Comments Sent From SAB Member, Dr. John Christy, to SAB Chair, Dr. Michael Honeycutt, January 9, 2020

I'm sending you this email because I will likely be unable to be part of the conference-call discussion on the 22nd when the SAFE rule is on the docket (I will be in-route to a long-scheduled meeting out of state).

In my submission for this report (attached, see page 4), I noted model failings (none of the models will be very accurate), but the key point was that if the 2018 NPRM model were correct within a huge error margin of ±100 percent (yes, 100 percent, see page 4), there would still be no impact on the climate system that would be measurable or attributable to the rule. This seems to be the most important point regarding the models that assess the SAFE rule - the CO_2 impact of whatever rule (or model) is adopted will be insignificant. I didn't see this most fundamental point made in the letter report, and I believe it is the crux of the matter. (I do see some of the issues I raised in the uncertainty section of the supplementary material, but I do not see, unless I missed it, the main point I made that whatever action might be taken will produce an undetectable response.)

I had testified as an expert witness in the 2007 US Federal case regarding CAFE standards and demonstrated that the proposed new rule in that case would be spittin' in the ocean (well, not quite those words, but quantitatively the result was similar). As the judged stated in the ruling, "James Hansen [witness for the other side] did not contradict" my findings of an inconsequential impact on the climate. This is an area I have done a good bit of on-the-record work both in court and before congress, and the simple fact is it doesn't matter whether the entire country or entire world adopts California's rule or the SAFE rule … there will be no measurable climate impact. Consequently, it seems to me, one should take the pathway that leads to healthy economic development, especially for the more financially-constrained citizens of our country (we could have economists chime in here).

That's my story. I hope this point is made because it seems to me it's the most important point in this whole discussion.

Thank you.

John C.

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Attachment

Uncertainty in the CAFE model.

[Personal summary: Has the 2018 NPRM addressed the uncertainties to the extent its result is known to a confidence interval that allows policy to be made? After reading several hundred pages, I couldn't tell. The 2016 TAR used limited processes and out-of-date inputs while the 2018 NPRM has shortcomings. Assumptions in calculating the number of vehicles on the road in 2030 seems to be a major issue that has a significant impact on the final result. The assumptions regarding the calculation of SCC appear to have a significant impact too. In addition, the many factors related to the manner and timing that the manufactures incorporate new fuel-saving technologies into the production stream appears to be significant and uncertain. In the "View from 40,000 ft" you will see there really is no climate impact regardless of how large the error in the 2018 NPRM calculation is.]

Modeling a system that is driven by factors such as human behavior, opportunistic technological innovation, dynamic economics and unpredictable external events is notoriously difficult and complex. In such situations, a model result will depend more heavily on the assumptions and specific processes chosen to represent the way the system behaves rather than on the first principles of physical laws. Estimates of future outcomes from such models are often characterized by high uncertainty (low precision.)

To make progress with understanding such systems, modelers often run many thousands of simulations in which the various assumptions and processes are perturbed (quantifying parametric uncertainty) to understand the range of outcomes that are possible and how those outcomes depend on the assumptions. But even then, critical processes are likely poorly represented, poorly interconnected to other processes, or completely unknown, so that perturbation studies may still not capture the desired reality.

This is the case with the CAFE model utilized by EPA and NHTSA in which a key forecasted target-variable is the net cost by 2030 to U.S. society for the implementation of an emission standard for passenger cars and light-duty trucks. A main driver of this standard is the Endangerment Finding which requires EPA to set rules to reduce CO2 emissions since CO2 is a greenhouse gas that affects the radiation budget of the climate system. Obtaining a higher level of U.S. "energy security" by utilizing less carbon-based fuels, or higher mpg, was also a goal. The highly correlated parameters of automotive CO2 emissions and mpg standards brings the EPA (CO2 emissions) and NHSTA (CAFE requirements) together for defining the standards to be met.

Two modeling efforts, one in 2016 (known as the draft Technical Assessment Report or TAR) and another in 2018 (described in the Notice of Proposed Rule Making or NPRM), attempted to calculate the net cost of the 2012 standard (and updated in Jan 2017 as the "baseline-standard") put forth by NHSTA and EPA for 2017-2021 and 2022-2025. The reports came to conflicting conclusions – the former calculating a net benefit of $87.6B and the latter a net cost of $176.2B.

This more recent calculation led the EPA to propose a new “revised-standard” regarding the final year of 2017-2021 and all of 2022-2025 with the goal of allowing benefits to outweigh costs.

The two reports obviously applied differing assumptions for the input parameters and of the interacting processes which drive the computations to a solution. The number of these inputs is considerable and difficult to quantify with high confidence. A sampling of these inter-related components is given here:

(a) the “rebound effect” (i.e. the benefits owing to lower driving costs that increases miles traveled which is of value to the consumer),
(b) the cost to society related to extra CO2 emissions (particularly to climate),
(c) the calculation of the number of vehicles scrapped as new vehicles are manufactured and purchased,
(d) the per-vehicle cost of including technological advancements which lower emissions,
(e) costs related to the response of the consumer in terms of factors such as miles driven, willingness to buy higher-cost vehicles or continue driving old vehicles, etc.,
(f) costs related to the timing decisions of manufactures as they include improvements in the production stream,
(g) calculated value of avoided fatalities and property damage,
(h) number of EVs in the mix (dependent on state mandates and battery technology),
(i) value of energy security (how vulnerable is the U.S. to carbon shortages?), and
(j) accumulation and transfer of credits for overcompliance.

Bento et al. 2018 (B18) were highly critical of the 2018 NPRM modeling methods, though did not endorse the earlier TAR, calling both reports “flawed analyses.” They demonstrated in Table S.1. that the 2018 NPRM has a fuller representation of various processes (“channels of adjustment”) than does the 2016 TAR. However, B18 offered several instances in which the channels used on the 2018 NPRM, in their view, ran “afoul” of representing existing research and economic principles. This, in their view, led 2018 NPRM to inflate costs and diminish benefits, over-emphasizing the negative result (i.e. costs > benefits) of the “baseline-standard.” Below are some key criticisms by B18.

(1)The 2018 NPRM indicates that there will be a reduction in vehicle-miles-traveled (-2.4%) and 6 million fewer vehicles on the road (-1.9%) in 2030 as a result of (a) a new scrappage model and (b) not allowing for dynamic pricing of used vehicles in relation to prices of new vehicles. This appears to contradict economic theory. If the vehicles are now less expensive under the SAFE “revised-standard” due to less expensive fuel-technology, then more will be purchased vs. the “baseline-standard”. This will further impact the costs due to more vehicle miles – fatalities, property damage, emissions, etc. B18 believe the $90.7 billion gain in the “revised-baseline” estimated by 2018 NPRM will approach zero if properly quantified. [What is the uncertainty in the calculation of the number of vehicles in use by 2030?]

(2) The “rebound effect” is represented differently in the two reports, with 2018 NPRM doubling its magnitude from 10% to 20%. The rebound effect touches several of the processes that operate in the model. For example, a higher rebound

effect both (a) increases costs (lower benefits due to decreased vehicle miles traveled) and (b) increases benefits (more crashes avoided). Estimates from published reports for the "rebound effect" range from 0% to almost 20%. The net effect however is small as the various consequences of changes in the rebound effect tend to be offsetting.

(3) Costs of fuel-saving technologies and for the way manufacturers will stage these improvements into their production stream differ by more than a factor of two (2016 TAR $90.7B, 2018 NPRM $259.8B). This is a difficult cost to estimate. For example, only 19% of the 2017 MY cars and light-duty trucks met the 2017 standard suggesting technology was slower to be achieved and applied than anticipated. The NPRM removed some of the potential technologies that might be incorporated into the products, limiting options in the model. Another factor is the ZEV mandate - if one assumes the mandate stays and that more states will adopt ZEV mandates, then fewer fuel-saving vehicles will be required, lowering overall costs. The 2018 NPRM analysis implicitly assumes no ZEV mandate and assumes higher costs for EVs based on battery assumptions.

(4) The 2016 TAR allowed for transferring of credits for overcompliance from one vehicle class to another and from one year to another. The 2018 NPRM did not do so until 2022, leading to higher calculated manufacturers' costs.

(5) The climate benefits from reduced carbon emissions were calculated using a proxy known as the "Social Cost of Carbon (SCC)." The 2016 TAR used a global value for SCC set at $48 per ton while the 2018 NPRM used a domestic value of $7 per ton resulting in a benefit drop from $27.8 billion to $4.3 billion. B18 did not delve into the value of the SCC though it is a highly controversial subject. Here we note it is based on three main components each which contains considerable uncertainty, (a) the climate sensitivity, (b) the damage-cost function and (c) the discount rate. As with many complex models, the assumptions applied to generate SCC essentially predetermine the result. Dayaratna et al. 2017 applied empirical estimates for the key assumptions (rather than outdated theoretical estimates of the 2016 TAR) to demonstrate that the values of SCC, such as those used in the TAR, are significantly inflated. Indeed, using very reasonable assumptions one can generate distributions of SCC for which a major portion is negative, i.e. emissions produce a net benefit. Thus, the uncertainties in the SCC are large and contentious.

In general, B18 claim that to do the problem comprehensively requires a considerable addition of factors not so far included in any modeling exercise. In any case, B18 indicate that two factors, fleet size and the Social Cost of Carbon, account for $112 billion in differences between the 2016 and 2018 calculations. They conclude "although some of the changes in technology assumptions in the 2018 analysis are plausible, overall it uses pessimistic assumptions of future technology availability and performance compared with the 2016 analysis." A consistent statement would also be that the 2016 TAR used optimistic assumptions of future technology availability and performance.

Peer Review

In 2017 the Volpe Center arranged for formal peer review of the 2016 version of the CAFE model that was used in the 2018 NPRM, a process which was managed by DIGITALiBiz Inc. (iBiz). Quoting the summarized conclusion of the review,

> All of the peer reviewers supported much of the model's general approach, and supported many of the model's specific characteristics. Peer reviewers also provided a variety of general and specific recommendations regarding potential changes to the model, outputs, and documentation.
>
> NHTSA and Volpe Center staff agree with many of these recommendations and have either completed or begun work to implement many of them; implementing others would require further research, testing, and development not possible at this time, but we are considering them for future model versions. When NHTSA and Volpe Center staff disagree with certain general and specific recommendations, we note that often these recommendations appear to involve input values and policy choices external to the model itself, and are therefore beyond the scope of peer review.

CAFE Model Peer Review, DOT HS 812 590, NHTSA. U.S. Dept. Transportation, July 2019 (Revised). 468 pp.

View from 40,000 feet.

One of the driving motivations for the SAFE emission standard is the potential impact on the Earth's climate of extra CO2 emissions which directly relates to the Endangerment Finding and thus EPA's involvement. The difference regarding the impact on the climate system between the baseline-standard and the revised-standard is negligible. The EPA estimates SAFE will add 0.003 °C to the global temperature by 2100, a value that currently is too small to measure as global temperatures change by much more than this from month to month. Indeed, using the most recent empirical estimates of climate sensitivity the impact is very likely less than 0.003 °C. In terms of emissions, the net accumulation is estimated to be an extra 5.1 gt CO2 by 2100 or about 0.08% of the atmospheric concentration at that time (Federal Register, vol. 83, no. 165, 24 Aug 2018, pg 42,986). This indicates that if the 2018 NPRM model error were ± 100% (0 to 10.2 gt CO2), the impact on the climate system would still be negligible. Thus, large uncertainties in the inputs and processes will not impact the result in terms of absolute response of the climate system. Scaling this up to the entire world (using many simple and debatable assumptions) puts the net impact at 0.01 to 0.02 °C which is also negligible.

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Basic information related to the GHG targets the Endangerment Finding and its role in the standards discussed above:

Annual U.S. emissions for 2018:

1.099 gt CO_2 from gasoline vehicles
1.559 gt CO_2 from gasoline and diesel vehicles
1.925 gt CO_2 from all transportation
6.416 gt CO_2 from all energy-related sources
https://www.eia.gov/tools/faqs/faq.php?id=307&t=10

Global 2018

33.1 gt CO_2 emitted from fossil fuels (9.0 gt C) and from road transport alone ~5.3 gt CO_2 globally. https://www.iea.org/geco/emissions/

2018 Global emissions from fossil fuels were about 1% of the total CO_2 already residing in the atmosphere, but the net annual atmospheric increase is less due to re-absorption of a portion of these human-caused emissions of CO_2. The current annual growth rate is ~2.4 ppm/year or ~21 gt/yr. https://www.esrl.noaa.gov/gmd/ccgg/trends/gl_gr.html

2019 Total Atmospheric CO_2 concentration ~413 ppm = ~3,200 gt CO_2 (~870 gt C.)

By 2100, the proposed "revised-standard" would add 0.65 ppm or 5.1 gt CO_2 to the atmosphere vs. the current 2017 "baseline-standard." The background scenario for 2100 used values of 790 ppm or ~6,100 gt CO_2. (NPRM, Federal Register, 83, NO. 165, 42,996-42,997). A linear growth rate of 20 gt/yr net would imply ~4,800 gt CO_2 in 2100, thus the "revised-standard" assumed a nonlinear rate, gradually increasing from ~21 gt/yr in 2018 to ~48 gt/yr net addition by 2100 (i.e. a year to year compounded growth rate of 1.008). Note: 1 ppm ~ 7.8 gt CO_2.

Background on modeling effort.

The Department of Transportation (DOT) is required to set Corporate Average Fuel Economy (CAFE) standards for passenger cars and light trucks at maximum feasible levels in each model years and requires DOT to enforce compliance with standards. Within DOT, the National Highway Traffic Safety Administration (NHTSA) carries out these assignments. Supporting NHTSA is the Volpe National Transportation Systems Center (Volpe Center) which conducts analyses through modelling to provide estimates of the impacts of potential future CAFE standards. The primary tool for estimating impacts it eh Volpe Center developed software simply known as the "CAFE model."

EPA also used four DOE and DOE-sponsored models to develop inputs to the CAFE model, including three developed and maintained by the DOE's Argonne National Laboratory. DOE's EIA's National Energy Modeling System was used to estimate fuel prices and Argonne's Greenhouse gases, Regulated Emissions, and Energy use in Transportation model to estimate emissions rates from fuel production and distribution processes. DOT also sponsored DOE/Argonne to use their Autonomie full-vehicle simulation system to estimate the fuel economy impacts for roughly a million combinations of technologies and vehicle types. (FR 63, 165 pg 43000)