			2018 Annual Energy Outlook[57]		
	VMT (billion)	Fuel Economy (mpg)	Gasoline Consumption (billion gallons)	VMT (billion)	Fuel Economy (mpg)	Gasoline Consumption (billion gallons)
2016	2224	23.4	95.0	2747	22.4	122.6
2017	2295	23.8	96.3	2794	22.8	122.5
2025	2865	29.4	97.6	2879	27.8	103.6
2030	3093	32.7	94.6	2943	31.7	92.8
2040	3207	34.9	91.9	3010	34.7	86.7
2045	3412	37.0	89.2	3086	36.6	84.3
2050	3536	41.3	85.6	3302	38.2	80.8

We focus first on calendar year 2016 as this represents historic data. It is also prior to any year in which the Volpe model projects any difference in technology application between the current CO2 standards and the proposed freeze at 2020 levels, which might lead to differences in scrappage impact. As can be seen, the Volpe Model's projection of both VMT and gasoline consumption are well below those of EIA. The EIA projection for gasoline consumption cannot be far off, as it must be reconciled with tax receipts. Other uses of gasoline, such as heavy-duty vehicles and off-road equipment, are very small relative to cars and light trucks. Also, NHTSA's projected fuel economy for the fleet in 2017 is 1.0 mpg higher than EIA's. We believe that both NHTSA and EIA use fuel economy estimates from EPA's Fuel Economy Trends report. Thus, this is not likely to be the source of the difference. For NHTSA to have a

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[56] VMT and average fleetwide fuel economy were taken from Table A7 of the appendix to the 2018 Annual Energy Outlook. Gasoline consumption by light-duty vehicles was calculated by dividing VMT by fuel economy.

[57] Annual Energy Outlook 2018 with projections to 2050, U.S. Energy Information Administration, Feb. 6, 2018.

higher fleetwide fuel economy than EIA, NHTSA's fleet must be younger on average than EIA's. Thus, for 2017, NHTSA is projecting much lower VMT than EIA and higher fleetwide fuel economy, resulting in 29% lower fuel consumption than EIA.

Fleetwide VMT is a function of both vehicle survival (or scrappage) and VMT by vehicle age. Other than its scrappage model, NHTSA did not describe making any changes to its vehicle survival fractions. (If NHTSA changed its projected survival fractions when it changed its mileage accumulation schedules, it did not describe this process.) We ran the Volpe Model with and without the scrappage model enabled. The scrappage model increases VMT in 2016 by over 10%, equally for all control scenarios. Thus, the VMT in the Volpe Model would be even lower in 2016 than shown in Table 11 without the scrappage model enabled. In any event, the scrappage model would be adding older vehicles to the fleet, which would be reducing fuel economy, not increasing it. Thus, it cannot be the cause of the 1.0 mpg difference shown in Table 11.

As mentioned above, the cause of the large difference in VMT between the Volpe Model and EIA could be in the number of vehicles on the road or their VMT per year. However, given that NHTSA says that it reduced the static lifetime VMT of cars and light trucks by 29-32% via their new VMT schedules, and the dynamic lifetime VMT by 13-15%, it seems fair to conclude that eliminating this change would eliminate half to all of the discrepancy between the Volpe Model's fuel consumption and EIA's measurement of actual gasoline consumption in 2016 (and 2017). In either case, the new mileage accumulation schedules are causing the Volpe Model's estimates of national fuel consumption to differ substantially from accurate estimates of national fuel consumption.

It is puzzling that NHTSA did not check its new projections against this independent and obvious source of data. This is especially puzzling given that NHTSA refers to the Highway Trust Fund (which is the recipient of Federal highway fuel excise taxes) on page 43187 of the preamble to the proposal. However, it is consistent with NHTSA's approach to their scrappage model, where they didn't feel the need to ensure that the VMT that scrappage was adding was consistent with the lost VMT from new vehicle sales, the cause of the presumed increase in scrappage in the first place.

Looking forward to 2025, the Volpe Model's projection of fleetwide VMT has caught up to EIA's. The Volpe Model's fleetwide average fuel economy is still above EIA's. The difference has even widened to 1.6 mpg. This is surprising, as the scrappage model should be adding older vehicles to the fleet under the current CO2 standards. Older vehicles have worse fuel economy than newer ones. With higher fuel economy, the Volpe Model still projects slightly lower fuel consumption.

Between 2017 and 2025, fleetwide VMT grows by 3.1% per year in the Volpe Model, while it only grows 0.5% per year in the 2018 Annual Energy Outlook. These are both projections, so they inherently have some degree of uncertainty associated with them. However, we checked growth in total VMT historically using data collected by the Federal Highway Administration (FHwA). Estimates of total annual VMT nationwide are available from their Travel Monitoring website.[58] The monthly report for December of each year includes the VMT for the entire year. Prior to 2003, VMT is shown on a line chart going back to 1975.

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[58] FHw A, Travel Monitoring, https://www.fhwa.dot.gov/policyinformation/travel_monitoring/tvt.cfm, submitted via a file named FHwA Historical VMT.pdf.

Between 1993 and 2003, annual VMT grew by a steady 70 billion miles per year. As of 2003, national VMT was 2850 billion miles. Thus, this growth represented a growth of 2.5% of 1993 VMT. By 2007, national VMT had only grown to 3,003 billion miles, or only 35 billion gallons per year. Due to the Great Recession, national VMT was still only 2,972 billion miles in 2013. By 2017, the latest year with an annual VMT estimate, nationwide VMT had growth to 3,208 billion miles. This represents average annual growth of 2% per year since 2013, but includes the recovery of any pent up demand from the recession due to the good economy of the past several years. Also, national VMT in 2017 was actually less than that in 2016. Thus, the projection of 3% growth per annum over the next 8 years seems to be too high even during the high growth years of the late 1990s and much too high given recent data during and after the recession.

We attempted to determine where this high growth in VMT is coming from in the Volpe Model. When we set the rebound effect to zero, VMT in 2025 actually increases and growth from 2017 increases to 3.2% per year. When we disable the scrappage model and set rebound to zero, VMT decreases in both 2017 and 2025, but growth between 2017 and 2025 increases to 3.4% per year. Disabling the fleet share model had little impact on national VMT in either 2017 or 2025, so it was not causing the growth.

Finally, we disabled the sales response model and found two effects. First, it eliminated any changes in new vehicle sales over time. New vehicle sales remained constant at 2016 levels. Thus, without the sales response model operative, the future sales projections contained in the Parameter file are no longer utilized. Second, disabling the sales response model eliminates any changes in new vehicle sales across CO2 scenarios. These effects imply that it is the sales response model that is the cause of the large growth in VMT between 2016 and 2025. Growth in the sale of new vehicles is very low over this time period, meaning that is not a significant contribution to the growth in VMT. Something else is causing national VMT to grow by 3% per year during this time frame. About two-thirds of the growth is coming from an increase in the size of the onroad vehicle fleet. About one-third of the growth is coming from an increase in VMT per year for the average vehicle on the road. Neither of these changes appears to have any connection with the sales response model. Lifetime mileage of newer, 2027 and later MY vehicles is not changing at all.

Beyond 2025, the Volpe Model continues to project much higher growth in VMT compared to EIA. Again, the reasons for this are not clear, as rebound, scrappage and fleet share models do not appear to be the cause. The scrappage model certainly increases VMT, but it does so to the same degree in 2025 as it does in 2040, so it contributes more of a step increase in VMT and not year over year growth, per se. In this timeframe, year-over-year growth is coming entirely from an increase in the size of the onroad vehicle fleet, as VMT per year per the average onroad vehicle is shrinking.

It is interesting to see the impact of the various Volpe "modules" on lifetime VMT. As mentioned by NHTSA, the new mileage accumulation rates drastically reduce lifetime VMT.[59] With no rebound, no scrappage module, and no fleet share module active, the lifetime VMT of cars and light trucks is only 161,000 miles. This mileage is not affected by CAFE or CO2 control scenario.

Adding the scrappage model, but without the "price" factors, lifetime VMT for cars and trucks increases to 174-175,000 miles under the proposed freeze and 175-176,000 miles under the current CO2

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[59] FR, Vol 83, No. 165, August 24, 2018, pp 43092

standards. Thus, not surprisingly, the scrappage model adds used vehicles to the fleet by reducing scrappage. This in turn adds mileage to the each model year's life. Oddly, this increase in lifetime mileage is essentially the same starting with the 2016 MY through the 2050 MY. Even more oddly, the increase in used vehicle VMT is larger for the current standards than under the proposed freeze. In this run, the only scrappage effects are those related to fuel costs per mile. Economic theory would argue that the better the fuel economy of new vehicles (and over time, relatively new vehicles as these new vehicles age), the less desirable older vehicles become and the more these older vehicles are scrapped. NHTSA's fuel terms in their scrappage model produce the opposite effect, reducing scrappage for scenarios with better fuel economy. One expects this trend for higher new vehicle prices, but not for higher new vehicle fuel economy. NHTSA fails to point this out. Thus, instead of the effects of higher prices and lower fuel costs mitigating each other, both work to reduce scrappage. The next section will discuss the scrappage model in more detail. However, this finding contradicts fundamental economics. The current scrappage model should be rejected and any replacement for the model necessitates a reproposal.

In summary, regarding the impact of the Volpe Model's new mileage accumulation schedules on the analysis supporting the proposal, the effect appears to be substantial. As NHTSA stated, the lifetime VMT per vehicle decreased by 29-32% compared to past analyses. Unadjusted, this reduces the benefits of any technology applied to vehicles by roughly the same percentage. Given that the Volpe Model VMT falls far short of confident measurements of gasoline consumption, these mileage accumulation schedules need to be increased. The 2017 NHTS is now available and should be reviewed for possible use. Differences between the more recent NHTS and the Polk data should be analyzed in detail and this analysis released for public review. Regardless of the source of mileage accumulation data believed to be the most accurate, it must produce realistic estimates of national gasoline consumption from cars and light trucks or be adjusted appropriately. If it required adjustment (or calibration), the potential impact of the calibrated estimates on the benefits of the current or alternative proposal needs to be evaluated and again offered for review and comment.

Finally, referring back to Table 11, NHTSA must explain what is causing the large growth in VMT between 2017 and 2025 and present this function for comment. NHTSA should also justify this large growth, assuming it remains, in the face of EIA projections and recent increases in VMT estimated by FHwA.

X. Scrappage Module

NHTSA's new scrappage module is described in Section 8.10.4 of the PRIA. NHTSA's intention was that this model reflect what it referred to as the "Gruenspecht effect". This is the effect of an increase in the price of new vehicles (less consumer's value of improved fuel economy) on new vehicle sales.[60] (Note that we are now talking about a move from less stringent CAFE standards to more stringent ones, which is the opposite of the proposal.) This new vehicle price increase sets off a projected chain of events leading to reduced scrappage of used vehicles, which leads to a dramatic increase in older vehicle VMT.

The rationale behind NHTSA's scrappage model is that higher vehicle prices associated with more stringent CAFE and CO2 emission standards will reduce new vehicle sales. This increase in new vehicle prices and is then followed through to an increase in the number (and use) of used vehicles on the road.

NHTSA projects the following chain of events:

1) When a prospective vehicle purchaser does not buy a new vehicle because its price has increased, this person will continue to operate their existing vehicle. The continued operation of the existing vehicle may be in lieu of selling that vehicle (i.e., trading it in for the new one no longer being purchased) or may entail repair of repairing the existing vehicle rather than scrapping it.
2) This continued use of existing vehicles by people who otherwise would have purchased a new vehicle and put their used vehicle on the market will increase the demand for used vehicles, thereby raising their price (e.g., value).
3) This increase in value of older vehicles will cause the owners of some of these used vehicles to repair their vehicles where these vehicles would otherwise have been scrapped. The net result of increasing the price of new vehicles is a reduction in the number of new vehicles on the road, coupled with an increase in the number of used vehicles on the road. This increases the average age of vehicles on the road and slows the replacement of used vehicles with new ones, slowing the impact of improvements being introduced in new vehicles, such as fuel economy, performance, and safety.
4) NHTSA does not connect the loss of new vehicle sales to the increased number of used vehicles on the road. The agency states that it would have liked to have done this, but didn't have the time.[61] In any event, NHTSA did not connect the two models.
5) NHTSA does not vary the annual mileage of new or used vehicles. Since NHTSA does not track the number of vehicles on the road, neither do they track the amount of VMT occurring in any particular calendar year.

First, as described above, NHTSA focuses on vehicles, not VMT. This is a fundamental problem, as people rarely own vehicles just to have them. They own them to provide convenient personal transportation. VMT is the main measure of this demand. Both new and used vehicles satisfy this demand at a certain cost and comfort. Thus, developing a model which predicts vehicles on the road seems misplaced, particularly without any consideration of how these additional vehicles are driven.

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[60] PRIA, pp. 1003.

[61] FR, Vol 83, No. 165, August 24, 2018, p. 43099.

Second, scrappage is a continuous phenomenon, occurring with variability over roughly 40 years or so of a vehicle's potential life. It can occur for a number of reasons, but scrappage is primarily due to the need for a substantial investment to maintain a vehicle's drivability. When this investment, usually in the form of a repair, exceeds the value of the vehicle, the vehicle is scrapped. It is possible that the cost of maintenance would be sufficiently high to exceed the value of maintaining the vehicle's drivability. But in this case, the vehicle must be very close to the end of its life, as maintenance costs are usually in the tens to hundreds of dollars and much smaller than the value of a vehicle whose life can be significantly extended simply by maintenance (e.g., oil change, coolant change, new battery, new tires, etc.).

NHTSA does not evaluate how a change in new vehicle prices affects used vehicle prices of various designs and vintages. NHTSA does not evaluate the frequency of repairs over a vehicle's life, or the cost of these repairs. NHTSA does not evaluate the frequency or cost of maintenance over a vehicle's life. NHTSA does not even bother to define what types of vehicle activities would constitute repairs and what would constitute maintenance. The only cost relating to used vehicles addressed by NHTSA in their scrappage model is the vehicle's cost of fuel to drive 100 miles. Thus, NHTSA starts out with reasonable statements about higher used vehicle values encouraging more repairs and ends up with higher new vehicle prices and new and used vehicle fuel costs per mile -- not repair costs-- being determinative of scrappage. Fuel cost might be a factor on the margin, but is hardly the primary cause of vehicle scrappage. Worse, as already mentioned in the previous section, it appears that the terms in the scrappage model for pickup trucks related to new and used vehicle fuel costs actually work in the opposite direction of NHTSA's economic theory.[62] As new vehicle fuel economy increases, the survival fraction of used vehicles increases. At minimum, this needs to be described in detail and rationalized (assuming that is even possible).

Scrappage is not related to a model year. Every vehicle sold during each and every model year is eventually scrapped. Scrappage occurs in real time and is generally measured in terms of the age or accumulated mileage of the vehicle at the time of scrappage. This fact should make it obvious that NHTSA's inclusion of scrappage effects in a "model year" analysis is misguided, as discussed above.

NHTSA hypothesizes that increased new vehicle prices will reduce the sale of new vehicles. While new vehicle sales are described in terms of a model year, these sales occur during a specified period of time, usually a few months of the previous calendar year and most of the current calendar year. It is this increase in new vehicle prices during a specified period of real time that affects scrappage. The continued use of higher priced (when new) vehicles has no effect on scrappage. So again, the inclusion of scrappage in a model year analysis is inappropriate.

Looking at the 2025 CY in the NHTSA simulation of the CO2 standards, VMT from new 2025 cars and trucks decreases by 4 billion miles with the current CO2 standards compared to the proposal. In response, the scrappage model adds 28 billion miles of VMT from used vehicles in CY 2025. Thus, the scrappage model adds 7 miles of used vehicle operation for each lost mile of new vehicle operation.

There is nothing in NHTSA's rationale for the scrappage effect which would support a net increase in VMT -- much less a 7-fold increase -- when the cost of new vehicles is increasing. The

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[62] See FR, Vol 83, No. 165, August 24, 2018, pp 43095 for a discussion on how NHTSA expects that improved new vehicle fuel economy should encourage the scrappage of older, less fuel efficient vehicles.

Gruenspecht effect might argue that an increase in new vehicle prices could increase the value of used vehicles.[63] However, there is nothing within this theory which argues that the increase in used vehicle prices in unbounded. As NHTSA's own hypothetical economic figures show, the demand for vehicles (really personal travel) has not changed. NHTSA does not present a theory which would support their finding that the demand for used vehicles will increase more than the decrease in new vehicle sales. NHTSA must address the question of how used vehicle prices (values) would continue to increase once the increase in used vehicles on the road equaled the reduction in new vehicles on the road.

Under NHTSA's theory, both new and used vehicle prices increase. NHTSA also argues that vehicle transactions occur frequently, leading to new equilibriums of vehicle ownership over a short period of time. This means that the cost of buying a used vehicle will increase for those who need a new used vehicle. The cost of operating a new vehicle increases and decreases (due to the improvement in fuel economy). However, the cost of operating a used vehicle can only increase (due to higher insurance costs for all used vehicle owners and purchase prices for those who need a new used vehicle). In the fact of these increased costs, there is no economic theory which will support an increase in the total demand for VMT. The increased value of used vehicles could lead some owners to repair their vehicles when they otherwise would have scrapped them. But the finite demand for VMT will limit the number of vehicles for which this is true. NHTSA did not constrain its analysis to prevent their "model" from overcompensating in this way. In the end, it overcompensates and predicts that the overall demand for VMT will increase in the fact of increasing costs. This needs to be corrected and new analyses conducted and reproposed for public comment.

A sophisticated model is not needed to correct this problem. One only needs to adjust the VMT added by the "scrappage model" so that it matches the VMT lost by the sales response model. Put another way, used vehicles would be used to the same extent as new vehicles since they meet the identical demand (possibly minus a rebound effect).[64] NHTSA clearly states that the scrappage model should be linked to the sales response model, but isn't.[65] NHTSA implies that this lack of linkage was due to inadequate time. However, calibrating the increased VMT from reduced scrappage to match the lost VMT from new vehicles could have been accomplished with a few hours of programming. We've done this outside the Volpe model ourselves. Thus, we can only assume that NHTSA did not want to do this, as it would have reduced the increase in VMT from reduced scrappage dramatically and reduced the proffered justification for their "Safer Vehicle" proposal.

Even this adjustment would still be in favor of the proposal, as it assumes that all of the VMT lost from fewer new vehicle sales would be replaced by used vehicle VMT. This assumes that travel is inelastic. This is clearly not the case given NHTSA's position on the rebound effect. NHTSA must first justify the used vehicle response to any change in new vehicle sales. Then, in the unlikely event that this can be done, NHTSA must link the scrappage model to the sales response model to ensure that the combination of the two models does not increase VMT in any calendar year (and probably show a decrease, as the overall cost of driving will have increased).

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[63] PRIA, pp. 1003.

[64] See, e.g. proposal at 43135 giving an example of just this type of "truing up".

[65] <u>FR</u>, Vol 83, No. 165, August 24, 2018, p. 43099.

It is important to note that NHTSA fails to account for three large economic impacts occurring during this process.

1) The increase in value of the entire used vehicle fleet from 2017-2050. This is a windfall gain for all current vehicle owners that is completely ignored;
2) The cost of repairing and maintaining the older vehicles which are no longer scrapped,
3) The value of the additional driving that these vehicles provide.

NHTSA only counts the costs related to the additional driving performed by the non-scrapped vehicles. Again, NHTSA's decision to only include this cost maximizes monetary costs related to the current standards and minimizes those related to the proposal.

NHTSA was able to hide these exclusions because their scrappage model does not even evaluate the increase in used vehicle value that might result from a change in new vehicle costs. Likewise, they never evaluate the cost of repairs to this increase in used vehicle values. The value of additional driving could easily have been estimated, as NHTSA did this for rebound related driving (treating these identical situations in opposite fashion is of course a classic instance of arbitrariness). The fact that NHTSA does not do this in the case of scrappage-affected driving is a sign of directional bias. The repair and maintenance costs, however, are an impediment to reduced scrappage and NHTSA nowhere shows how this impediment is overcome. The value of the additional driving must exceed both the incremental cost of the driving plus the repair and maintenance cost, or consumers would not conduct the repairs in the first place. Ignoring this value is yet another indication of NHTSA's bias in this proposal.

A more detailed evaluation of the scrappage model is continued below. However, at this point in our review several strong conclusions can already be drawn.

1) NHTSA's scrappage model increases VMT relative to the loss of new vehicle VMT; this is contrary to fundamental economic theory;
2) NHTSA has ignored the increase in the value of used vehicles to current owners of these vehicles; thus, its economic analysis of the proposal is fundamentally flawed;
3) NHTSA has ignored the cost of repairs needed to reduce scrappage; again leading to a fundamentally flawed analysis of the proposal;
4) NHTSA has ignored the value of the driving performed by any vehicles no longer being scrapped, again causing its analysis of the proposal to be fundamentally flawed.

As a result, the current scrappage model should itself by scrapped. As this model is a primary cause of many of the findings in NHTSA's proposal, any action taken on the basis of this proposal should be considered arbitrary and capricious, as the decisions associated with the current model are deeply flawed.

Detailed Evaluation of the Impact of the Scrappage Model on VMT

Because NHTSA's estimates of the impact of a change in new vehicle price on new vehicle sales and use (the sales response model) and the impact on used vehicles (the scrappage model) are not linked, steps one and three above operate as two entirely separate rationales. Economic reality demands that they be linked, as steps two and three occur only to the degree that step one reduces the sales of and thus, the amount of driving by new vehicles. Because the two models are explicitly not linked, however, step one and steps two and three work independently and, as it turns out, inconsistently.

The sales response model is used to project the impacts of step one, higher vehicle prices. That model was evaluated above. On the surface, its projections are fairly straightforward: higher vehicle prices, lower vehicle sales. However, as described above, NHTSA failed to find an effect of fuel economy on new vehicle sales. Rather than questioning the validity of its model in the face of evidence to the contrary, NHTSA accepted its sales response model and inserted it into the Volpe Model. Accepting this directional change for the sake of argument here, if drivers purchase fewer new vehicles, they will drive older vehicles instead. Note that this substitution implicitly assumes that the demand for driving is inelastic; fewer new vehicle VMT, more used vehicle VMT. NHTSA does not claim that driving is inelastic in its description of the scrappage model. They ignore any discussion of driving entirely, focusing on vehicles instead. In contrast, NHTSA's premise behind the rebound effect is that the demand for driving is clearly elastic. In an elastic market, an increase in the cost of a good (here driving) results in lower demand. However, NHTSA never evaluates this relationship. Instead, NHTSA skips to steps two and three above, with the economically absurd result that an increase in the cost of driving will produce more driving. In other words, NHTSA projects that used vehicle VMT will increase more than new vehicle VMT declines![66] This will be shown below in detail as we present the results of NHTSA's Volpe Model projections.

Again, NHTSA does not consider the decrease in new vehicle VMT when developing its scrappage model. Instead, it focuses on the rationale behind steps two and three above that the increased demand for older vehicles will increase their price (value). This will cause more of them to be repaired rather than scrapped, increasing the amount of driving proportionately. There is no limit on the amount of this increased VMT by older vehicles. The increase in older vehicle VMT could and does exceed the reduction in new vehicle VMT, producing the absurd result that increasing the cost of vehicle ownership will increase the number of vehicles on the road. It is necessary to evaluate each of the steps in NHTSA's description of how this scrappage impact works to ascertain which rationale is at work at each step and assess the degree to which the scrappage module follows NHTSA's own economic logic.

Before doing so, we point out a glaring hole in NHTSA's analysis. When describing the process whereby a potential new vehicle purchaser chooses to forego buying a new vehicle and continues to drive their existing vehicle, NHTSA's scrappage model ignores the fact that this action shifts VMT from a new vehicle with a higher average mileage per year to a used vehicle with a lower average mileage. Either the driver of this vehicle will drive their older vehicle less, causing overall VMT to decline, or the average mileage of the used vehicle will increase without any need to affect scrappage. By focusing solely on scrappage, and focusing the change in scrappage on those vehicles with the worst fuel economy (i.e., the oldest vehicles), NHTSA essentially shifts new vehicle VMT to the oldest vehicles. According to NHTSA's own rationale, much of the lost VMT from new vehicles will be replaced by vehicles only a few years old. The VMT of these relatively new used vehicles which is then replaced by

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[66] Even interagency commenters other than EPA noted this startling prediction, so at odds with the most elementary economic theory. Thus, in addition to recommending several times that NHTSA peer review the scrappage model, reviewers also recommended the following charge question: "The new sales and scrappage models projects an increase in the size of the vehicle fleet under the augural standards case compared to the proposed alternative , despite an expected increase in the price of vehicles. This results in an increase in VMT, even beyond the level that would be predicted by rebound effects, and therefore increased exposure to crashes. For both the sales and scrappage models, please answer the following: Are the assumptions and the structure of the model reasonable and appropriate?" Interagency Comments of July 17, 2018 at 2:51 PM.

VMT from older used vehicles, and so on. t is likely that NHTSA is vastly over-estimating the impact on the oldest used vehicles and under-estimating the impact on newer used vehicles.

Increases in New Vehicle Prices Will Increase Used Vehicle Prices

In general, this seems to be a reasonable assumption. Consumers looking to purchase an automobile can choose either a new or used vehicle, so the two markets compete. In fact, they are simply two aspects of one single market for personal transportation, since a one-year old "used" vehicle is much closer in price and quality to a "new" vehicle than a 20-year old "used" vehicle, yet both of those vehicles are considered "used" by NHTSA. NHTSA states that Gruenspecht acknowledged that a structural model which allows new vehicle prices to affect used vehicle scrappage only through their effect on used vehicle prices would be preferable,[67] NHTSA states that such data were limited. Therefore, NHTSA sis not attempt to include used vehicle prices in their scrappage model.[68] However, they apparently could not find any, despite extensive publication of used vehicle values in Kelly's Blue Book and other publications. In the absence of any data or analysis, NHTSA did not describe the extent to which changes in new vehicle prices affect used vehicle prices of varying age, condition, etc. Given that vehicles can sell for as little as a couple of hundred dollars and new vehicle prices average over $30,000, used vehicle prices can be as little as 1% of that of a new vehicle. Given that the largest increase in new vehicle prices projected by NHTSA in the NPRM is less than $3000, and assuming that its effect on used vehicle prices is likely to be roughly proportional to current relative prices, this might mean that the value of a very old vehicle or one in poor condition might only increase by $30 (decline by $30 under the proposal). It is difficult to see how such a change in value would have a measurable impact on scrappage. Of course, the impact of an increase in new vehicle prices on used vehicle prices might be more or less than proportional to their current relative values. However, NHTSA has done nothing to show which might be the case. The probability of any realistic change in used vehicle prices to induce the scrappage of used vehicles is still a complete mystery.

NHTSA also completely ignores the decrease in value of the onroad fleet which was caused by the decrease in new vehicle prices projected for the proposal. As soon as new vehicle prices decrease, the value of each and every used vehicle will decrease. This does not change the cost of operating a used vehicle, other than in insurance and licensing fees, which will likely decrease. However, it will decrease the value of a vehicle being traded in (or sold by owner) when the purchaser of a new vehicle trades up. NHTSA acknowledges this effect.[69] However, NHTSA makes no mention of the loss in value to these used vehicle owners who now have to scrap their vehicle, or to all the other owners of used vehicles who suddenly realize that their vehicles have dropped in value. This decrease in the value of the used vehicle fleet should be counted against the proposal (or credited to the more stringent standards which would increase vehicle prices. But NHTSA does not do this. Nor does NHTSA explain why it completely ignores the societal cost of decreasing the value of used vehicles associated with the proposal. This should be a major cost of the proposal, but NHTSA says nothing about it. This is a glaring omission.

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[67] FR, Vol 83, No. 165, August 24, 2018, p.43093

[68] *Ibid*.

[69] FR, Vol 83, No. 165, August 24, 2018, pp 43099

The Increase in the Value of Used Vehicles Will Reduce Their Scrappage

That an increase in the value of used vehicles will reduce their scrappage is a reasonable expectation. For example, is it common for insurance companies to compare the value of a vehicle which has been in an accident to the cost of repairing it and decide whether it is cheaper to repair it or scrap it and pay the owner the value. Of course, the insurance company does not need to find a replacement vehicle, assess its quality, possibly obtain financing and physically obtain the vehicle and register it for use. Still, some comparison of repair cost to replacement cost is made. NHTSA again expresses the desire to have data on the frequency and severity of repairs (this would have to include potential repairs which are not performed in lieu of scrappage).[70] However, NHTSA could not find any such data. Thus, again, any quantitative relationship between used vehicle prices and scrappage are a complete mystery.

In addition, in lieu of using repair data to project vehicle scrappage versus repair, NHTSA substitutes operating and maintenance costs. It is not clear what NHTSA meant by maintenance; whether this means an oil change, a change of air filter, tune up, new tires, etc. While some maintenance costs can be substantial, maintenance can usually be put off until something breaks. In fact, a casual drive reveals vehicles having a wide degree of body maintenance and repair. In the end, NHTSA does not even include maintenance costs in its scrappage. They simply assume that the cost of fuel per mile is an adequate surrogate for the cost of repairing and maintaining a vehicle as it ages. Thus, NHTSA begins with a reasonable, if general, theory linking new vehicle prices to used vehicle prices and used vehicle prices to the likelihood of scrappage and ends up with a correlation between new vehicle prices and new and used vehicle fuel economy and the likelihood of scrappage.

Given the tenuous connection between fuel costs and scrappage, the inclusion of fuel costs in NHTSA's scrappage model is of questionable value. Historically, fuel economy has been generally increasing for over the past 40 years, with the cost of fuel per mile decreasing over this same time frame. Thus, NHTSA's use of fuel cost per mile of used vehicles in its scrappage model simply orients scrappage towards either the newest vehicles on the road (those with the lowest fuel cost per mile) or towards the oldest vehicles on the road (those with the highest fuel cost per mile), depending on the sign of the coefficient for this factor. It seems that, in the absence of data actually pertinent to the decision to scrap a vehicle or not, NHTSA has simply substituted a readily available vehicle factor which has little relevance to the scrappage decision. We cannot even determine how important these fuel cost per mile terms were to the model, as NHTSA did not publish any of the underlying data or statistical analysis.

NHTSA did not evaluate how vehicles being scrapped under the proposal would have been driven if they had not been scrapped. NHTSA does generally discuss how the proposal will shrink the size of the overall fleet. NHTSA states that this is expected, given that the increased number of new vehicles sold tend to be driven more than the older vehicles which would be scrapped.[71] NHTSA points out how the size of the onroad fleet in 2050 would be 1.5% larger under the augural standards than the proposal,

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[70] PRIA p. 1016, though NHTSA's statement is missing the word "not", as the sentence as written indicates that NHTSA was able to find an adequate source of repair cost data. However, the next sentence indicates that should a reliable source of information on repair costs be found, this factor would be added to the scrappage model in the future.

[71] *Ibid.*

but national VMT in 2050 would only be 0.4% larger. NHTSA did not point out that national VMT in 2036 would be 0.9% higher under the augural standards than the proposal. None of these estimates include the impact of rebound.[72]

NHTSA's economic theory does not justify any increase in VMT under the augural standards. Instead, national VMT should decrease if any change occurs at all. The proposal reduces the cost of new vehicles and NHTSA postulates that this in turn reduces the cost of used vehicles. While NHTSA focuses on the effect of these lower costs on the desirability of repair, the fact is that lower vehicle costs increase the opportunity to own a vehicle and drive it. These reductions in vehicle costs (used vehicle operating costs don't change) should increase the level of national VMT (i.e., move up the supply curve). Yet NHTSA's scrappage model decreases VMT under the proposal.

Focusing on 2050, the 0.4% increase in national VMT referenced by NHTSA for the augural standards (2025 CO2 standards) represents 12 billion miles. In 2050, NHTSA projected that total vehicle sales would decrease by 200,000 units under the 2025 CO2 standards. At 17,000 miles per year, NHTSA's estimate for new vehicles in their first year of operation, the loss of VMT from these 200,000 new vehicles is 3.4 billion miles. NHTSA's scrappage model replaced the lost 3.4 billion mile from new vehicles with 15.4 billion miles of used vehicle VMT for a net gain of 12 billion miles under the 2025 CO2 standards. NHTSA fails to mention these details when it refers to the changed scrappage patterns as the cause of the increase.

NHTSA Scrappage Module and Its Results

The lack of data on used vehicle prices and repair costs led NHTSA to conduct a purely statistical analysis of vehicles on the road against many forms of potentially relevant factors, each of unknown and unevaluated accuracy and even relevance. NHTSA does not present the results of any of its preliminary or scoping analyses, nor the results of any alternative scrappage models which it rejected or its reasons for rejecting them. The final scrappage model projects changes in the numbers of vehicles on the road by age as a function of macroeconomic factors, new vehicle price and vehicle fuel cost per mile (which in a particular calendar year is solely a function of fuel economy) by model year. As NHTSA admits, no attempt was made to connect the projections of the sales response module with those of the scrappage module, despite the fact that it is only the reduction in new vehicle sales that justifies the change in scrappage patterns.[73] Because the scrappage module only predicts vehicles on the road, as mentioned above, NHTSA uses the same estimates of VMT per year by age that they use prior to the adjustment for scrappage. NHTSA presents no data or analysis to justify this assumption. Based on the rationale behind the reduced scrappage, there should be no growth in the onroad fleet or onroad VMT; at most a one for one substitution of a repaired used vehicle for each lost sale of a new one, coupled with a decrease in total VMT due to higher vehicle costs. As will be seen, this is far from the case with NHTSA's scrappage module.

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[72] This sets aside another issue. Page 953 of the PRIA states that the sales impact of a $1000 price increase is highest in the first year and diminishes over the next ten years. Yet in 2050, 20 years after the price impact of the augural standards have stabilized, sales are still 200,000 units lower under the augural standards than the proposal. Worse, this sales impact is twice that projected for the 2036 MY.

[73] PRIA, p. 1064

In order to identify the impacts of the scrappage module on NHTSA's projections related to the proposed freeze, we conducted two runs of the Volpe Model, each with three CO2 control scenarios. The first run set rebound to zero, disabled the dynamic fleet share (DFS) module and disabled the scrappage module. The second run set rebound to zero and disabled the DFS module, but included the scrappage module. Rebound was removed so that direct comparisons could be made between the Volpe Model's projection of total VMT across CO2 control scenarios. The DFS module was disabled for the same reason, as it shifts the relative sale of cars and light trucks based on their relative fuel economy. The DFS cannot be shut off independently of the sales response module, which we desired to remain active, as this is the driver for the change in scrappage. We effectively disabled the DFS module by setting the value of the Rho and Dummy coefficients to 1.0 and the value of the other coefficients to zero. (The impact of the DFS module on the Volpe Model's projections is evaluated elsewhere.)

The three CO2 control scenarios were: 1) the current CO2 standards, 2) the proposed freeze of CO2 standards at 2020 levels, and 3) 1 mile per gallon (mpg) standards for both cars and light trucks. Under the last scenario, the 2016 model year fleet simply continues forward with no change being made to individual vehicle models. However, changes in total and relative sales of vehicle models do occur, driven by the macro-economic factors of the sales response model. Use of this control scenario allows impacts of the vehicle price and fuel economy variables in the sales response module to be identified.

The first step in this analysis is to compare the effect of the current and proposed CO2 standards on total car+light truck VMT by calendar year compared to that of the 1 mpg scenario. Table 12 shows these projections. In this run of the Volpe Model, rebound was set to zero, and the DFS and scrappage modules were disabled. The only module affecting vehicle sales and VMT is the sales response model. Projections are shown for 2018-2032. There were no differences between the two CO2 control scenarios in 2016 or 2017. After 2032, the effect of the sales response model was relatively constant, with a very slow decline.

Table 12: Effect of the Sales Response Module on VMT by Calendar Year Relative to a 1 MPG (No Control) Scenario– No Rebound, No Scrappage Module, No DFS Module (Billions of Miles)						
Calendar Year	Passenger Car		Light Truck		Total	
	Current Standards	Proposed Freeze	Current Standards	Proposed Freeze	Current Standards	Proposed Freeze
2018	-0.03	-0.03	-0.03	-0.03	-0.06	-0.06
2019	-0.08	-0.08	-0.07	-0.07	-0.15	-0.15
2020	-0.12	-0.12	-0.10	-0.10	-0.22	-0.22
2021	-0.17	-0.17	-0.14	-0.14	-0.31	-0.31
2022	-0.9	-0.5	-0.8	-0.4	-1.7	-0.9
2023	-1.7	-0.6	-1.5	-0.5	-3.2	-1.1
2024	-2.7	-0.7	-2.3	-0.6	-5.0	-1.3
2025	-3.9	-0.8	-3.3	-0.7	-7.2	-1.4
2026	-5.2	-0.8	-4.5	-0.7	-9.7	-1.5
2027	-6.7	-0.9	-5.7	-0.7	-12.3	-1.6
2028	-7.8	-0.9	-6.6	-0.7	-14.4	-1.6
2029	-8.8	-0.8	-7.5	-0.7	-16.3	-1.5
2030	-9.7	-0.8	-8.2	-0.7	-17.9	-1.5
2031	-10.1	-0.7	-8.6	-0.6	-18.7	-1.4
2032	-10.3	-0.7	-8.8	-0.6	-19.1	-1.2

While the projections in Table 12 are primarily for background relative to the subsequent tables, there are a couple items of note in these projections. First, the reductions in VMT for both the current CO2 standards and the freeze are the same for 2018-2021. This is likely due to round-off, as vehicle sales are reduced to a greater extent under the current CO2 standards than under the proposed freeze starting in 2018. Second, by 2032, the reduction in VMT under the current CO2 standards is over 15 times that under the proposed freeze. This is surprising given that the costs of the current CO2 standards are only a factor of 5-6 higher than those under the proposed freeze.

Table 13 shows the same projections, only this time with the scrappage model operative.

Table 13: Effect of the Sales Response and Scrappage Modules on VMT by Calendar Year Relative to a 1 MPG (No Control) Scenario– No Rebound, No DFS Module (Billions of Miles)						
Calendar Year	Passenger Car		Light Truck		Total	
	Current Standards	Proposed Freeze	Current Standards	Proposed Freeze	Current Standards	Proposed Freeze
2018	0.41	0.20	0.10	0.06	0.51	0.27
2019	1.46	0.38	0.88	0.30	2.34	0.68
2020	3.1	0.7	1.7	0.6	4.8	1.3
2021	5.7	1.1	3.0	1.0	8.6	2.0
2022	8.1	1.2	3.5	1.1	11.6	2.4
2023	10.4	1.4	4.3	1.3	14.6	2.7
2024	12.5	1.6	4.4	1.4	16.9	2.9
2025	14.0	1.6	4.2	1.3	18.2	2.9
2026	15.1	1.6	3.7	1.3	18.8	2.9
2027	16.3	1.6	3.0	1.3	19.4	2.9
2028	17.6	1.7	2.3	1.4	19.9	3.0
2029	18.6	1.7	1.5	1.4	20.1	3.1
2030	19.6	1.8	0.8	1.4	20.4	3.1
2031	20.7	1.8	0.7	1.4	21.4	3.2
2032	21.8	1.9	0.8	1.5	22.6	3.4

As can be seen, with both the sales response and scrappage modules active, VMT in any given calendar year increases by 0.5-23 billion miles under the current CO2 standards relative to a no control case. Total VMT from cars and light trucks ranges from 2.4 trillion miles in 2028 to 3.2 trillion miles in 2032. While the increases shown in Table 13 are small in comparison to total VMT, they have an outsized impact on all of the relevant aspects of the proposal (CO2 emissions, fuel consumption, fatalities), because the increased VMT is from vehicles with relatively low fuel economy and high fatality rates per mile. VMT also increases under the proposed freeze, though to a far lesser extent. The net result of these unjustifiable increases in VMT under the current standards is that the increase in CO2 emissions and fuel consumption associated with the freeze are underestimated and the reduction in fatalities are overestimated.

As discussed above, there is nothing in NHTSA's rationale for reduced new vehicle sales and associated reduced scrappage which would indicate that VMT should increase. We are not aware of any economic arguments which would support such an increase. All that can be said is that NHTSA put data from a variety of sources through a statistical regression and never bothered to see if the results were reasonable or consistent with its own economic theory. It is noteworthy that this negligence is in the direction of supporting its proposed freeze in lieu of the current CAFE and CO2 standards.

We present one last table which highlights the degree that the scrappage model overestimates the loss of VMT related to reduced new vehicle sales. Table 14 presents the ratio of the VMT added by the scrappage module to the loss in VMT from the sales response module.

Table 14: Ratio of the VMT Added by the Scrappage Module to the Loss in VMT from the Sales Response Model by Calendar Year

Calendar Year	Passenger Car		Light Truck		Total	
	Current Standards	Proposed Freeze	Current Standards	Proposed Freeze	Current Standards	Proposed Freeze
2018	13.63	7.18	4.54	3.32	9.44	5.40
2019	19.16	5.71	13.76	5.40	16.67	5.57
2020	26.98	6.91	17.41	6.91	22.57	6.91
2021	34.97	7.35	21.89	7.97	28.95	7.64
2022	9.92	3.69	5.59	3.85	7.93	3.76
2023	7.02	3.45	3.89	3.53	5.58	3.49
2024	5.64	3.20	2.93	3.23	4.39	3.21
2025	4.61	3.04	2.28	3.02	3.54	3.03
2026	3.89	2.95	1.83	2.86	2.94	2.91
2027	3.45	2.89	1.54	2.80	2.57	2.85
2028	3.26	2.95	1.35	2.91	2.38	2.93
2029	3.10	3.07	1.20	2.96	2.23	3.02
2030	3.02	3.25	1.10	3.05	2.14	3.16
2031	3.05	3.51	1.08	3.25	2.14	3.39
2032	3.11	3.85	1.09	3.58	2.18	3.72

As can be seen, the scrappage model over-compensates for any loss in total VMT from reduced new vehicle sales by a factor of 2-29 under the current CO2 standards and a ratio of 4-8 for the proposed freeze. (As shown in Table 13, the total increases in VMT were much smaller under the proposed freeze than under the current CO2 standards, so even a large ratio has little net impact.) This over-compensation is much larger for cars than trucks. It is not clear why. Again, the model's lack of transparency and the agency's failure to provide adequate technical documentation has limited our ability to analyze this phenomenon.

Finally, whenever a vehicle is driven an additional mile, there is value associated with that travel. NHTSA completely ignores the value of any additional travel which occurs due to reduced scrappage. Including this value would not be an adequate surrogate for the additional repair costs required to keep older vehicles on the road. Just as NHTSA is now recognizing that rebound VMT is due to drivers' express decision to drive more, any driving of older vehicles in lieu of new vehicles is due to the same choice. To treat these identical choices in 180 degree different manners is of course manifestly arbitrary.

XI. Rebound

Level of the Rebound Effect

NHTSA describes its approach to estimating the rebound effect in Section 8.9 of the PRIA. NHTSA estimated rebound to be negative 20% in two prior rules establishing light truck CAFE standards for MYs 2005-07 and 2008-2011. NHTSA, along with EPA, decreased its estimate of rebound to a negative 10% in the two rules establishing CAFE and CO2 standards for cars and light trucks for MYs 2012-2016 and 2017-2021/25. NHTSA, EPA and the California Air Resource Board also decided to retain this negative 10% rebound estimate in the TAR for the MY 2022-2025 standards. In the PRIA to this proposal, NHTSA states that it decreased its original negative 20% rebound estimate to negative 10% because several studies found the rebound effect to be decreasing over time. NHTSA has returned to an estimate of negative 20%, citing several studies performed since the final rule establishing the CAFE and CO2 standards for 2016-2021/25 MY cars and light trucks.

NHTSA's review of the various "rebound" studies in the PRIA is very different than that conducted in the TAR. In the PRIA, NHTSA presents the overall results of approximately 15 studies in Table 9-8 and then devotes roughly a paragraph of discussion for each study. A notable exception pertains to the study by Greene (2012), which is not mentioned except in Table 8-8. It just happens that Greene is one of the researchers who found rebound to be relatively low (8-10%), as well as finding rebound decreases over time. No explanation is presented regarding this exclusion. The discussion of each study is much more extensive in the TAR. Each study's specific method of analysis, its sources of data, the geographical location of the data (e.g., the U.S. or Europe), whether its results focused on the effect of fuel price on driving or the effect of fuel economy, etc. were discussed at length.[74] The introduction to the review in the PRIA mentions several of these factors, indicating that they would be adequately considered. However, the discussion of the individual studies does not meaningfully examine these issues.

For example, NHTSA discusses a study by Barla (2009) of driving in Canada. Fuel prices in Canada are much higher than those in the U.S. due to fuel taxes. The other costs of driving should be similar, as NHTSA points out in its discussion of cash for clunkers-like programs. A 1% change in Canadian fuel prices is much larger than a 1% change in U.S. fuel prices. While discounting European studies in the TAR for this reason, NHTSA makes several notable positive observations about how this Canadian study was conducted, but makes no mention of higher fuel prices. Again, given the discussion in the TAR, this inconsistent and arbitrary treatment is likely explained by the fact that Barla projected a rebound of 20% in the long term, which is consistent with NHTSA's preferred outcome.

The most significant flaw in NHTSA's current assessment of rebound is that it ignores the fundamental fact that with CAFE and CO2 standards, drivers will have to pay something for their reduced fuel cost per mile. For consumers buying a vehicle with a loan, the incremental fuel savings will be larger than the incremental vehicle payment, but the net benefit to most vehicle purchasers will be less than simply the incremental fuel savings. NHTSA recognizes this when it includes vehicle depreciation in its general economic discussion of rebound in Section 8.9.2 of the PRIA. However, it disregards this factor when it estimates the rebound effect. The more in-depth discussions of the rebound studies in the TAR make it clear that each study employs a different approach and uses

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[74] TAR at pp. 10-10 to 10-20.

different methods. None of the studies directly address the situation presented by this proposal. It is one thing to examine how driving changes with a change in fuel price. It is another thing to examine how drivers of differing economic status purchase different vehicles and drive them differently. It is still another thing to evaluate how a driver will respond to a higher vehicle loan payment and a lower monthly fuel cost.

To demonstrate the problem, we focus on another study described by NHTSA, that was performed by Bento et. al. The focus of this study is not the rebound effect related to the effect of buying a new, more efficient vehicle on driving. Rather, it is the "distributional and efficiency effects of U.S. gasoline taxes." This study first described and estimates an extremely high rebound effect of 34% on average.

Bento examined data obtained from the 2001 National Personal Transportation Survey. The data include over 20,000 households. Thus, the data includes a wide range of households, vehicles, and geographies, but a very short period of time. No vehicle transactions seem to be covered. Based on NHTSA's adjustments to Bento's results, Bento estimated the "elasticity of vehicle use with respect to per mile operating costs." NHTSA then modified this result by focusing the elasticity of vehicle use solely on fuel costs per mile, which represented just under half of the total operating costs per mile.

NHTSA's description of both the study and NHTSA's processing of its conclusions raises more questions than it answers. NHTSA apparently assumed that the entire elasticity of vehicle use which Bento attributed to differences in per mile operating costs was due solely to the difference in fuel costs. NHTSA does not justify this assumption. Households presumably chose their vehicles with their driving needs and desires in mind. Those driving the most presumably emphasized per mile operating costs more than those driving less, other things being equal. Bento, *et al*, seem to base their analysis on the presumption that increasing the gasoline tax will shift a household to a higher operating cost per mile stratum and shift their driving to the lower level of driving of this new stratum. Given that the NPTS data only covers a limited range of time, the data do not cover a wide range of fuel prices, but instead covers a wide range of vehicle characteristics, including fuel economy. As just stated, it seems reasonable to assume that drivers' vehicle selection was informed by their driving habits. If so, then driving habits explain the differences in operating costs per mile, not the other way around as NHTSA assumes. It is difficult to see, given what NHTSA has presented, how this study applies in any way to the issue faced in the NPRM.

As an aside, when evaluating the level of driving performed by vehicles of various age, NHTSA previously used the results of the 2001 NPTS. However, as discussed elsewhere in this assessment, NHTSA discarded this data in its analysis for the NPRM on the basis that it was too dated. NHTSA does not explain why the 2001 NPTS is too dated for use in developing vehicle use versus age, but is sufficient for estimating rebound.

NHTSA must present a detailed evaluation of each and every rebound-related study referenced in the NPRM and reasonably explain its use in the context of varying CAFE and CO2 standards. NHTSA must also consider the impact of increased or decreased expenditures on new vehicle costs on driving. Finally, NHTSA must be consistent in its conclusions that driving is elastic or inelastic across the various aspects of driving being addressed by the Volpe Model.

XII. The Proposal Can Not Reasonably Affect Technology Applied to Last Year's Vehicles

NHTSA's Volpe Model begins applying technology starting with the 2017 MY. This is reasonable given that it uses a description of the baseline fleet based on 2016 MY vehicles. However, in doing so, NHTSA has allowed the model to base its decisions to apply technology in the 2017 and 2018 MYs to differ between various control scenarios. This makes no sense. The technology applied in the 2017 and 2018 model years cannot be changed. Any decisions made by manufacturers were made under the auspices of the current CAFE and CO2 standards. Even 2019 MY technology cannot, at this point, be altered based on any changes to the standards. Some MY 2019 vehicles are already being sold and the designs of the rest are set. Prices for individual models may be changed later in the model year, but not until after any final rule is issued. (Given all the errors and unreasonable assumptions and projections made in the analyses supporting this proposal, it is reasonable to project that any such price changes will have to follow a reproposal and then a final rule.) Thus, it is unlikely that any change in 2019 MY pricing could be made, as well. That leaves 2020 as the first model year which could be affected by the proposed standards.

NHTSA should modify the Volpe Model to base all application of technology through MY 2019 on the current CAFE and CO2 standards and only allow technology application to change between scenarios beginning with the 2020 standards.

XIII. Key Aspects of the Volpe Modeling are not Integrated and Appear Biased

NHTSA's biases with this proposal are further confirmed by examining how its model treats the two primary aspects of improving the fuel efficiency and lowering the CO2 emissions of light duty vehicles--the cost of the enabling technology and resulting reduced fuel consumption. From a consumer's point of view, the former is a cost or price to pay up front when the vehicle is purchased and the latter is a benefit which accrues over time. In other words, these impacts counterbalance each other. It makes no sense to focus on just one or the other of these two effects, since you cannot achieve one without the other.

All four of the new aspects of the Volpe Model, sales response, fleet share, scrappage and rebound (a 20% level for this effect is new), should be economically affected by both vehicle and fuel costs, since both costs affect the consumers who are projected to make the individual decisions which result in these four vehicular impacts. Yet, while both technology cost and fuel savings change with CAFE and CO2 control scenarios, and both affect consumers, NHTSA has chosen to selectively apply these in three out of the four new (or modified in the case of rebound) aspects of the Volpe Model. What connects NHTSA's decision to base the vehicular effect on either cost or savings is that their decision always makes more stringent standards appear to look worse and the proposal to look better than is actually the case. In every case, there is absolutely no consideration given to the other aspect of the rule to mitigate the main effect modeled.

Table 15 shows the four aspects of the Volpe Model along with NHTSA's choice of technology cost or fuel savings as the primary driver of each aspect and how this choice impacts the evaluation of control scenarios.

Table 15: Bias in the Development of Four Key Aspects of the Volpe Model

Module	Cost or Savings Selected	Impact on the Comparison of Control Scenarios
Sales Response	Vehicle cost	Increases sales under relaxed standards, which speeds up fleet turnover to new standards with its improved fuel consumption, emissions and safety
Fleet Share	Fuel savings	Reduces sales of trucks under relaxed standards, which reduces fleet-wide fuel consumption and CO2 emissions and upstream refinery and crude oil production emissions
Rebound	Fuel savings	Decreases VMT under relaxed standards, which reduces fleetwide fuel consumption, emissions, accidents and fatalities
Scrappage	Vehicle cost and fuel cost per 100 miles	Both sets of terms decrease scrappage under relaxed standards, which reduces older vehicle VMT and reduces fleetwide fuel consumption, emissions, accidents and fatalities

As Table 15 shows, the sales response module is driven solely by technology cost and its projected impact on vehicle prices. The rebound and fleet share modules are driven solely by fuel savings. In each case, economic theory would support the inclusion of both vehicle cost and fuel savings. In addition, much research has been performed to support the inclusion of both factors and their relative contribution to these three modules. The scrappage module consider both vehicle and fuel costs and will be discussed last.

With respect to the first three modules listed in Table 15, inclusion of the factor not chosen by NHTSA as the driver of the module's effect would have the opposite impact compared to that shown in the table. For example, basing the sales response module on vehicle costs increases sales under relaxed standards. Basing the sales response module on fuel savings (e.g., consumers value fuel savings) would reduce sales under relaxed standards. Basing the relative share of cars and light trucks sold on relative fuel consumption increases car sales and reduces truck sales under relaxed standards. Basing the relative share of cars and light trucks sold on relative costs would decrease car sales and increase truck sales under relaxed standards.

It is difficult to fathom how NHTSA could come to opposite conclusions on total vehicle sales and relative car-truck sales. NHTSA assumes that total car plus truck sales are solely a function of vehicle cost/price. Relative fuel consumption has absolutely no impact. When it comes to buying a car or a light truck, relative fuel consumption is the only feature that matters in the analysis. Vehicle price has absolutely no impact. The only consistency in these two findings is that both decisions overstate the benefits of the proposal and dramatically understate its costs.

NHTSA doubled its projection of the rebound effect. NHTSA simply assumes that vehicle prices have no impact on consumers' decision to drive more or less, and determines that only fuel costs per mile matter. The amount of money in a consumer's checking account or their debt accumulation has no impact.

Finally, the impact of new vehicle standards on the scrappage of older vehicles is more complicated and discussed in greater detail above. It appears that both the vehicle price and fuel cost factors in NHTSA's scrappage module work to misrepresent the benefits and costs of the proposal. While higher new vehicle costs should theoretically (at least according to NHTSA's economic theory) work to decrease used vehicle scrappage and higher new vehicle fuel economy should work to increase used vehicle scrappage, NHTSA has developed their model so that both effects decrease scrappage, increase on-road fuel consumption and emissions, increase accidents and fatalities, and increase upstream emissions. Thus, while it appears on the surface that NHTSA has considered both aspects of more stringent CAFE and CO2 standards on scrappage, they have developed a model that allows for both theoretically contradictory effects to nonetheless align in overstating the benefits and understating the costs of the proposal.

The net result of this analysis is that whenever it could, NHTSA chose either vehicle cost or fuel savings as the driver of a new aspect of its regulatory modeling. In three out of four cases, it chose the factor which made the impacts of its proposal to relax the existing standards look more favorable than is actually the case. In the case of the scrappage model, choosing both vehicle and fuel costs benefited the proposal.

XIV. Upstream Emissions

NHTSA states in several places in the NPRM that the U.S. is becoming self-sufficient in crude oil production and no longer needs the reductions in fuel consumption associated with stringent CAFE standards. EIA's 2018 Annual Energy Outlook does show some increased domestic production, though does not provide assurances that this trend will continue, nor does it eliminate the need to conserve fuel to protect against future price shocks (given that oil prices are a global commodity and remain susceptible to severe price fluctuations). President Trump has asked OPEC several times to increase crude oil production to keep prices in check, indicating the pressure that the public can put on the nation's politicians to provide low-cost fuel. Better fuel economy reduces the impact of a given increase in crude oil price. Thus, NHTSA's posture that stringent CAFE standards no longer have any purpose seems at cross purposes with the reality and the administration's actions in other arenas.

At a more technical level, while NHTSA is touting U.S. oil independence, it's analysis of the source of both the crude oil used to produce motor gasoline and the refineries used to produce this gasoline are stuck in the past and do not reflect current data. Section 8.11.2 of the PRIA discusses many ways in which the projected energy independence of the U.S. will reduce certain externalities related to increased petroleum, such as military spending. This section mentions that refining emissions will increase with increased gasoline use. However, NHTSA fails to present its assumptions about either the source of the petroleum used to produce this additional gasoline or the location of the refineries producing the fuel.

A review of the Parameters file used by NHTSA in their Volpe Model runs shows that NHTSA assumed that 50% of all the gasoline saved by more stringent CAFE and CO2 standards would have been imported (i.e., refined overseas). In contrast, the latest EIA data show that imports of refined fuel in 2017 represented only 0.3% of the total national consumption of refined fuel.[75,76] It is difficult to see how this could be the case when the nation is producing enough crude oil to be a net exporter. It is also difficult to see how this could be the case when gasoline consumption is decreasing and sufficient domestic refining capacity exists to fulfill today's demand, let alone decreased demand in the future.

Even worse, NHTSA assumed that 90% of the crude oil refined domestically to produce the remaining 50% of any difference in gasoline consumption between control scenarios would be imported. This may have been reasonable 20 years ago, but does not reflect current realities.

Assuming that the vast majority of the increased crude oil production and half of the refining associated with the proposal's increased gasoline consumption occurs overseas allows NHTSA to ignore significant increases in criteria pollutant and air toxic emissions. Due to these assumptions, NHTSA projects that the proposed freeze of the standards at 2020 levels will actually reduce criteria pollutant emissions relative to the current standards, instead of increase them. This finding is also helped by the unsupportable increases in total VMT due to NHTSA's new scrappage model. The fact that these

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[75] Gasoline imports from EIA data: 11,784,000 barrels per year (491 million gallons per year) in 2017. . https://www.eia.gov/dnav/pet/pet_move_impcus_a2_nus_epm0f_im0_mbbl_a.htm

[76] Gasoline consumption in 2017 was 143 billion gallons. EIA, Frequently Asked Questions: How much gasoline does the United States consume?, available at https://www.eia.gov/tools/faqs/faq.php?id=23&t=10.

assumptions were not described in the NPRM, nor updated, is another indication of NHTSA's bias in this proposal.

Assuming that 100% of the differences in gasoline consumption between control scenarios will be refined in the U.S. appears to be much more consistent with the available data. Likewise, it seems reasonable to assume that differences in the crude oil requirements of the various scenarios will also affect domestic production more so than imports. This would have a large impact on the criteria pollutant and air toxic emission impacts associated with the proposal, which we analyze.

XV. Inefficient Application of Technology and Suitability of the Volpe Model to Fulfill EPA's Legislative Mandate

In the proposal, when discussing the application of technology to enable manufacturers' compliance with the standards, NHTSA states that it does this in a way which "minimizes the cost of compliance."[77] As will be shown below, this is simply false. There are several reasons for this that relate to the ways that the application of technology is managed in the Volpe Model.

First, the Volpe Model uses a metric called "effective cost" to rank technologies for application to enable compliance at the least cost. Second, NHTSA has categorized fuel-saving technology in several technology paths. The application of technology follows the order of each of these paths. Third, NHTSA allows some technologies to be applied in any model year, some to be applied only when the vehicle model is being redesigned or refreshed, and others only when the vehicle model is being redesigned. Fourth, at least when evaluating compliance with the CO2 standards, NHTSA does not utilize the generation and use of CO2 credits to reduce compliance costs and smooth out the effects of limiting the application of certain technologies to refresh and redesign years, as mentioned in point 3. The first three aspects of the Volpe Model are described in the documentation to the Volpe Model, the TAR and the proposal.[78] The use of credits to enable compliance under the CO2 standards is not addressed by NHTSA in the proposal and it appears that the Volpe Model has not been designed to do this, despite NHTSA's claim that it can be used to support the establishment of both CAFE and CO2 standards.

Other reviewers (e.g., NRDC) have investigated the limitations that these criteria place on the application of technology and found them to be unrealistically restrictive and overly-costly. We will restrict our review to a broader assessment of the major aspects of two of these criteria, the technology paths and the effective cost and their interaction.

The Effective Cost when the Volpe Model is being run in fuel economy mode is defined to be:

Effective Cost = Technology cost per vehicle – fuel savings over first 30 months of operation – reduction in CAFE fines due to the improvement of fuel economy.

When run in CO2 emission mode, the increase in CO2 credit value is substituted for the reduction in CAFE fines. The value of a credit of CO2 is specified in the Scenario input file.

The rationale for the inclusion of the fuel savings term is that consumers value 30 months of fuel savings when considering which vehicle to purchase. The rationale for including the reduced cost of CAFE fines (or increased CO2 credit value) obviously assumes that the manufacturer sees paying a fine in lieu of compliance as a viable option. Since this has historically been true for only a select group of manufacturers (namely European manufacturers) which represent a small fraction of total U.S. sales, the inclusion of this term here is inaccurate with respect to most manufacturers. It is certainly suspect when the Volpe Model is run in CO2 compliance mode, as the fines imposed for non-compliance in this case are extremely high and do not represent a viable alternative for any manufacturers. Moreover, we do not understand (and NHTSA does not explain) how it can assign a value to a CO2 credit prior to running the model and observing the incremental cost of compliance.

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[77] FR, Vol 83, No. 165, August 24, 2018, Pp 43002

[78] FR, Vol 83, No. 165, August 24, 2018, p. 43174

The fundamental flaw in NHTSA's definition of Effective Cost is that it does not include a measurement of the technology's reduction in fuel consumption or CO2 emissions. NHTSA's definition obfuscates this lack by including the 30-month fuel savings. However, CAFE and CO2 compliance is the primary goal of adding technology. Doing so without affecting sales is a fine additional criterion. But it is not the goal. The goal is compliance. For most manufacturers trying to comply with the CAFE standards and all manufacturers trying to comply with the CO2 standards, the goal is to reduce fuel consumption or CO2 emissions. NHTSA's effective cost represents the degree to which manufacturers may have to raise vehicle prices to maintain profitability and potentially lose some sales, but it fails to place these impacts in the context of the degree to which this technology moves them towards their goal: compliance. This omission is so glaring that it is impossible to understand why it hasn't been changed for the past decade or more. This same Effective Cost metric has been used in the Volpe Model going back to at least the 2012-2016 CAFE and CO2 rulemaking. Normally, something which has withstood the test of time indicates a high degree of robustness. In this case, it appears to reflect a persistent irrationality.

Again, the inclusion of 30 month fuel savings obfuscates the problem. Fuel savings in dollar terms are clearly directly related to changes in fuel consumption per mile and CO2 emissions per mile. Thus, the inclusion of the fuel savings provides the Effective Cost with some measure of the degree to which a technology moves a manufacturer towards compliance. However, the choice of 30 months is arbitrary. Studies indicate that consumers value fuel economy more or less than this. NHTSA's own sales response model assumes that consumers place no value on fuel economy, though we argue this above. If, for example, we applied the findings of NHTSA's sales response model here, and recognized that fine paying is not a viable alternative to most technology applications, the definition of Effective Cost would simply be the cost of the technology. The Volpe Model would simply apply the cheapest technology first and move down the list. This clearly makes no sense. A technology which costs $10 and reduces fuel consumption by 1% is not better than one which costs $20 and reduces fuel consumption by 3%. Yet this is similar to what the Volpe Model is currently doing.

Another indication that NHTSA's definition of Effective Cost is incorrect is that fuel savings are put in dollar terms. This may be fine for sales analyses. However, fuel savings in dollar terms clearly depend on the price of fuel. The cost of technology is generally not a function of the price of fuel. Thus, the ranking of technology using NHTSA's Effective Cost will change with the price of fuel. However, compliance with the CAFE and CO2 standards is independent of the price of fuel. While fuel savings in dollar terms may be relevant in how consumers view the desirability of a particular vehicle model, it has no impact on the degree to which the application of a particular technology moves the manufacturer towards compliance.

EPA has developed a clearly superior way to rank technology. EPA borrowed NHTSA's Effective Cost for the numerator of its technology ranking metric (Technology Application Ranking Factor or TARF). (While the fine term can be included, it normally is not relevant, as already mentioned.) However, EPA also added a denominator to the TARF which represented the change in CO2 emissions accomplished by the addition of that technology. Thus, EPA's TARF accounts for the consumer's potential valuation of fuel savings, while still measuring progress towards the primary goal: CO2 emission (or fuel consumption) reduction. NHTSA invites comment on whether it should modify its definition of Effective Cost.[79] Clearly we believe that the use of EPA TARF metric would represent a major improvement.

One can reasonably posit that the primary purpose of the Volpe Model is to project compliance at the minimum cost possible given knowledge of available technology, etc. The addition of modules which project vehicle use, scrappage, response to fuel prices, tailpipe emissions, refinery and electrical power generation emissions, and others, may also be included. However, neither the Volpe Model nor EPA's OMEGA model are the primary models for any of these other factors. The Volpe Model purports to apply technology to simulate cost effective compliance with the CAFE and CO2 standards. We believe, however, that the model fails at this task.

Regarding limitations of the application of certain technologies to only those model years when a vehicle is being refreshed or redesigned, we refer to the example of the Chevrolet Equinox provided by NHTSA in the proposal.[80] In this example, NHTSA describes how various vehicles share the same engine, transmission and/or platforms of other vehicles produced by the same manufacturer. NHTSA determines the "leader" vehicle for each engine, transmission and platform based on the vehicle model which has the highest sales volume of all the models which share that engine, transmission or platform. The Equinox in this example happened to be the leader vehicle for its engine and platform, but not its transmission. Thus, in NHTSA parlance, this Equinox is a transmission "follower." It can only receive a new transmission when the vehicle which is its transmission "leader" gets a new transmission. As NHTSA progresses through its technology application for this vehicle, they describe how the Volpe Model gives the Equinox a new engine in 2018, but not a new transmission, because its transmission's leader vehicle has not yet received a new transmission. Then, three model years later, after its transmission's leader vehicle receives a new transmission and the Equinox hits a "refresh" year, the Equinox receives this new transmission.

This sequence is absurd. First, the new engine given to the Equinox involves a more significant redesign of the vehicle than the subsequent transmission. Per NHTSA's judgment, the new engine can only be received during vehicle redesign, while the new transmission can be received during vehicle refresh or redesign. (Refresh occurs once or twice in between vehicle redesigns and involves less significant changes to the overall vehicle design.) This Equinox is undergoing a major engine change, plus other changes involving its platform. However, it cannot receive a new transmission because it is not the transmission's "leader." The assignment of "leader" designation is arbitrary. For example, NHTSA has been predicting the refresh and redesign cadence of vehicles for a decade. NHTSA has never reviewed its past projections to determine if they were reasonable or not. NHTSA has never compared the actual introduction of new engine, transmission, and platform technologies to the "official" refresh and redesign years of the relevant vehicle models

For the TAR, NHTSA assumed that the leader vehicle for each engine, transmission and platform was the vehicle with the lowest sales volume. Now it assumes that the leader is the vehicle for each engine, transmission and platform was the vehicle with the highest sales volume. NHTSA clearly does not have any objective reason for either of these simple assumptions. The one consistency is that NHTSA does the choosing and this choice cannot vary regardless of how it affects the application technology

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[79] FR, Vol 83, No. 165, August 24, 2018, p. 43174

[80] FR, Vol 83, No. 165, August 24, 2018, p. 43175 and PRIA, pp 497.

and ultimate cost of compliance. If General Motors needs additional fuel consumption or emission reductions when this Equinox is being redesigned, NHTSA needs to explain, in real practical terms, why it cannot become the "leader" for its transmission and receive a new transmission at the same time. The net result of NHTSA's arbitrary, and rigid assignment of "leader" and "follower" vehicles for engines, transmissions, and platforms only serves to slow down the application of technology in ways that do not reflect obvious flexibilities available to manufacturers.

This rigidity is exacerbated by the inability to appropriately reflect real compliance flexibilities accorded by EPA's emission credit system. This credit system is designed to allow manufacturers to over and under-comply with the standards in any particular model year, generating and using credits as necessary and to maintain compliance and vehicle production over the long haul. NHTSA's extremely limited use of credits in its assessment of the CO2 standards, combined with its rigidity in applying technology, clearly over-estimates the cost of compliance with these standards.[81]

Regarding technology paths, we limit ourselves to a few major points. First, the paths simply list technologies of a similar focus (e.g., engine, transmission, electrification) in their order of perceived effectiveness. This reflects a certain degree of common sense that a manufacturer would not apply a new technology and increase fuel consumption or CO2 emissions. However, NHTSA ignores the cost of the technology when developing this list. For example, the basic engine path starts out with an engine with variable valve timing. The first step along this path is to add variable valve lift (VVL), then apply gasoline direct injection (SGDI), and then apply cylinder deactivation (DEAC). After this, NHTSA assumes that the manufacturer must make a choice to move to turbocharging (TURBO1) or high compression ratio design (HCR).

As mentioned above, it is very difficult to obtain NHTSA's estimates of the cost and effectiveness for these individual technological steps. We were only able to do so by creating an artificial Vehicle file which limits the application of technology in a way which forced the model to stop adding technology after each one of these steps was reached. In other words, we were able to obtain a modified vehicle fleet which contained identical vehicles except for the addition of these four engine technologies, one at a time.

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[81] See NRDC comments on the proposal.

Table 16 presents some of the results of this assessment. The vehicle being modeled had little other technology on it. The evaluation of the interaction between these engine technologies and transmission and electrification technologies would only make the points made here stronger.

Table 16. NHTSA Cost and Effectiveness of Several Engine Technologies (Costs in $/Vehicle)

	Total Cost	Incremental Cost	Total Effectiveness	Incremental Effectiveness	Cost/ Effectiveness
VVL	$423	$423	4.4%	4.4%	$9,653
SGDI	$890	$467	6.6%	2.3%	$20,491
DEAC	$929	$39	7.3%	0.8%	$4,963
TURBO1	$900	$(28)	16.4%	9.8%	$(290)
HCR	$842	$(87)	14.2%	7.5%	$(1,157)

The incremental costs and effectiveness values shown are those relative to the previous row, except for HCR. As mentioned above, HCR is on its own path and would be applied by the Volpe Model to an engine which had progressed to the DEAC step. Thus, HCR and TURBO1 are essentially two independent steps of moving past DEAC.

As shown in the table, the cost effectiveness of both VVL and SGDI are very poor compared to the rest of the engine technologies shown. No manufacturer would stop at these technologies if the additional technologies were available. There is no reason for the Volpe Model to include these technologies except to understand the starting points of 2016 vehicles which had these technologies. Even DEAC, which on the increment is clearly better than VVL or SGDI, has a much worse cost effectiveness than either TURBO1 or HCR. Both TURBO1 and HCR are projected to cost less than an engine with VVL, SGDI and DEAC and both deliver more fuel and CO2 control. The continued inclusion of inefficient legacy technologies in the Volpe Model only gives the model opportunity to erroneously apply technologies, which it apparently does.

The second aspect of the technology paths is the interaction between the paths. The effectiveness of improving transmission efficiency by adding gears or by moving to a continuously variable transmission will depend on which of the above engine technologies is present. Since the Volpe Model adds technologies one at a time, it is possible that the model could add a 10-speed transmission to a vehicle with a very basic engine, because, using the ineffective “Effective Cost” metric, it appeared to be the most cost effective next step. However, if the manufacturer required greater fuel or CO2 emission control, the Volpe Model might move to a TURBO1 or HCR engine. With either of these two more advanced and efficient engines, it may no longer make sense for the vehicle to have a 10-speed transmission. A 6-speed or 8-speed transmission might be more cost effective. However, the Volpe Model is not designed to look backwards along its technology paths. Thus, the opportunity to recover the expenditure of inefficient technology is missed. NHTSA might argue that a manufacturer will not invest in 10-speed transmissions, for example, and then return to an older design. Whether or not this is true in real life, such a view would put too much stake in the Volpe Model projections. The model simply projects what could be done, not what will be. Anyone examining the progression of technology and noting the reversion of transmission technology could easily modify the model inputs to avoid this. Also, if NHTSA evaluated combinations of technologies prior to entering them in the model piecemeal, it would automatically avoid such apparent problems.

The final aspect of the technology paths to be addressed here is the split in paths which NHTSA imposes on engine and electrification technology. As already mentioned, once on the TURBO path, a vehicle cannot receive HCR technology and vice versa. Also, once a vehicle has a belt drive starter generator system (BISG) it cannot receive a crank integrated starter generator system (CISG). We noted that a large portion of BMW's 2016 vehicles already had TURBO1 technology, which means that BMW, if allowed to, could not move these vehicles to HCR or HCR2 regardless of whether this would save money or improve effectiveness. Presumably, this would negate an investment BMW had already made in TURBO1 technology. However, NHTSA projects that roughly half of BMW's sales would need to become strong hybrids under the current CO2 emission standards. Strong hybrid vehicles do not include downsized turbocharged, direct injection engines. Thus, NHTSA's projections already include the fact that BMW will be discarding much of this investment. It makes little sense to allow BMW to make this same change by moving to HCR technology. When we allow all manufacturers to use HCR and HCR2 technology, the need for strong hybrids drops precipitously and would presumably for BMW, as well.[82]

In order to assess the ability of the Volpe Model to apply technology in a cost minimizing manner, we performed several runs of Volpe Model in exactly the same manner as done by NHTSA in its modeling of the CO2 standards. The only exception was that some aspects pertaining to technology were changed.

In one run, we reduced the cost of each and every technology by a factor of two. This was accomplished by simply multiplying the technology costs in the Technology input file by 50%. These costs are listed in columns P through AG of the 10 worksheets which pertain to various vehicle sub-classes (e.g., Pickups). In an analogous run, we reduced technology costs by 75%.

In another run, we limited the application of mass reduction as done by NHTSA in its analyses for the TAR. Mass reduction on small passenger cars was limited to the first two steps of mass reduction (MR1 and MR2). Mass reduction on medium cars was limited to the first three levels of mass reduction (MR1, MR2, and MR3).

In another run, we set the fuel savings period in the Effective Cost calculation to 15 years, or a period covering the majority of a vehicle's lifetime VMT. Finally, we ran the model prohibiting the application of one technology which added significant cost with essentially no benefit: cooled exhaust gas recirculation #1 (CEGR1). Other commenters have found significant problems with NHTSA's projections regarding the effectiveness of many of the fuel-saving technologies included in the Volpe Model, including CEGR1. Still, given that NHTSA specified that CEGR1 provided essentially no benefit to its application, the fact that the Volpe Model chose to apply this technology and add its cost to total compliance costs is a strong sign that the methods being used to apply technology are very defective.

The compliance cost projections of these alternative runs are compared to NHTSA's own simulation in Table 17 below. We present compliance costs for cars and light trucks combined because manufacturers are allowed to trade emissions between the two vehicle classes. The degree and even

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[82] We could not fully evaluate this flexibility for BMW, as the limitation of vehicles already having TURBO1 technology is embedded in the code of the Volpe Model and could not be changed using the model's input files.

direction of such trades can affect final emission levels of either vehicle class and thus, the compliance costs for each class. The combined car plus light truck costs are a much better indication of the model's overall efficiency in finding the low cost option. We focus on compliance costs for the current CO2 standards, as opposed to those for the proposed freeze. The Volpe Model usually projected large levels of over-compliance for the proposal, which varied across the various simulations. Thus, it is difficult to fairly compare compliance costs. Finally, we focus on compliance costs for the 2028-2032 MYs. In NHTSA"s own simulation of the CO2 standards, there was a compliance shortfall until the 2028 MY. Therefore, compliance costs prior to this are not comparable across scenarios. In general, there was little if any over-compliance with the current CO2 standards. When this did occur, we identify it in our discussion below.

Table 17: Average Car+Truck Compliance Costs Under the Current CO2 Emission Standards[83] ($ per vehicle)

Model Year	NHTSA Analysis	50% Technology Costs	25% Technology Costs	Skip CEGR1	15 Year Fuel Savings	TAR Limits on Mass Reduction
2028	$2,785	$1,682	$938	$2,660	2,353	$2,767
2029	$2,815	$1,713	$983	$2,678	2,380	$2,786
2030	$2,773	$1,683	$965	$2,627	2,398	$2,735
2031	$2,730	$1,649	$945	$2,584	2,441	$2,691
2032	$2,707	$1,620	$927	$2,553	2,486	$2,661

Starting with NHTSA's own analysis, compliance costs peak in 2029 and gradually decrease over the next 3 years. This gradual decrease is likely due to reductions in the costs of individual technologies due to expected "learning." Our run with the 50% reduction in technology costs is shown next. As Table 17 shows, compliance costs decrease by less than 50%. The Volpe Model could have simply applied exactly the same technologies as it did in the NHTSA run and decreased costs by 50%. The fact that it did not means that it chose to apply different technologies, technologies which were not as cost effective in reducing CO2 emissions by the traditional sense of the term "cost effective." Similarly, our run with the 75% reduction in technology costs did not reduce the NHTSA run compliance costs by 75%.

We believe that the reason neither the 50% nor 25% technology cost runs resulted in commensurate reductions in compliance costs can be traced to NHTSA's use of the Effective Cost metric. As technology costs are reduced, the value for each technology's Effective Cost begins to be dominated by the fuel savings term. Ranking technologies solely on their fuel savings is no better than ranking them solely on their cost. In this case, technologies offering the largest reduction in CO2 emissions would be ranked higher than those promising smaller reductions. The cost of achieving either the larger or small CO2 emission reductions would not receive its full consideration, at least compared to the NHTSA model run. The result is an inefficient application of technology.

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[83] All runs of the Volpe Model have the sales response and fleet share module enabled. Rebound was set at 20% and the scrappage model enabled, but these should not affect compliance costs.

The next run shown prevents the Volpe Model from applying one technology: CEGR1. This limits the choices available to the Volpe Model compared to the NHTSA run. Theoretically, this can only increase costs, as the model should be choosing the minimum cost options and should be skipping over cost ineffective technologies using the Effective Cost metric. If the model has fewer choices, costs should not decrease; they should only remain constant or increase. As seen in Table 17, the opposite occurs. The exclusion of one technology was able to reduce compliance costs by $120-150. By reviewing the Vehicle Reports from the NHTSA run, we found that most of the vehicles which had become strong hybrids under the current CO2 standards continued to have engines with CEGR1. In the Skip CEGR1 run, these vehicles could not possibly have this technology. The fact that the Volpe Model continued to equip a strong hybrid vehicle with a CEGR1 engine is extremely inefficient. The benefits of CEGR1 and strong hybrid systems overlap significantly, at least according to NHTSA.

This raises a more basic issue about the list of technologies included in the Technology file by NHTSA. NHTSA makes no assessment about the relative cost effectiveness of the technologies it included in the Technology file. It relies on the logic of the Volpe Model and the Effective Cost metric to select the most cost-effective combinations of technologies. This approach is clearly failing. Again, EPA has developed a better way to isolate and reject cost ineffective combinations of technologies. EPA develops a list of a few hundred thousand combinations of technologies, calculates their total costs and total effectiveness in reducing CO2 emissions and then develops a set of technology combinations which progressively achieves greater reductions in CO2 emissions at the lowest possible cost. The number of technology group steps for vehicle sub-class is usually less than 50. EPA then includes only these 50 or so technology combinations in their OMEGA model runs. This process avoids the possibility of the model applying cost-ineffective technologies.

NHTSA uses a very analogous set of several hundred thousand technology combinations. However, instead of evaluating them prior to a model run (their costs and effectiveness don't change with different control scenarios), NHTSA evaluates individual additions of technology along several "technology paths" on the fly for every vehicle model in every model year. Not only is this computationally intensive, it is clearly not working as intended (unless the intention is to over-estimate costs of the most stringent control scenarios). Either NHTSA needs to correct these flaws in their current approach, or adopt something like EPA's approach which has already been programmed and could be applied to NHTSA's technology groupings.

Increasing the period over which the fuel savings were determined to 15 years also reduced compliance costs. This is not surprising, as 30 months is such a small period of a vehicle's life. Still, including this more reasonable benefit of reduced CO2 emissions in the numerator of the Effective Cost and in dollar terms is not as efficient as including the more straightforward reduction in CO2 emissions in a denominator term. As can be seen, this simple change again reduced compliance costs by over $400 in 2028. We focus on this model year for this simulation, as the vehicle fleet met the current 2025 standards in this year with no over-compliance. After 2028, the Volpe Model continued adding technology and the fleet began to significantly over-comply with the 2025 CO2 standards, leading to an unfair comparison with the costs for the NHTSA run. Four hundred dollars is a sizeable figure indicating a significant degree of inefficiency in NHTSA's use of Effective Cost to select technologies.

The final set of compliance costs limited the application of mass reduction to cars. Compliance costs should have risen. However, again, compliance costs decreased. The cost reductions were not large, but the fact that costs decreased at all is again an indictment of the use of Effective Cost to select technology.

The net result of these simple comparisons is that the current Volpe Model is not designed to select the minimum cost of compliance for any set of standards. Since this should be its goal, the projected compliance costs presented in the proposal should be discarded, the model modified and a re-proposal made.

This brings us to the issue of the suitability of the Volpe Model to fulfill EPA's mandate in the Clean Air Act (CAA) to establish standards to reduce greenhouse gas emissions from cars and light trucks.[84] One, the inefficiency at which the Volpe Model decides which technology can be used to meet specified standards at the lowest cost is inconsistent with this statutory obligation. The use of NHTSA's Effective Cost metric is fundamentally flawed and clearly does not result in the selection of the least cost technology enabling compliance. This causes the Volpe Model to overestimate the cost of compliance, which clearly affects the net benefit of any standard and fails to fulfill EPA's CAA mandate.

Two, the Volpe Model's requires that technology be added incrementally along "technology paths" which do not reflect the true cost effectiveness of either individual technologies, nor combinations of technologies. This is demonstrated by the fact that we could lower the projected cost of compliance in the Volpe Model by simply preventing it from choosing technologies which could readily be observed to be cost-ineffective.

Three, the timing of any standards is an inherent part of their environmental effectiveness. NHTSA's arbitrary and rigid designation of leader-follower vehicles for engine, transmission and platform level technologies unrealistically slows the rollout of technology into the new vehicle fleet and the indication of the date at which new technology can be implemented.

Four, the Volpe Model is not capable of reasonably simulating manufacturers' ability to utilize CO2 credits to smooth the introduction of technology throughout their vehicle line-up. This again slows the date at which standards can be found to be feasible and increases their cost. The Volpe Model also requires that manufacturers comply with the CO2 standards in each model year. The inflexible designation of leader and follower vehicles is unnecessarily rigid and inconsistent with reality.

Five, not only does the Volpe Model select technology using an inefficient metric (Effective Cost), but it applies this technology to arbitrarily limited cohorts of vehicles in specific model years. We are again referring to NHTSA's arbitrary designation of leader vehicles for specific engine, transmission and platform oriented technologies. The Volpe Model requirement that each manufacturer comply with the CO2 standards in each model year without adequate consideration of credits means that for model years when NHTSA believes that few vehicles are being redesigned, the Volpe Model must add an inordinate level of technology to achieve compliance. This inordinate technology is then "inherited" by every other vehicle model in later years which shares the original vehicle's engine, transmission or platform. This inordinate technology contributes to compliance in future years, but with an inefficient cost. Either more flexible assignments of leader vehicles or the consideration of credits would mitigate and potentially alleviate this problem.

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[84] The Clean Air Act, as amended, Section 202(a).

We demonstrated this by simply allowing vehicles to receive any technology in any model year by setting each vehicle's redesign years to include every model year. The number of strong hybrids, PHEVs and BEVs required by the current CO2 standards decreased from 3.7 million vehicles using NHTSA's redesign schedule to 2.3 million when technology could be added in any model year. Similar reductions in the number of strong hybrids was achieved by allowing more widespread application of HCR and HCR2 engines, but without changing the redesign schedule.[85] The combination of allowing HCR and HCR2 engines, more flexible redesign schedules, and to use credits to smooth out their progress in CO2 emission reduction should reduce the number of required strong hybrids even more dramatically and have a major impact on the projections of requisite control technology, cost and net benefits. Thus, again, the Volpe Model fails at fulfilling EPA's mandate under the CAA.

Five, NHTSA has proposed to cease encouragement of technology and refrigerants with low global warming potential to reduce GHG emissions from automotive air conditioning units. The Volpe Model is not designed to reflect the use of these technologies and refrigerants. NHTSA has not conducted any technical analysis outside of the Volpe Model to evaluate these techniques. Thus, EPA has demonstrated the feasibility and cost-effectiveness of these GHG reducing techniques in the past.

Six, finally, NHTSA made it very clear that it considers it is more important to ensure that consumers have the greatest possible choice of vehicle performance (e.g., towing capability, acceleration, etc.) than it is to set maximum feasible CO2 standards. NHTSA refers to consumer preferences and choices dozens of time in the proposal. One example is its discussion of the application of downsized turbocharging.[86] There NHTSA clearly prefers to allow manufacturers to be the ones who choose whether to apply this technology to reduce fuel consumption and CO2 emissions or improved low-end torque (a measure of towing capacity). But EPA has its own duties to ensure it is fulfilling its mandates to reduce pollution and protect public health.

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[85] From both EDF runs of the Volpe Model in CO2 mode and NHTSA's sensitivity run allowing widespread application of HCR2 technology.

[86] FR, Vol 83, No. 165, August 24, 2018, p 42991.

XVI. Technology Limits Imposed by NHTSA

We have not conducted a detailed review and evaluation of NHTSA's estimates of the cost and effectiveness for every technology. Other reviewers have done so and found significant problems. There is one glaring issue which we did evaluate. NHTSA only allows the use of high compression ratio (HCR) engines by some manufacturers representing about 30% of sales. NHTSA states that several Asian manufacturers have used HCR engines in their small vehicles.[87] Review of the Market input files used by NHTSA in its Volpe Model runs indicate it restricted the use of HCR technology to a subset of Asian manufacturers. NHTSA does not explain why other manufacturers could not use HCR engines in their smaller vehicles. NHTSA arbitrarily prevented a number of manufacturers from adding HCR to their engines given that that these manufacturers--including GM, Ford, and Nissan-Mitsubishi-- already utilize engines with HCR. Thus, NHTSA's restriction of this technology to only a few manufacturers is unsupported and arbitrary.

NHTSA also claims that its engine benchmarking was not suitable for 8-cylinder engines nor some 6-cylinder engines. There are 6-cylinder, HCR engines in NHTSA's 2016 baseline fleet. NHTSA provides no further explanation of its rationale for limiting the application of this technology other than these brief statements. It also does not explain why it didn't benchmark additional HCR engines if this was the cause of the limitation. Other reviewers have addressed this issue in much greater detail and concluded that NHTSA's limits on the use of this technology are unsubstantiated. Finally, NHTSA does not consider the turbocharging of HCR engines (commonly referred to as Miller cycle engines). A 4 cylinder Miller cycle engine would produce the power of a non-turbocharged 6 cylinder engine, which would at minimum extend NHTSA's application of HCR engines to all 4 and 6 cylinder engines.

In addition, there is a second level of HCR technology (HCR2) included in the Volpe Model input files, but is excluded from use in the Volpe Model runs used to evaluate the standards. NHTSA states that this technology will not be ready for use in the timeframe of this rule.[88] However, other reviewers have noted that equivalent technology is already being used in the current fleet. So again, based on their review, NHTSA's approach to applying HCR2 technology is arbitrarily inconsistent with reality and prevents manufacturers from using otherwise cost-effective technology.

In order to demonstrate the importance of allowing technologies like HCR and HCR2 when projecting the potential cost of the proposal, we ran the Volpe Model in CO2 mode exactly as done by NHTSA, the only change being we allowed all manufacturers to use HCR and HCR2 technology. This was done by removing the "SKIP" labels (in the Market input file) for those manufacturers for which NHTSA did not allow the application of HCR. It also involved entering "TRUE" in the Technology file for HCR2 technology. We did this while allowing the model to select any of the automatic transmissions included in NHTSA's modeling, as well as CEGR1 technology, and also while prohibiting the use of these technologies. The decision to apply this technology to any specific vehicle model was still made by the Volpe Model using the inefficient Effective Cost metric. The resulting compliance costs from this run and NHTSA's simulation of the CO2 standards are shown in Table 18.

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[87] FR, Vol 83, No. 165, August 24, 2018, pp 43038.

[88] *Ibid*.

Table 18: Average Car+Truck Compliance Costs Under the Current CO2 Emission Standards[89] ($ per vehicle)			
Model Year	NHTSA CO2 Standards Run	Same with HCR and HCR2 Allowed	Same with HCR and HCR2 Allowed and AT7-10 and CEGR1 Disabled
2028	$2,785	$2,167	$2,148
2029	$2,815	$2,192	$2,145
2030	$2,773	$2,174	$2,122
2031	$2,730	$2,153	$2,098
2032	$2,707	$2,144	$2,086

As can be seen, the inclusion of HCR and HCR2 technology reduces compliance costs by $550-$600 per vehicle. The number of strong hybrids required to meet the current CO2 standards also decreases by almost a factor of two. This indicates the importance of the careful and appropriate consideration of available technology, which NHTSA has not done in its proposal.

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[89] All runs of the Volpe Model have the sales response and fleet share module enabled. Rebound was set at 20% and the scrappage model enabled, but these should not affect compliance costs.

XVII. Monetized Emission Benefits

NHTSA updated its estimated value for GHG emissions in the proposal to reflect a new "interim" value for the social cost of carbon, which purports to recognize only those climate-related impacts occurring within the U.S. This decreased the monetized value of avoided CO2, methane and nitrous oxide emissions dramatically.

Regarding GHG emissions, however, the effects of local emissions are global. There are no local effects due solely or primarily to local emissions. If every nation took NHTSA's approach to only consider the impacts of GHG emissions on their own local economy and public health, the grand sum of all the nations analyses would exclude a large portion of both the impacts of GHG emissions on the global economy and public health. The net result would be a dramatic under-estimation of these impacts and disregard for the emission impacts on other nations. Therefore, it is imperative that NHTSA use the peer-reviewed, Intergovernmental Working Group (IWG) estimates of the SCC.

Moving to criteria pollutants, Table 19 summarizes the monetized emission benefits for three pollutants which NHTSA used in its analysis: NOx, SOx, and PM2.5. These benefits are consistent with those used in the TAR and those used in the final rule implementing the 2017 and later CAFE and CO2 standards. The result of this is that they date from circa 2010.

Table 19: Monetized Value of NOx, Sox, and Fine PM Emissions ($/ metric ton)			
	Nitrogen Oxides	Sulfur Dioxide	Particulate Matter
NHTSA	$8,200	$48,000	$371,100
EPA ($2010, 3% discount rate per annum)			
Mobile Sources	$10,010-$23,100	$28,600-$63,800	$506,000-$1,100,000
Refineries	$23,100-$9,020	$63,800-$23,100	$1,100,000-$451,000

Table 19 also shows a range of values published in 2013 based on two more recent studies of the value of these emissions.[90] Note that we have converted these values from cost per ton to cost per metric ton to be consistent with those used by NHTSA. EPA's estimates were based on a relationship between annual emissions from 17 distinct emission sources and PM-related health impacts (and their monetary benefits).[91] These relationships were developed using a three step process (cited directly from the EPA report):

1) Use source apportionment photochemical modeling to predict ambient concentrations of primary PM2.5, nitrate and sulfate attributable to each of 17 emission sectors across the Continental U.S. (On-road emission sources are one of the 17 sectors addressing by the modeling);

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[90] Technical Support Document, "Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors," U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, January 2013.

[91] Technical Support Document, "Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors," U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, January 2013.

2) For each sector, estimate the health impacts, and the economic value of these impacts, associated with the attributable ambient concentrations of primary PM2.5, sulfate and nitrate PM2.5 using the environmental Benefits Mapping and Analysis Program (BenMAP v4.0.66);
3) For each sector, divide the PM2.5-related health impacts attributable to each type of PM2.5, and the monetary value of these impacts, by the level of associated precursor emissions. That is, primary PM2.5 benefits are divided by direct PM2.5 emissions, sulfate benefits are divided by SO2 emissions, and nitrate benefits are divided by NOx emissions.

This modeling tool was developed for use in support of various regulatory actions being considered or taken by EPA. It provides mid-range health effects and benefits, as opposed to worse-case estimates (e.g., 90th or 95th percentile effects). While the purpose of the estimates of emission reductions on mortality, morbidity and their value are considered generic, when found to be substantial, the results merit a much closer examination of the impact of a regulation on public health. This will be apparent below.

As can be seen from the figures shown in Table 19, the NHTSA estimates for the value of the emissions of NOx and PM2.5 are slightly below the lower end of the range of EPA benefits for refinery emissions. While NHTSA's analysis shows that vehicle emissions predominate, due to their unreasonable scrappage impacts, in actuality (and consistent with all previous analyses), upstream, refinery emissions actually predominate the emission impacts of these three pollutants. Thus, the NHTSA valuations of NOx and PM2.5 are close to the lower end of the EPA range for the bulk of the emission impacts. For SOx emissions, EPA is within the range for vehicle emissions, but well below the lower end of the range for refinery emissions.

It is not clear why NHTSA made the effort to modify their valuations for GHG emission and not criteria pollutant emissions. However, the apparent consistency is again that the lower valuations for GHG emissions helped the proposal and the higher valuations for criteria pollutants would have hurt the proposal. In any event, we substitute the EPA ranges for the valuation of these three pollutants when we present our estimates of the net benefits (or cost as it turns out) of the proposal.

In addition, while NHTSA included the monetary value of changes in NOx, SOx, and PM emissions in their analysis, they did not mention the changes in premature mortality which comprise the vast majority of EPA's projected benefits. We correct this omission at the end of this review when we project more realistic impacts of the proposal on emissions and public health.

XVIII. More Realistic Impacts of the Proposed Freeze of the CO2 and CAFE Standards

We developed two separate estimates of the impacts of the proposal on costs, benefits, emissions and health impacts. The first follows as closely as reasonable to NHTSA's 1977-2029 MY lifetime analyses which predominated NHTSA's presentations in the preamble to the rule. The second follows as close as reasonable to NHTSA's 2017-2050 CY analyses which NHTSA presented in the PRIA. While we believe that the 2017-2050 CY analysis provides a more complete picture of the impact of the proposal, NHTSA focused so much of its attention on the MY analysis that we felt that we had to present more reasonable projections using this format.

Methodology

The two types of analyses utilize the same runs of the Volpe Model. Before we present any results, we describe how we conducted the three runs of the Volpe Model needed to produce our projections. Where possible, we retained the methodology utilized by NHTSA. We only modified what we consider were the most egregious problems identified above to project more realistic costs, benefits and other impacts of the proposal.

The following presents the ways in which we modified the Volpe Model and processed its outputs to accomplish this task.

First, we ran the Volpe Model in CO2 mode. As done by NHTSA, we evaluated both the current CO2 standards and the proposed freeze at 2020 levels. We also ran the Volpe Model with both the sales response and fleet share modules enabled. As discussed above, there are real issues involved with both models and they should be modified before being used formally. Taken together they appear to have little impact on the total VMT under various CO2 and CAFE control scenarios. However, the dynamic fleet share in particular decreases fuel consumption under the proposal by increasing car sales relative to trucks. This reduces the increase in fuel consumption due to the proposal. The rationale behind this model is highly suspect. However, we left this and the sale response model activated in order to limit our modifications to only those aspects which are particularly unreasonable and have an inordinate impact on the proposal's costs, benefits and other effects.

Second, in order to address any lingering concerns about vehicle safety, we restricted the application of mass reduction in the same way that NHTSA did in their analyses conducted for the TAR. This meant leaving mass reduction completely unrestricted for light trucks. Mass reduction for small cars was restricted to only the first two stages of mass reduction: MR1 and MR2. Mass reduction for medium cars was restricted to only the first three stages of mass reduction: MR1, MR2 and MR3. These restrictions were implemented in the Technology file by entering FALSE in cells D61, D62 and D63 on the worksheets labeled SmallCar and SmallCarPerf and cells D62 and D63 on the worksheets labeled MedCar and MedCarPerf.

Third, for 2025 and beyond, we changed the fractions of incremental transportation fuel assumed to be from domestic crude oil and domestic refineries. We set both fractions to be 1.0 for both gasoline and diesel fuel on the Fuel Import Assumptions worksheet of the Parameters file (cells B47, d47, B49, D49, B54, D54, B56, D56, B61, D61, B63, D63, B68, D68, B70, D70, B75, D75, B77, D77, B82, D82, B84, and D84). Recent data on gasoline imports to the U.S. indicate levels of around 0.3% of total gasoline consumption. Given that the U.S. is projected to become energy independent by the mid 2020's, assuming that all incremental crude oil production related to differences in the CO2 standards would come from domestic production. We also updated the value of NOx, SOx and PM2.5 emissions to reflect more recent estimates made by EPA.

Fourth, we turned off the scrappage model by leaving the button blank on the Model Inputs page of the Volpe Model GUI and by entering FALSE into cells C4, D4, and E4 of the Scrappage Model Values worksheet of the Parameters file. Scrappage was modeled outside of the Volpe Model as described below.

Fifth, we ran the Volpe Model three times, once with no rebound, once with -10% rebound and once with -20% rebound. The case with no rebound was used to estimate the degree of scrappage needed to match the VMT by calendar year across the two CO2 control scenarios.

Several additional modifications were made to the Volpe Model output, as the desired adjustments could not be made using changes to the input files.

The first adjustment made to the model output was to eliminate the significant degree of over-compliance NHTSA projects under the proposed 2020 standards. As described above, NHTSA assumes that manufacturers will apply “Cost Effective” technology even if they do not require this technology to enable compliance. The 2020 standards are so lax that a number of technologies not required to enable compliance are still available to many manufacturers once compliance is attained. NHTSA does not present any evidence or analysis to support this assumption. NHTSA did not project any significant over-compliance with the current, 2025 CO2 standards, so the projected fleetwide CO2 levels under this control scenario required no adjustment. There is no way to disable NHTSA’s assumption that manufacturers will apply the “Cost Effective” technology, so this adjustment had to be made to the model output.

Table 20 shows the application of the proposed CO2 standards to the baseline fleet in the Market file of the NHTSA Volpe Model runs. We begin with the 2019 model year, as performance in earlier model years could be considered to be related to compliance with the 2020 standards (though even this over-compliance is questionable). As can be seen, the proposed standards increase in value in 2021 relative to 2020. This is due to the change in the way that air conditioning credits are treated.

Table 20: Fleetwide CO2 Compliance Requirements and Projected Compliance Levels Projected by the Volpe Model Under the Proposed 2020 Standards

Model Year	Fleetwide Required CO2 Emission Levels (g/mi)	Projected Compliance Level (g/mi)	CO2 Emission Adjustment
2019	236	234	1.0000
2020	227	228	1.0000
2021	241	236	1.0197
2022	241	233	1.0305
2023	241	232	1.0349
2024	241	231	1.0394
2025	240	231	1.0393
2026	240	232	1.0368
2027	240	231	1.0413
2028	240	231	1.0413
2029	240	230	1.0433
2030	240	229	1.0457
2031	240	229	1.0457
2032+	240	229	1.0456

For passenger cars, the fleet only over-complies in 2020 by 1 g/mi CO2. However, the degree of over-compliance increases 16 g/mi CO2 by 2032. The next column shows the ratio of the CO2 standard to the projected fleetwide emission level (e.g., 1.060 in 2032). We adjusted the projected levels of total fuel consumption, total CO2 emissions and upstream criteria pollutant and air toxics emissions for each model year up to 2050 in the Annual_Societal_Effects_Report.csv by multiplying them by these ratios. The same was done for light truck fuel consumption and emissions. We also adjusted the pre-tax, tax and retail fuel costs, CO2 emission costs and criteria pollutant emission costs for each model year up to 2050 in the Annual_Societal_Effects_Report.csv in the same way.

Since we are increasing CO2 emissions essentially back to levels projected for the 2020 model year, we adjusted the technology costs projected by the Volpe Model to those projected for the 2020 model year. Table 21 shows the adjustment factors used to accomplish this.

Table 21: Adjustments to Technology Costs Projected by the Volpe Model Under the Proposed 2020 Standards			
	Fleetwide Technology Cost ($)	Adjusted Compliance Cost ($)	Cost Adjustment
2019	$323	$323	1.000
2020	$399	$399	1.000
2021	$499	$415	0.832
2022	$515	$415	0.805
2023	$523	$415	0.794
2024	$519	$415	0.800
2025	$514	$415	0.808
2026	$517	$415	0.803
2027	$522	$415	0.795
2028	$520	$415	0.798
2029	$517	$415	0.803
2030	$515	$415	0.806
2031	$512	$415	0.811
2032+	$512	$415	0.810

Regarding technology costs, we did not conduct a detailed review of the costs that NHTSA projects for each and every technology. We did find that simply allowing all manufacturers to choose high compression ratio engines, which are already in use today by a wide range of manufacturers, the incremental savings of the proposal decreased from $2200 to $1600. Others have performed more detailed evaluations and found significant bias and errors. To represent the result of these findings, we reduced NHTSA's projection of technology costs by 50%. This could not be accomplished by simply multiplying the technology costs in the Technology input file (of Volpe Model) by 50%, as discussed below. When we did this, projected fleetwide technology costs decreased by less than 50% due to inefficiencies in the Volpe Model related to the technology paths and their definition of Effective Cost. Plus, projected over-compliance under the proposed CO2 standards became extreme. Thus, this 50% adjustment was made outside of the model by simply multiplying the vehicle related costs in the Annual_Societal_Costs_Report file by 50%. Vehicle-related costs include insurance and similar costs, as NHTSA assumes that these are proportional to technology costs. We show the results of our modeling both with and without this 50% adjustment to demonstrate the significance of the other factors on the projected effects and costs of NHTSA's proposal.

The final adjustment made outside of the model was related to scrappage. There could be some decrease in fleetwide VMT by calendar year should vehicle prices rise. The degree of this reduction has not been evaluated by NHTSA. In order to bracket this reduction, we will present modeling results both with and without scrappage. The results without scrappage require no further adjustment to the modeling results, as we ran the model in all cases without the NHTSA scrappage module enabled. The incorporation of a much more reasonable scrappage effect, which simply replaces any lost VMT from new vehicles with the same level of VMT from used vehicles, is described below. In order to reduce the number of modeling cases to a manageable level, we couple the assumption of 10% rebound with no scrappage response and 20% rebound with the VMT-neutral scrappage response. These two combinations provide the full range of regulatory effects and costs covered by all four possible combinations of these two factors (e.g., 10% rebound and VMT-neutral scrappage).

We determine the VMT-neutral scrappage level from the Volpe Model with no rebound, as the presence of rebound would not be expected to result in the same levels of VMT across control scenarios. Our goal was to simply have the VMT by calendar year under the current CO2 emission standards match those under the proposed freeze. We oriented our goal in this direction, as the impacts of the sales response module and fleet share module are smaller under the proposed freeze. Given the high degree of uncertainty involved in these two modules, we believed it was more reasonable to base the VMT for both control scenarios on values which had been adjusted less rather than more.

The first step was to calculate the level of VMT for cars and light trucks by calendar year under both CO2 control scenarios. The ratio of the VMT levels under the proposed freeze to those under the current CO2 standards was determined for each calendar year. The goal of this process is to adjust the VMT under the current CO2 standards so that this ratio is 1.0 for each calendar year.

The second step was to determine the ratio of total VMT in each calendar year to the VMT by vehicles aged one year and older (used vehicles). This ratio is relevant, as our goal is to increase total VMT in each calendar year, but this is done only by adjusting the VMT of used vehicles.

The third step was to apply adjustments to used vehicle VMT by age in each calendar year and carry these adjustments forward into the future in order to simulate the continued use of any vehicles which were no longer being scrapped. This adjustment likely over-estimates the effect of any reduced scrappage in the long term, but has the benefit of being straightforward and transparent. Our goal was not to develop the “right” scrappage model, only one which would reasonably represent an upper bound should drivers respond to an increase in new vehicle prices by increasing their use of older vehicles.

For example, the ratio of VMT under the current standards to the proposed standards for calendar year 2017 and the ratio of total VMT to used vehicle VMT in 2017 were both multiplicatively applied to the VMT of each model year cohort on the road in calendar year 2017 having an age of one or greater. Essentially by definition, this causes total VMT in 2017 to match that under the current standards. Note that this adjustment to used VMT under the current standards applies to vehicles aged one year to 39 years. We believe that this is reasonable because, if there is a “scrappage” response, it will occur in two ways. One could be that focused on by NHTSA: the repair of older vehicles which would have been scrapped. However, the more likely response would be the increased driving of older vehicles which would have been traded in upon the purchase of a new vehicle which is no longer being purchased. For example, the owner of a three-year old vehicle decides not to buy a new vehicle. Under NHTSA’s assumptions regarding vehicle mileage accumulation, the new vehicle would have been driven more upon its purchase. It seems reasonable to assume that this driving is simply transferred to a now four year old vehicle. There are no more four-year old vehicles on the road, but the VMT of four-year old vehicles has increased.

This adjustment has increased the VMT from 2016 and earlier model year vehicles in 2017. We next project this change into the future on a model year basis. This is done by applying the same adjustment (ratio of total VMT under the current standards to that under the proposal and ratio of total

VMT to used vehicle VMT in 2017) to the VMT by 2016 and earlier model years in calendar years 2018 and beyond under which there are no longer any of these vehicles on the road per the Volpe Model. This extends the adjustment for calendar year 2017 to all later model years to a diminishing degree, as in each subsequent calendar year, the adjustment is made to fewer vehicles (e.g., only 2 year old and older vehicles in 2018, three year old and older vehicles in 2019, etc.).

We next determine the ratio of total VMT under the current standards in calendar year 2018, after applying the 2017 adjustment factor, to 2018 VMT under the proposal. This ratio plus the ratio of total VMT to used vehicle VMT in 2018 under the current standards is applied multiplicatively to all VMT by vehicles one year old and older in 2018. Again, total VMT in calendar year 2018 is matched between the two control scenarios. This 2018 adjustment is applied to all VMT by 2017 and earlier model year vehicles in subsequent calendar years. This process was continued through calendar year 2050.

We next determined the net adjustment to each model year's VMT under the current standards in each calendar year. This produced a matrix of adjustment factors running from model years 1978-2049 and calendar years 2017-2050. We applied these adjustments to the fuel consumption, CO2 and other emissions, and safety-related fatalities in the Annual_Societal_Effects_Report file of the Volpe Model run with 20% rebound. We did the same to the fuel-related costs, driving-related costs and emission-related costs in the Annual_Societal_Costs_Report file for the same Volpe Model run.

We made one further adjustment to the scrappage factors used in the 1977-2029 MY analysis. As discussed above, it is not fair or appropriate to assign two sets of scrappage factor to a single model year: one occurring during the calendar year the model year's vehicles are sold as new vehicles and another occurring throughout that model year's life, which are actually due to the sale of later model year vehicles. Since NHTSA included the "calendar year" scrappage effects in its MY analysis by including the scrappage effects on 1977-2016 MY vehicles, we also chose to include these vehicles and the scrappage effects that they might experience. In order to avoid double-counting, however, this necessitated removing all scrappage effects due to the sale of MY 2030 and later vehicles, since they are not part of the analysis. This was accomplished simply by removing the scrappage factors described above in all calendar years 2030 and beyond.

NHTSA did not quantify the impact of the proposal on public health. To remedy this, we used a a regulatory assessment tool developed by EPA which projects estimates of various PM-related health outcomes from changes to annual emissions from 17 distinct emission sources. [92] It also provides estimates of the monetary value of these health impacts. This modeling tool was developed for use in support of various regulatory actions being considered or taken by EPA. It provides mid-range health effects and benefits, as opposed to worse-case estimates (e.g., 90th or 95th percentile effects). These relationships were developed using a three step process (cited directly from the EPA report):

1) Use source apportionment photochemical modeling to predict ambient concentrations of primary PM2.5, nitrate and sulfate attributable to each of 17 emission sectors across the Continental U.S. (On-road emission sources are one of the 17 sectors addressed by the modeling);

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[92] Technical Support Document, "Estimating the Benefit per Ton of Reducing PM2.5 Precursors from 17 Sectors," U.S. Environmental Protection Agency, Office of Air and Radiation, Office of Air Quality Planning and Standards, Research Triangle Park, NC 27711, January 2013.

2) For each sector, estimate the health impacts, and the economic value of these impacts, associated with the attributable ambient concentrations of primary PM2.5, sulfate and nitrate PM2.5 using the environmental Benefits Mapping and Analysis Program (BenMAP v4.0.66);
3) For each sector, divide the PM2.5-related health impacts attributable to each type of PM2.5, and the monetary value of these impacts, by the level of associated precursor emissions. That is, primary PM2.5 benefits are divided by direct PM2.5 emissions, sulfate benefits are divided by SO2 emissions, and nitrate benefits are divided by NOx emissions.

This regulatory tool only considers health effects related to fine PM. Thus, it does not address other known health effects of PM and NOx emissions, nor does it include any health effects of other pollutants which are shown in the previous section and which differ across CO2 control scenarios.

Tables 22 and 23 present the EPA-based estimates for the monetized health impacts of a ton of NOx, SOx, and PM emission in the U.S. in 2030. Note that we multiplied the EPA damage factors by 1.1 as EPA presented them per English ton and we present them per metric ton, as the latter are in metric tons. We also multiplied EPA's factors by 1.10 to convert them from $2010 to $2017. As discussed above, NHTSA does include monetized benefits related to similar health effects in their estimates of the costs and benefits of the proposal. However, the values per ton of NOx, SOx, and PM emissions used by NHTSA are lower than those developed by EPA. We use the EPA figures in the EDF estimates in this section, as they were developed since those used by NHTSA. We present NHTSA's estimates of the monetary value of changes in emissions as they are calculated in the Volpe Model.

Table 22: EPA Estimates of Health Benefits and Health Improvements per Metric Ton per Year of Mobile Source Emission in 2030

	NOx	SOx	PM
Monetized Value of Health Impacts: Mortality and Morbidity			
Krewski: 3% discount rate	$10,010	$28,600	$506,000
Lepeule: 3% discount rate	$23,100	$63,800	$1,100,000
Mortality and Morbidity Impacts per metric ton per year			
Premature Mortality: Krewski	0.0011	0.0031	0.0561
Premature Mortality: Lepeule	0.0025	0.0070	0.1210
Morbidity			
Respiratory emergency room visits	0.0006	0.0013	0.0286
Acute bronchitis	0.0017	0.0048	0.0825
Lower respiratory symptoms	0.0209	0.0616	1.0450
Upper respiratory symptoms	0.0297	0.0880	1.5400
Minor Restricted Activity Days	0.8250	2.3100	40.7000
Work loss days	0.1320	0.3850	7.0400
Asthma exacerbation	0.0737	0.0902	3.7400
Cardiovascular hospital admissions	0.0004	0.0009	0.0198
Respiratory hospital admissions	0.0003	0.0007	0.0165
Non-fatal heart attacks (Peters)	0.0013	0.0030	0.0649
Non-fatal heart attacks (All others)	0.0001	0.0003	0.0070

Table 23: EPA Estimates of Health Benefits and Health Improvements per Metric Ton per Year of Refinery Emission in 2030

	NOx	SOx	PM
Monetized Value of Health Impacts: Mortality and Morbidity			
Krewski: 3% discount rate	$9,130	$94,600	$440,000
Lepeule: 3% discount rate	$20,900	$209,000	$990,000
Mortality and Morbidity Impacts per metric ton per year			
Premature Mortality: Krewski	0.0010	0.0105	0.0484
Premature Mortality: Lepeule	0.0023	0.0231	0.1089
Morbidity			
Respiratory emergency room visits	0.0005	0.0050	0.0231
Acute bronchitis	0.0015	0.0154	0.0726
Lower respiratory symptoms	0.0198	0.1980	0.9350
Upper respiratory symptoms	0.0286	0.2860	1.3200
Minor Restricted Activity Days	0.7480	7.7000	35.2000
Work loss days	0.1320	1.3200	5.9400
Asthma exacerbation	0.0297	0.2970	1.4300
Cardiovascular hospital admissions	0.0004	0.0036	0.0176
Respiratory hospital admissions	0.0003	0.0031	0.0143
Non-fatal heart attacks (Peters)	0.0012	0.0121	0.0539
Non-fatal heart attacks (All others)	0.0001	0.0013	0.0058

The following two sections present these two separate views of the impacts of the proposal. Both strongly support the conclusion that the proposal should be rejected and NHTSA's analysis scrapped and begun anew with much more oversight from the public.

Impact of the Proposal Using a More Reasonable 1977-2029 MY Lifetime Analysis

Table 24 presents the key non-monetary results of our more realistic projection of the impacts of the proposal on 1977-2029 MY vehicles, along with NHTSA's estimates from their modeling of the CO2 standards. As noted in the table, we have either excluded any scrappage effect from the projection, or allowed scrappage to the extent that the change in used vehicle VMT matches the change in VMT from the change in new vehicle sales.

Table 24: Effect of the Proposal on 1977-2029 MY Lifetime Safety, Fuel Consumption and Emissions				
	NHTSA	EDF – 10% Rebound and No Scrappage	EDF – 10% Rebound and VMT-Neutral Pre-2030 Scrappage	EDF – 20% Rebound and VMT-Neutral Pre-2030 Scrappage
	Mortality Impacts			
Vehicle Safety				
Fatalities	(15,644)	(2,147)	(2,623)	(5,949)
Fatality rate per billion miles	Did not present	0.0035	0.0028	0.0072
Pollutant-Related Mortality	Did not present	5,413-12,076	4,832-10,780	4,261-9,511
	Fuel Consumption			
Billion gallons	79	148	146	133
	GHG Emissions (million metric tons)			
CO2	872	1,636	1,616	1,467
CO2 equivalent	910	1,722	1,700	1,543
	Criteria Pollutant and Air Toxic Emissions (metric tons)			
CO Total (t)	(5,994,040)	159,281	4,886	(560,982)
VOC Total (t)	(139,973)	505,404	489,778	423,172
NOx Total (t)	(189,825)	526,615	511,280	438,876
SO2 Total (t)	70,976	298,618	294,355	263,169
PM Total (t)	(4,398)	36,410	35,671	31,082
Acetaldehyde Total (tons)	(5,438)	(44)	(164)	(692)
Acrolein Total (tons)	(283)	12	5	(23)
Benzene Total (tons)	(11,810)	2,405	2,059	952
Butadiene Total (tons)	(1,827)	58	14	(146)
Formaldehyde Total (tons)	(2,767)	719	636	319
DPM10 Total (tons)	38,636	91,507	90,330	81,861

It is clear from the impacts shown in Table 24 that NHTSA has grossly overestimated the benefits of the proposal and underestimated the negative impacts of the proposal. We project reduced traffic fatalities with the proposal, though these are partially due to the use of NHTSA's flawed sales response and fleet share modules. However, the next line in Table 24 shows that all of these reductions are due to lower VMT levels under the proposal. The average fatality per million miles of driving increases under the proposal.

NHTSA's completely outdated and unrealistic projections about the source of the additional gasoline required by the proposal hid the fact that NOx, SOx and PM2.5 emissions would increase under the proposal. Using official EPA estimates of the effect of these emissions on mortality indicate that the proposal would increase deaths due to ambient PM levels by 2,262-9,511 under this MY analysis. These deaths, unlike those due to rebound, are not due to voluntarily chosen activities such as driving. All that these people are doing is breathing. NHTSA must revise these emission impacts and quantify the mortality impact that they produce. While we use what is commonly referred to as a "scoping tool" in producing these estimates, the results of this tool indicate that the potential impacts are large. NHTSA and EPA must conduct detailed and thorough emission, photochemical and health effects modeling to quantify the effect of this or any other proposal to relax the CAFE and CO2 standards and increase upstream emissions.

Table 25 presents the monetized costs and benefits related to these and other impacts of the proposal. We followed NHTSA's precedent for presenting certain values as costs and others as benefits, based on the heading for that row. This makes it very difficult to add up the various columns. However, it does allow individual rows to be understood as long as the heading for that row is read carefully. For example, the values for Rebound Non-Fatal Crash Cost and the Benefit Offsetting Rebound Non-Fatal Crash Cost are always the same values. Adding them together doubles them and they do not offset each other. However, one is labelled a "cost" and the other a "benefit". NHTSA adds one to total costs and the other to total benefits. In this way, they cancel each other out.

Table 25: 1977-2029 MY Lifetime Net Costs and Benefits of the Proposal ($ billion)				
	NHTSA	EDF		
Rebound	20%	10%	10%	20%
Scrappage	VMT-Increasing	None	VMT-Neutral	VMT-Neutral
Technology Costs	NHTSA	50-100% NHTSA	50-100% NHTSA	50-100% NHTSA
Technology Cost	(260)	(137)-(275)	(137)-(275)	(137)-(275)
Pre-Tax Fuel Savings	(143)	(262)	(258)	(238)
Mobility Benefit	(69)	(32)	(32)	(64)
Refueling Benefit	(9)	(14)	(14)	(13)
Non-Rebound Fatality Cost	(45)	8	4	4
Rebound Fatality Cost	(47)	(22)	(22)	(41)
Benefit Offsetting Rebound Fatality Cost	(47)	(22)	(22)	(41)
Non-Rebound Non-Fatal Crash Cost	(70)	12	7	7
Rebound Non-Fatal Crash Cost	(74)	(35)	(35)	(64)
Benefit Offsetting Rebound Non-Fatal Crash Cost	(74)	(35)	(35)	(64)
Congestion and Noise Cost	(61)	(9)	(12)	(25)
Energy Security Benefit	(12)	(0.1)	(0.1)	(0.1)
CO2 Damages *	(5)	(7)	(8)	(6)
Other Pollutant Damages, including mortality *	(1)	(33)-(74)	(43)-(96)	(29)-(64)
Total Costs	(557)	(184)-(321)	(195)-(332)	(256)-(393)
Total Benefits	(360)	(404)-(445)	(412)-(465)	(454)-(489)
Net Benefits	(197)	84 -262	80-270	60-233

* Even though this row is labeled “damages”, the negative numbers in NHTSA’s tables indicate that NHTSA considers this row to be considered a “benefit.”

We were able to reproduce NHTSA’s figures in VII-51 of the preamble to within a billion dollars or less for each component of costs and benefits, except for the value of the fatal and non-fatal crashes due to rebound. We are able to match the total value of fatal crashes and total value of non-fatal crashes with rebound, but not the portion due to rebound alone. We obtained the rebound portion of these two components by subtracting the value of fatal and non-fatal crashes from NHTSA’s Volpe Model run without rebound from those with rebound. We were able to come within $1-$2 billion dollars in each case. However, our total net cost for the proposal from NHTSA’s run is $(197) billion, while NHTSA shows a net cost of $(201) billion. This is still very close.

As can be seen, all six of the EDF cases show that the proposal would increase net societal costs, even when using NHTSA’s over-estimated technology costs from the Volpe Model. It is not clear why the energy security benefit decreased when fuel consumption increased. Larger decreases in fuel savings were a primary contributor. Reduced non-rebound related fatalities and crashes due to lower scrappage VMTs was another significant contributor. The non-rebound fatality and non-fatality accident impacts of the proposal are no longer savings, but costs. This is the result of the TAR's restrictions on mass reduction, the limitation on scrappage effects to only those necessary to return VMT to original levels, and the elimination of scrappage effects in CY 2030 and beyond. Finally, the significant increases in criteria pollutant emissions under the proposal also contributed a $30-$96 billion swing between the NHTSA and EDF projections for the value of these impacts of the proposal. The cause of the difference in energy security benefit between the NHTSA and EDF estimates could not be determined. However, this negative value in the NHTSA analysis actually contributes to the negative total benefits. So a smaller value under the EDF runs makes the proposal appear more favorable. This energy benefit may be related to reduced imports of crude oil, which we assumed would not occur under our evaluation of emissions related to crude oil production and refining. Thus, if there should still be a value for reduced crude oil use, it would only have made the proposal more costly under the EDF runs.

The bottom line is that correcting the numerous problems in the NHTSA model clearly swings the proposal from producing a net benefit to society to increasing net costs. NHTSA should correct its analyses and officially rescind the proposal.

The next section addresses the impacts of the proposal on calendar year basis.

Impact of the Proposal using a 2027-2050 Calendar Year Analysis

The following four sections present the impacts of the proposal on fuel usage, projected traffic fatalities, emissions and net costs for calendar years 2017-2050. This regulatory metric has passed the test of time. It excludes none of the impacts included in NHTSA's 1977-2029 MY lifetime analysis on the early end, as NHTSA's analysis includes no impacts prior to calendar year 2017. (Obviously, NHTSA's ability to affect anything that is going to happen in 2017 and 2018 is questionable, as this is history. But we've gone along with them for the sake of simplicity and the fact that the Volpe Model cannot be used to maintain the same technology applications across control scenarios for historical years like 2017 and 2018, and then allow differential applications thereafter.) On the long end, the 2017-2050 CY analysis avoids double counting scrappage impacts. The scrappage impacts, if any, due to the sale of 2017-2050 MY vehicles are included, but the scrappage effects of 2051 and later MY vehicles are not included. This is consistent with the fact that the usage of 2051 and later MY vehicles are excluded from the analysis, as well. Because the entire operation of 2025-2050 MY vehicles is not included in these projections, yet the complete technology savings of the proposal are included, this calendar year analysis should be considered liberal with respect of evaluating the benefit of the proposal vis-à-vis the current CO2 standards.

Fuel Savings

Table 26 presents the impacts of the proposed freeze on total fuel consumption by calendar year.

Table 26: Fleetwide Fuel Consumption by Calendar Year (billion gallons per year)

Calendar Year	NHTSA Analysis	EDF Analysis		
		10% Rebound and No Scrappage	10% Rebound and VMT-Neutral Scrappage	20% Rebound and VMT-Neutral Scrappage
2025	4	7	7	6
2030	8	13	12	11
2035	10	16	16	14
2040	11	18	17	15
2045	12	19	18	16
2050	12	19	19	16
2017-2050	270	422	411	366

As can be seen, we project much greater increases in fuel consumption for the proposal than NHTSA, ranging from a 33% to a 70% increase in this important aspect of the rule. These increases are due primarily to NHTSA's unjustified projection of manufacturer's gratuitous over-compliance with the proposed CO2 standards coupled with the completely unjustified projection that the fuel economy of the 2032 model year fleet will continue to increase by 0.75-1.28% year over year through 2050 without any regulation. In addition to the direct cost of this additional fuel, the need to produce and refine the crude oil used to produce this gasoline increases the upstream emission impacts of the proposal proportionately, as will be presented below. It should be noted that the increased fuel consumption of 19 billion gallons per year is equivalent to 1.24 million barrels per calendar day. This is equivalent to the gasoline output of 12 reasonably sized 200,000 barrels per day (of crude oil) refineries, or equivalent to the total fuel output of 6 such refineries.

Traffic Fatalities

Table 27 presents the impacts of the proposed freeze on traffic fatalities. The robustness and applicability of the underlying safety coefficients used by NHTSA to this rule is being addressed elsewhere. Here, we simply use these coefficients as if they were accurate and applicable.

Table 27: Impact of the Proposal on Traffic Fatalities by Calendar Year

	Projected Traffic Fatalities				Fatality Rate per Mile (NHTSA did not present this metric)		
Calendar Year	NHTSA Analysis	EDF Analysis			EDF Analysis		
		10% Rebound and No Scrappage	10% Rebound and VMT-Neutral Scrappage	20% Rebound and VMT-Neutral Scrappage	10% Rebound and No Scrappage	10% Rebound, VMT-Neutral Scrappage	20% Rebound, VMT-Neutral Scrappage
2025	(509)	(116)	(164)	(327)	0.003	0.0024	0.0048
2030	(855)	(169)	(296)	(590)	0.003	0.0025	0.0053
2035	(1091)	(246)	(364)	(730)	0.005	0.0034	0.0056
2040	(1171)	(293)	(407)	(820)	0.005	0.0034	0.0049
2045	(1119)	(293)	(428)	(863)	0.004	0.0033	0.0042
2050	(1089)	(305)	(455)	(918)	0.004	0.0032	0.0038
2017-2050	(27,522)	(6,653)	(9,798)	(19,703)	0.0061	0.0065	0.0120

As VMT under the current standards is higher than under the proposed freeze, and this driving is being voluntarily chosen, we show both projected total traffic fatalities and the rate of traffic fatalities per mile. As can be seen in Table 27, we continue to project that the proposal would reduce fatalities, assuming that the safety coefficients selected by NHTSA are both statistically significant and applicable to mass reduction as it would be applied in response to this rule. However, the levels of reduced fatalities are much lower than those projected by NHTSA and are almost entirely due to rebound VMT and to a lesser extent, scrappage-related VMT.

While NHTSA did not present the rates of fatality per mile for any of the control scenarios, their Volpe Model output showed that the proposal would reduce the average fatality rate per mile over CY 2017-2050. However, this was due to their inordinate amount of increased vehicle scrappage under the proposed freeze and completely unrestricted mass reduction on new cars. However, by simply restricting mass reduction for cars in the same way NHTSA did in its analyses for the TAR, and limiting scrappage to the maximum levels justified by NHTSA’s own economic theory, we project that the proposal will increase the rate of traffic fatalities per mile compared to the current standards. These rates include both old and new vehicles in each calendar year. These figures demonstrate the absurdity of NHTSA’s labeling of this proposal as “safer.” This is made even more clear in the next section on criteria and air toxic pollutant emissions.

GHG, Criteria, and Air Toxic Emissions

We present projected emissions under both the current CO2 standards and the proposed freeze for 6 calendar years: 2025, 2030, 2035, 2040, 2045, and 2050. This was done in order to facilitate comparison with analogous estimates which NHTSA presented in the DEIS. The one exception is that NHTSA presented CO2 emissions for 2020. It is not clear why this was done, as the rule has a negligible impact on 2020 emissions of any pollutant given that the CAFE and CO2 standards are exactly the same for both control scenarios through the 2020 MY.

Table 28 presents CO2 emissions for both control scenarios using both NHTSA's modeling and our own. We developed these emission projections from the Annual_Societal_Effects_Report.csv file, which is one of the output files of the Volpe Model. For the "NHTSA Analysis", we used the Annual_Societal_Report.csv file published by NHTSA for their simulation of the CO2 standards on their website. We simply sum the various columns of the file which contain the total emission values (column AW for CO2, AX for methane, AY for nitrous oxide, AR for CO, AS for VOC, AT for NOx, AU for SOx, and AV for PM). We select the emission totals according to the calendar year shown in Table 28 (and those following) for the relevant scenario (0 for the current standards, 2 for the proposed freeze), "TOTAL" for vehicle class, and "TOTAL" for fuel. The lower end of the range of emissions shown for our modeling reflects no scrappage response to lower new vehicle sales. The upper end of the range of emissions shown for our modeling reflects our estimate of scrappage which matches the VMT lost from lower new vehicle sales.

Table 28: GHG Emission Impacts of the Proposal by Calendar Year – (Million Metric Tons per Year)

	CO2 Emissions			
		EDF Analyses		
Calendar Year	NHTSA Analysis	10% Rebound and No Scrappage	10% Rebound and VMT-Neutral Scrappage	20% Rebound and VMT-Neutral Scrappage
2025	46	61	75	67
2030	89	111	137	123
2035	112	136	172	154
2040	124	148	189	168
2045	134	157	199	177
2050	138	162	207	182
2017-2050	2,983	4,672	4,542	4,051
	CO2-Equivalent Emissions[93]			
2025	48	81	79	71
2030	93	150	144	130
2035	118	186	181	162
2040	130	204	199	176
2045	140	215	209	186
2050	144	224	217	191
2017-2050	3,117	4,915	4,777	4,259

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[93] Included the effect on methane and nitrous oxide emissions, with global warming potentials of 25 and 298, respectively, consistent with the values used by NHTSA in the Volpe Model.

As can be seen, correcting NHTSA's projection of over-compliance under the proposed freeze and unjustified improvement in fuel economy after 2032 for all scenarios increases the projected increase in CO2 emissions by about 20-60% in 2035. We project that the CO2 emission impact of the proposal over the entire 2017-2050 timeframe would be 33-50% higher, depending on the actual level of rebound. Scrappage has a minor impact in our projections.

Table 28 also presents CO2 equivalent emissions for both control scenarios using both NHTSA's modeling and our own. We utilize the same global warming potentials as used by NHTSA in their modeling: 25 for methane and 298 for nitrous oxide. Again, correcting NHTSA's projection of over-compliance under the proposed freeze and unrealistic assumptions about the crude oil source and refining of the additional gasoline required increases the projected increase in CO2 equivalent emissions by roughly the same degree as seen for CO2 emissions alone.

Table 29 present similar projections for five criteria pollutants included in the Volpe Model.

Table 29: Impacts of the Proposal on Emissions of Criteria Pollutants (Metric Tons per Calendar Year)

Calendar Year	NHTSA Analysis	EDF Analysis		
		10% Rebound, No Scrappage	10% Rebound, VMT-Neutral Scrappage	20% Rebound, VMT-Neutral Scrappage
	CO Emissions			
2025	(179,669)	5,329	(10,710)	(32,771)
2030	(291,249)	18,314	(19,892)	(61,698)
2035	(329,250)	22,098	(11,600)	(67,259)
2040	(274,429)	20,037	(10,056)	(76,008)
2045	(208,359)	22,417	(10,295)	(81,945)
2050	(180,148)	21,708	(13,205)	(90,794)
2017-2050	(7,149,422)	504,060	(353,973)	(1,891,914)
	VOC Emissions			
2025	(3,529)	53,275	22,050	18,965
2030	2,365	63,779	40,389	34,691
2035	13,021	63,507	51,949	44,461
2040	20,696	65,175	57,572	48,604
2045	26,914	67,291	60,992	51,363
2050	29,412	69,352	63,181	52,718
2017-2050	382,287	1,881,218	1,372,865	1,164,672
	NOx Emissions			
2025	(5,547)	24,831	23,225	19,838
2030	(2,182)	45,740	41,992	35,876
2035	76	56,401	53,182	45,252
2040	3,687	61,304	58,454	49,011
2045	8,367	64,877	61,722	51,608
2050	10,401	67,337	63,902	52,921
2017-2050	44,308	1,490,576	1,407,497	1,186,406
	SOx Emissions			
2025	4,022	14,105	13,671	12,093
2030	7,400	25,477	24,391	21,571
2035	8,838	31,221	30,238	26,583

2040	9,541	33,651	32,704	28,372
2045	10,611	35,650	34,539	29,962
2050	11,232	37,177	35,946	31,022
2017-2050	241,831	826,916	800,462	699,229
	PM Emissions			
2025	177	1,726	1,652	1,437
2030	354	3,159	2,967	2,572
2035	324	3,874	3,693	3,174
2040	499	4,215	4,041	3,418
2045	746	4,457	4,255	3,586
2050	843	4,623	4,401	3,674
2017-2050	13,253	102,594	97,815	83,339

As can be seen, the projected criteria pollutant impacts of the proposal are very different using NHTSA's assumptions versus our own. NHTSA projected that the proposal would decrease CO emissions very substantially. This is almost entirely due to NHTSA's inordinate scrappage model. With 10% rebound and VMT-neutral scrappage, we project about one-twentieth of NHTSA's projected reductions.

Other than NOx emissions in 2025 and 2030, NHTSA projected that proposal would increase the remaining criteria pollutant emissions modestly. Our projections, which correct many of NHTSA's errors and unreasonable assumptions are quite different. We project that the impacts of the proposal would be larger by a factor of 4-5 for VOC emissions, 30-40 for NOx emissions, 4 for SOx emissions, and 8-10 for PM emissions. These are inordinate differences and show the cascading impact of NHTSA's biased assumptions.

Chief among these assumptions is that NHTSA assumes that only half of the increased gasoline needed under the proposal is refined domestically. NHTSA also assumes that the vast majority of the crude oil required to produce the increased gasoline required under the proposal is imported. NHTSA does not consider or include overseas criteria pollutant emissions in its projected impacts, so its assumptions about crude oil sourcing and refining essentially push these emissions outside the boundary of their consideration. Consistent with NHTSA's own claim that the U.S. will be a net crude oil exporter in the 2025 timeframe, we assume that any crude oil and refining impacts associated with changes to the CO2 standards will be reflected in domestic crude oil production and refining. Again, there is the impact of NHTSA's scrappage model, with its unjustified decrease in VMT under the proposed freeze. Finally, unjustified over-compliance with the 2020 standards through 2032 and for both control scenarios after 2032 reduce upstream emissions which comprise most of our emission impacts shown in Table 29.The impact of these corrected emission impacts of the proposal have a large effect on the health impacts of the proposal, as will be described below.

Table 30 present similar projections for six air toxic emissions included in the Volpe Model.

Table 30: Air Toxic Emission Impacts of the Proposal (Metric Tons per Calendar Year)

Calendar Year	NHTSA Analysis	EDF Analysis		
		10% Rebound, No Scrappage	10% Rebound, VMT-Neutral Scrappage	20% Rebound, VMT-Neutral Scrappage
	Acetaldehyde Emissions			
2025	(120)	(2)	(14)	(33)
2030	(240)	(0)	(33)	(73)
2035	(319)	(4)	(35)	(88)
2040	(297)	(3)	(33)	(100)
2045	(226)	(2)	(35)	(105)
2050	(190)	(5)	(39)	(111)
2017-2050	(6,682)	(81)	(871)	(2,342)
	Acrolein Emissions			
2025	(6)	0	(0.3)	(1)
2030	(12)	1	(0.5)	(3)
2035	(16)	2	0.1	(3)
2040	(14)	2	0.3	(3)
2045	(10)	2	0.4	(3)
2050	(8)	2	0.3	(4)
2017-2050	(320)	43	1.5	(77)
	Benzene Emissions			
2025	(427)	107	71	27
2030	(558)	218	134	49
2035	(501)	277	206	94
2040	(364)	301	242	107
2045	(222)	324	261	114
2050	(160)	335	268	108
2017-2050	(11,307)	7,210	5,449	2,311
	Butadiene Emissions			
2025	(56)	2	(3)	(9)
2030	(85)	6	(5)	(17)
2035	(95)	9	(1)	(17)
2040	(79)	10	1	(18)
2045	(59)	11	2	(19)
2050	(50)	12	1	(21)
2017-2050	(2,079)	226	(23)	(467)
	Formaldehyde Emissions			
2025	(79)	32	24	11
2030	(111)	65	44	20
2035	(120)	82	63	31
2040	(92)	90	73	34
2045	(52)	96	78	36
2050	(34)	99	80	35
2017-2050	(2,461)	2,143	1,675	773

	DPM10 Emissions			
2025	2,037	4,301	4,181	3,753
2030	3,977	7,967	7,663	6,886
2035	4,984	9,888	9,613	8,601
2040	5,499	10,829	10,563	9,355
2045	5,923	11,450	11,136	9,847
2050	6,100	11,892	11,542	10,139
2017-2050	132,337	261,209	253,782	225,675

Except for diesel particulate (greater than 10 microns in diameter, DPM10) emissions, NHTSA projected that the proposal would reduce air toxic emissions. These reductions were due primarily to their unreasonable scrappage model and their 20% estimate of rebound. Correcting these and other problems, the proposal is now projected to increase air toxic emissions except for acetaldehyde. This is consistent with all previous modeling of relaxed CO2 standards that have been performed. It should be noted that the levels of DPM emissions shown in Table 30 are greater in magnitude than the levels of PM emissions in Table 29. We did not have time to resolve this discrepancy, except to note that it is a direct result of the upstream and tailpipe emission factors used by NHTSA in their analysis, as these have not been changed since the TAR.

Health Impacts

Table 31 presents the application of these health impact factors to the effect of the proposal on NOx, SOx, and PM emissions in 2030 shown in Table 29.

Table 31: Effect of the Proposal on PM-Related Health Impacts in 2030: EPA Regulatory Analysis Tool			
	EDF - 10% Rebound and No Scrappage	EDF - 10% Rebound and VMT-Neutral Scrappage	EDF - 20% Rebound and VMT-Neutral Scrappage
Monetized Value of Health Impacts: Mortality and Morbidity ($2016 million)			
3% discount rate	$3,553-$7,928	$4,393-$9,802	$5,011-$11,183
Mortality and Morbidity Impacts			
Premature Mortality	356-795	440-982	502-1121
Respiratory emergency room visits	1,014	1,195	239
Acute bronchitis	3,183	3,761	747
Lower respiratory symptoms	40,979	48,467	9,615
Upper respiratory symptoms	58,088	68,586	13,775
Minor Restricted Activity Days	1,551,239	1,832,427	368,570
Work loss days	262,670	310,022	63,070
Asthma exacerbation	61,796	68,802	13,971
Cardiovascular hospital admissions	768	908	178
Respiratory hospital admissions	628	743	148
Non-fatal heart attacks (Peters)	2,388	2,818	576
Non-fatal heart attacks (All others)	258	305	62

As can be seen, just the effect of the proposal on NOx, SO2 and PM emissions produces $20-50 billion of health impacts in 2030. The vast majority of this monetized health impact is due to premature deaths. As shown, the proposal would cause 502-1,413 more premature deaths in 2030. These premature deaths due to PM emissions and precursors are an order of magnitude greater than the traffic deaths saved by the proposal in 2030, even including 20% rebound. NHTSA must consider these PM-related deaths when they consider relaxing CAFE and CO2 standards in the future.

We extended this analysis to the public health impacts associated with the total emission impacts over the entire 2017-2050 CY period in Table 32. It should be noted that we are applying damage functions estimated for CY 2030 to emission impacts which run from essentially 2021-2050, though the bulk of the emission impacts occur in 2030 and beyond (70-75%). CY 2030 was the last year for which EPA estimated damage functions. These functions steadily increased between 2016 and 2030, even in constant dollars. Thus, applying the damage functions for 2030 to emission impacts predominantly occurring later is conservative. We only present the health impacts and not their monetary benefits. Monetary benefits over such a long period would require discounting in order to be summed and this is done in the next section.

Table 32: Effect of the Proposal on PM-Related Health Impacts from 2017-2050: EPA Regulatory Analysis Tool

	EDF - 10% Rebound and No Scrappage	EDF - 10% Rebound and VMT-Neutral Scrappage	EDF - 20% Rebound and VMT-Neutral Scrappage
Monetized Value of Health Impacts: Mortality and Morbidity ($2016 billion)			
3% discount rate	\$93-\$205	\$89-\$197	\$85-\$188
Mortality and Morbidity Impacts			
Premature Mortality	11,434-25,520	14,501-32,362	10,284-22,911
Respiratory emergency room visits	32,723	40,089	10,282
Acute bronchitis	102,687	126,057	32,169
Lower respiratory symptoms	1,322,290	1,623,910	414,108
Upper respiratory symptoms	1,874,195	2,299,464	592,747
Minor Restricted Activity Days	50,051,131	61,424,459	15,884,847
Work loss days	8,474,747	10,395,427	2,712,198
Asthma exacerbation	1,987,858	2,358,166	591,593
Cardiovascular hospital admissions	24,768	30,418	7,658
Respiratory hospital admissions	20,273	24,887	6,386
Non-fatal heart attacks (Peters)	77,049	94,492	24,758
Non-fatal heart attacks (All others)	8,335	10,222	2,680

As can be seen, the proposal’s increase in health-related premature mortality is far greater than the safety-related benefits claimed by NHTSA in their proposal even with all of the unreasonable assumptions and projections described above. These figures argue very strongly for an extensive and thorough analysis of the proposal on refining emissions in particular and their impact on public health. As we have said before, the proposal is so completely deficient in identifying its likely impact on public health that it needs to be rescinded. Any re-proposal needs to consider impacts like those shown in Table 32.

2027-2050 Calendar Year Costs, Benefits and Net Benefits

We calculated the total costs, benefits and net benefits for the proposal relative to those under the current standards. We found a very significant problem with the driving values contained in the Annual_Societal_Costs_Report produced by the Volpe Model. In the proposal, NHTSA points out that drivers value the additional driving associated with rebound VMT. They present traditional demand-supply curves to demonstrate that there is a surplus benefit associated with this additional VMT (or lost value under the lower VMT associated with the proposal). They describe a fairly straightforward approximation of this surplus value. NHTSA states that the value of this additional driving is slightly greater than the cost of this driving. NHTSA goes on to calculate the value of this surplus value over the cost of the driving. NHTSA appears to (conveniently?) forget to include the much larger driving itself, which is actually easier to calculate since the Volpe Model already does so.

Table 33 shows the driving related costs of the proposal over the current standards both with and without rebound. Fuel-related costs include direct, retail fuel costs, and the value of refueling time.

Table 33: Net Costs and Benefits of the Proposal over 2017-2050 CY ($billion)

	NHTSA	EDF		
Rebound	20%	10%	10%	20%
Scrappage	VMT-Increasing	None	VMT-Neutral	VMT-Neutral
Technology Costs	NHTSA	50-100% NHTSA	50-100% NHTSA	50-100% NHTSA
Technology Cost	(709)	(367)- (733)	(367)-(733)	(367)-(733)
Pre-Tax Fuel Savings	(415)	(652)	(633)	(565)
Mobility Benefit	(172)	(87)	(87)	(175)
Refueling Benefit	(23)	(33)	(32)	(29)
Non-Rebound Fatality Cost	(39)	17	1	1
Rebound Fatality Cost	(112)	(53)	(53)	(107)
Benefit Offsetting Rebound Fatality Cost	(112)	(53)	(53)	(107)
Non-Rebound Non-Fatal Crash Cost	(62)	27	1	1
Rebound Non-Fatal Crash Cost	(175)	(83)	(84)	(167)
Benefit Offsetting Rebound Non-Fatal Crash Cost	(175)	(83)	(84)	(167)
Congestion and Noise Cost	(100)	(23)	(35)	(76)
Energy Security Benefit	(33.7)	(0.1)	(0.1)	(0.1)
CO2 Damages	(14)	(22)	(22)	(19)
Other Pollutant Damages, including mortality	(9)	(93)-(205)	(89)-(197)	(85)-(188)
Total Costs	(1,196)	(482)-(848)	(538)-(904)	(715)-(1,082)
Total Benefits	(954)	(1,024)-(1,136)	(1,001)-(1,109)	(1,148)-(1,251)
Net Benefits	(242)	175-654	97-571	66-535

As expected, the impact of the proposal on fuel costs is lower with rebound than without rebound. Rebound increases VMT under the current CO2 standards with their lower fuel costs per mile than under the proposed freeze with its higher fuel costs per mile. This additional VMT increases total fuel costs under the current standards and reduces the impact of the proposal on total fuel costs.

Because of this additional rebound driving, the effect of the proposal on accidents and projected fatalities are greater with rebound than without it. If NHTSA were fully valuing the additional VMT due to rebound, the proposal would cause driving related costs to increase by the cost of the additional fuel required by the rebound VMT plus a significant portion of the cost of the additional accidents and projected fatalities.[94] However, the cost of the additional driving falls well short of these amounts. We believe that this is evidence that NHTSA included the surplus value of rebound driving over fuel, accident and congestion costs, but failed to include these other costs. Thus, in stating that they were accounting for the value of rebound VMT, NHTSA appears to have made a gross exaggeration. Given the effort needed to account for the very small surplus value over and above fuel, congestion and accident costs, it seems impossible that NHTSA could have accidentally forgotten to include these other costs as well. This seems to have been an intentional mistake to again make the proposal look as good as possible, deserved or not.

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[94] It is possible that a consumer might fail to value the cost of an accident to the “other” driver. However, on average, this consumer would at least value the cost of an accident to themselves. Thus, we conservatively estimate that a consumer would value half of the cost of additional accidents and possible fatality estimated by NHTSA.