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December 5, 2013

Ms. Gina McCarthy
Administrator
U.S. Environmental Protection Agency
Air and Radiation Docket, Mail Code: 6102T
1200 Pennsylvania Avenue, NW
Washington, DC 20460

Re: Docket ID No. EPA-HQ-OAR-2013-0643

Dear Administrator McCarthy:

On behalf of Mercedes Benz, USA and its parent, Daimler AG (hereinafter jointly referred to as "Mercedes Benz"), please find enclosed written rebuttal comments for EPA's consideration pursuant to the Agency's notice seeking comments on an *Alternative Method for Calculating Off-Cycle Credits for Mercedes-Benz Vehicles Under the Light Duty Greenhouse Gas Emissions Program*, at 78 Fed. Reg. 60,275, 60,279 (Oct. 1, 2013).

Thank you.

Sincerely,

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Enclosures

cc: Chris Grundler
Byron Bunker
Bill Charmley

Mercedes-Benz Rebuttal Comments

Alternative Method for Calculating Off-Cycle Credits for Mercedes-Benz Vehicles Under the Light-Duty Greenhouse Gas Emissions Program

[EPA-HQ-OAR-2013-0643; FRL-9901-57-OAR]

Submitted December 5, 2013

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RESPONSE TO COMMENTS

Mercedes Benz ("MB") appreciates the opportunity to provide responses to the comments received by EPA regarding MB's alternative demonstration application for calculating off-cycle credits for model year ("MY") 2012-2016 vehicles under the light-duty greenhouse gas ("GHG") emissions program (hereinafter "the Petition").[1] Specifically, MB requested GHG credits for start-stop technology, as well as for high efficiency lighting, active seat ventilation and thermal control glazing technologies. The alternative demonstration methodology is available to manufacturers, pursuant to subsection 40 C.F.R. § 86.1269-12(d) of the GHG regulations, as an optional opportunity to receive additional credits for "new and innovative technologies that reduce vehicle CO2 emissions, but for which CO2 reduction benefits are not significantly captured over the 2-cycle test procedures used to determine compliance with the fleet average standards (i.e., 'off-cycle')." 77 Fed. Reg. 62,832 (2012). MB's alternative methodology application is wholly consistent with both the requirements and the intent of the GHG regulations, as well as with EPA's commitment to provide GHG credits for off-cycle technologies to encourage manufacturers to implement such fuel and emission saving technologies into their U.S. fleets. MB urges EPA to approve its Petition, and requests that the Agency complete its review and approval process prior to the end of 2013.

MB's comments reference information contained in MB's Petition, EPA's previous rulemaking documents, and clarifying descriptions of MB's vehicle system along with supporting test data where appropriate.[2] As described further below, to the extent several of the commenters raised concerns with the implementation of the GHG regulations as currently written, these issues are more appropriately addressed in future rulemaking and/or during the regulation's mid-term review.

[1] MB's responses are intended to address comments submitted to EPA. The Federal Register notice seeking comment invited MB to file for EPA's consideration written rebuttal comments to respond to comments received from the public during the comment period. 78 Fed. Reg. 60,275, 60,729 (2013). Nothing herein is intended to serve as a new or revised application.

[2] MB's comments address all eight comments submitted to the docket: (1) Alliance of Automobile Manufacturers ("Alliance"), EPA-HQ-OAR-2013-0643-0004; (2) American Council for an Energy-Efficient Economy, ("ACEEE"), EPA-HQ-OAR-2013-0643-0006; (3) American Honda Motor Co., Inc. ("Honda"), EPA-HQ-OAR-2013-0643-0008; (4) Association of Global Automakers ("Global"), EPA-HQ-OAR-2013-0643-0005; (5) California Air Resources Board ("CARB"), EPA-HQ-OAR-2013-0643-0007; (6) International Council on Clean Transportation ("ICCT"), EPA-HQ-OAR-2013-0643-0003; (7) Natural Resources Defense Council ("NRDC"), EPA-HQ-OAR-2013-0643-0009; and (8) Union of Concerned Scientists ("UCS"), EPA-HQ-OAR-2013-0643-0010.

I. INTRODUCTION

A major goal of the off-cycle credit program is to provide an incentive for the development and expanded use of new technologies recognized to achieve reductions in CO2 emissions. *See* 77 Fed. Reg. at 62,833. All of the comments submitted to EPA agree with the purpose of the GHG regulations concerning off-cycle technologies. Approval of MB's request is consistent with these goals.

As stated by the Union of Concerned Scientists ("UCS"):

> *Encouraging the deployment of the full range of such [off-cycle] technologies is one of the primary reasons for the MY2012-2016 and MY2017-2025 regulations, and these regulations are the single-most powerful tool the administration has employed to mitigate global warming.* (UCS Comment at 1)

The California Air Resources Board ("CARB") also reiterated that it "supports the off-cycle credit program as a means of promoting implementation of innovative technologies and recognizing their impact on [GHG] reductions." (CARB Comment at 1)

In addition to supporting the goals of the off-cycle credit program, all of the comments accepted (or did not object to) MB receiving credits for high efficiency lighting, active seat ventilation and thermal control glazing technologies.[3] The primary focus of a number of commenters was MB's request for credits for its start-stop technology. While some of the comments raise concerns with the amount of credits MB requested for its start-stop technology, several comments acknowledged the efforts that MB has made to integrate start-stop technology in MB's vehicles. Specifically, UCS noted that

> *Mercedes-Benz has made engine stop-start technology an integral component of reducing the greenhouse gas reductions from its vehicle fleet, adopting the technology across the board far ahead of expectations and other manufacturers.* (UCS Comment at 4-5)

Overall, granting MB's credit requests will lead to even greater penetration of these advanced technologies in MB's US fleet, consistent with the purpose of the GHG regulations. Indeed, the Company has already increased its planning for start-stop usage to 93% of vehicles by MY 2016, from 1.5% in MY 2012. Notably, a recent update to EPA's MY 2014 Fuel Economy Guide, highlighted start-stop systems as a fuel saving technology and observed that, "[u]ntil recently, these systems were mostly found on hybrid vehicles, but as of the 2014 model year, they are available on about one hundred

[3] Honda requested clarification that such credits could be given for MYs 2012-2013. As described in the final rulemaking, granting credits for off-cycle technologies on the default credit menu under subsection (b), prior to MY 2014, is well within EPA's authority under subsection (d) (at 40 C.F.R. § 86.1269-12(d)). *See* 77 Fed. Reg. at 62,833.

conventional vehicle models."[4] Incentivizing early and increased implementation of technologies like start-stop into the U.S. fleet is the primary purpose of the off-cycle GHG emission credit program.

Of the eight comments submitted on MB's application, one, the Alliance, strongly supported approval of MB's Petition for all four technologies, including start-stop. Another comment, by Global, supported approval of the Petition with regard to high efficiency lighting, active seat ventilation and thermal control glazing technologies, but made no comment on start-stop. Of the remaining six comments, Honda did not object to additional credits for MB's start-stop technology, but raised several points for the Agency's consideration. Five other comments raised objections to MB's request for start-stop credits, though none provided any data or material evidence to contradict MB's Petition or to demonstrate that MB's start-stop technology is not entitled to additional off-cycle credits under the GHG program. These six comments regarding MB's start-stop technology can be divided into five categories:

(1) suggestions that MB should not be allowed to utilize its real-world idle fraction in favor of EPA's conservative idle time estimate for the pre-defined credit menu;

(2) questions regarding the statistical validity of MB's real-world data, which are answered by a review of MB's Petition and general statistical principles;

(3) criticisms of the EPA methodology that MB utilized to calculate the off-cycle effectiveness of start-stop, many of which were previously rejected by EPA during the GHG rulemaking;

(4) technical questions concerning MB's start-stop technology, demonstrating a lack of understanding regarding MB's sophisticated AC and battery systems interactions with start-stop; and

(5) requests for additional vehicle testing that are more appropriate for the certification program.

All of these comments are addressed in detail below. MB's start-stop technology is integral to the basic vehicle design and has the potential to yield off-cycle GHG emission improvements upon every key start and driving trip. In order to demonstrate the off-cycle emission reductions and GHG credits appropriate to MB's start-stop technology, MB developed and submitted statistically representative, manufacturer-specific data and engineering analysis as explicitly required by subsection (d) of the GHG regulations. Suggestions that MB should not be allowed to rely on its manufacturer specific data or engineering analysis disregard both the express content and intent of the GHG regulations.

[4] EPA and DOE, *MY 2014 Fuel Economy Guide*, at 4 (updated Dec. 3, 2013).

II. SUMMARY OF MB'S ALTERNATIVE DEMONSTRATION CALCULATION FOR START-STOP CREDITS

As EPA reviews MB's request for start-stop credit, it is important to consider that MB's field data and analyses were developed as the GHG off-cycle credit regulations were being established and that MB's credit application is the first opportunity that the Agency has had to implement those regulations with regard to an alternative demonstration methodology request. In the May 2010 final rulemaking on Light Duty Vehicle GHG Emission Standards and CAFE Standards for MY 2012-2016, EPA indicated that start-stop technology should not be eligible for off-cycle credits. *See* 75 Fed. Reg. 25,324, 25,438 (2010). Nevertheless, EPA "recognize[d] there may be additional benefits to start-stop technology beyond the 2-cycle tests (***e.g., heavy idle use***)," and committed to continue to assess start-stop technologies for credit eligibility. *Id*. (emphasis added). Two years later, in the August 2012 final rulemaking for Light Duty Vehicle GHG Emission Standards and CAFE Standards for MY 2017-2025, EPA determined start-stop technology was eligible for off-cycle credits. As part of the notice and comment rulemaking, the Agency generated a methodology for estimating the real-world off-cycle benefit of start-stop and established a pre-defined credit amount under subsection (b). 77 Fed. Reg. at 62,279; *see also* Final Joint TSD at 5-84 to 5-89. EPA further provided that manufacturers seeking *additional* credits for off-cycle technologies, including start-stop, could submit an alternative demonstration methodology application under subsection (d). *See* 77 Fed. Reg. at 62,727.

From 2010-2011, prior to issuance of the 2017-2025 GHG rulemaking, MB conducted a field test on 29 customer vehicles in the U.S. in large part to further the Company's research on fuel economy improvements. Indeed, MB began designing its U.S. field test in 2008, well before EPA finalized the 2012-2016 GHG rulemaking. MB invested significant time and resources to design the study, recruit a representative sample of vehicles, equip and instrument each vehicle with a sophisticated data logger and gather data for an average of 13 months from each vehicle. Overall, the field study process, from design to completion, took nearly three years—18 months of which was for data collection. Since start-stop technology was not available on MB vehicles in the U.S. until MY 2012—and even then, less than 1.5% of MY 2012 vehicles sold in the U.S. had start-stop—none of the customer vehicles were equipped with start-stop technology.

Given that designing and conducting a U.S. field test to gather statistically representative real-world data can take several years from start to finish, and that vehicles with start-stop technology were not available in the U.S. in significant numbers, it is reasonable and appropriate that MB used good engineering judgment to estimate the percentage of start-stop effectiveness for its MY 2012-2016 credit application. If EPA were to determine that manufacturers could not utilize any estimates or engineering judgment in calculating GHG off-cycle credits and could only submit applications based solely on real-world data, then MB and other manufacturers would be significantly delayed, if not completely excluded from, submitting a credit request under subsection (d) for MY 2012-2016 vehicles; and subsection (d) would not operate

as intended to incentivize adoption of new and innovative GHG reducing technologies.[5] Such a scenario is contrary to the stated purpose of the off-cycle credit program and would remove the incentive for early introduction and penetration of start-stop technology in the U.S. prior to MY 2017.

Many of the commenters noted that MB is the first manufacturer to submit an alternative demonstration methodology application for GHG off-cycle credits. As comments from the Alliance recognize, MB invested a considerable amount of time and resources to prepare and submit this application and to collect the test data on which the application is based. MB's alternative demonstration methodology generally follows the steps of EPA's approved methodology, which was used to derive the pre-defined credit values for start-stop technology, with adjustments made to account for MB-specific data and technology. To support its application, MB developed and submitted the following critical test data and analyses:

(i) A measurement of the total idle fraction of 23.8% which MB customer vehicles experience in the real-world. This measurement data was based on robust, verifiable and statistically representative data collected over an 18 month U.S. field test;

(ii) Independent, third-party data validating MB's real-world customer idle fraction data;

(iii) A/B testing data, conducted with and without start-stop, to demonstrate the emission reduction benefit of MB's start-stop technology for the various vehicle powertrains in which start-stop is available in MB's U.S. vehicles;

(iv) An engineering analysis to estimate MB's start-stop system effectiveness, as a percentage of MB's total idle fraction, based on a conservative application of MB's start-stop system design parameters to EPA's methodology.

These data and analyses not only support the MB Petition, they also address many of the comments.

[5] Not allowing the use of engineering analyses to estimate and project real-world effectiveness would eliminate MB's opportunity to obtain credits under subsection (d) for MYs 2012-2016, which would delay widespread adoption of start-stop technology in the U.S. and forego additional GHG emissions savings. This is because MB's stringent field test design and data collection activities, as described in the Petition at 4-5, make it unlikely that a field test could be completed before MY 2016, even if it were begun immediately following EPA's decision on this application. Accordingly, there would be no incentive for early introduction of technology if EPA restricted off-cycle credit applications only to testing equipment in the field.

III. COMMENTS RELATED TO MB'S SPECIFIC IDLE FRACTION

Several commenters suggested that MB's idle time estimate was incorrect for two reasons: (1) it is higher than EPA's conservative estimate of idle time for the credit menu; and (2) regardless of accuracy, manufacturers should not be allowed to use manufacturer-specific driving activity data to support credits higher than those on the menu. As detailed below, these comments disregard the regulations as written and threaten to jeopardize the effectiveness of the off-cycle credit program in reducing GHG emissions. The effectiveness of start-stop technology in reducing CO2 emissions is a direct function of the percentage of operating time a vehicle spends at idle, which itself is a function of vehicle operation, in the real-world. Not allowing manufacturers to fully account for real-world idle time, artificially lowers the GHG credits awarded to start-stop technology, and removes the incentive for OEMs to incorporate this expensive technology into their U.S. fleets at the earliest possible date, thereby foregoing early emissions reductions.

A. MB's Idle Time Is Correct

ICCT, and others, noted that MB's total idle time fraction of 23.8% was higher than average idle times estimated in other studies, including those studies relied on by EPA to select its conservative idle time estimate of 13.76% for the default credit menu. EPA's estimate was derived from earlier studies not specifically designed to evaluate periods of idle. In contrast, MB's idle time was measured as an actual percentage of vehicle operation for 29 vehicles instrumented for an average of 13 months across nine different metropolitan areas in the U.S. (*See* Petition at Section II). As described below and in Attachment A to the Petition, MB's idle time data are statistically representative of MB's U.S. vehicles. Moreover, MB's specific idle time is verified by independent data from Progressive Insurance, which recorded virtually the same idle time (23.9%) for more than 17,000 MB vehicles, from MY 1998-2012. Thus, the real-world idle time experienced by MB U.S. customers, has been demonstrated to be significantly higher than the idle time simulated by EPA's MOVES database, which was relied on for the default start-stop credit value at subsection (b).

Indeed, for the entire U.S. fleet (for all manufacturers) Progressive has second-by-second speed data on more than 1.2 Million vehicles, accounting for a total of 1.25 Billion trips and 8.3 Billion miles of driving experience.[6] These data indicate that 22.7% of trip time is spent idling (at 0 mph). Progressive's average idle time for the U.S. is closer to the average idle time observed in MB vehicles (23.8%) and significantly higher than EPA's estimate (13.76%) based on earlier studies. An important reason may be changes in traffic density since EPA's studies were conducted, which could have significant effects on certain off-cycle technologies. As suggested by UCS, the Agency should consider re-evaluating its estimated idle time for the entire U.S. fleet and all U.S. manufacturers. (*See* UCS Comment at 4). Large databases, such as that of Progressive Insurance and other independent third parties, could give important input

[6] These data are for all U.S. drivers participating in the Progressive Snapshot program, regardless of vehicle manufacturer. The data include MY 1996-2013 vehicles from 44 states.

for EPA's future assumptions.[7] The mid-term review on the 2017-2025 rulemaking may be an appropriate time to undertake such re-evaluation.

Despite the large amount of data supporting MB's real-world idle fraction, ICCT attempted to distinguish MB's real world idle time by referencing previous studies, from as far back as 1993, which suggest a minimum idle time of about 14%. (*See* ICCT Comment at 5). As described in Attachment A to the Petition, and Rebuttal Attachment 1 hereto, the idle fractions from the four locations used in the previous U.S. studies, including those for the 1993 SFTP program that ICCT cites, are consistent with MB's real-world idle time data once traffic densities are accounted for. *See* Rebuttal Attachment 1 at 3; Petition Attachment A at 18. Attempting to further support a lower idle fraction, ICCT also references European studies which were not designed to measure real-world idle fraction and certainly were not intended to be representative of any individual manufacturer in the U.S., including Mercedes vehicles. Specifically, the WLTC data referenced by ICCT were collected in various studies conducted in several different nations over different time periods and were then amalgamated with the single goal of developing a worldwide unified test cycle (Worldwide Harmonized Light Duty Vehicle Test Procedure, or WLTP).[8] These data were not intended to be representative of any one country or of any one manufacturer. Indeed, of the 146 vehicles in the WLTP database, there was only one Mercedes passenger car (C-Class). Such data are insufficient for challenging the two sets of real-world idle data on MB U.S. vehicles, from both MB and Progressive, supporting the Petition.

B. The Regulations Allow Manufacturer-Specific Driving Activity Data

Several commenters (ICCT, NRDC, ACEEE and Honda) raised concerns regarding MB's use of driving data to support an MB-specific idle time higher than the idle time used by EPA to derive the default credit value for start-stop. These commenters essentially suggest that manufacturers should not be allowed to use driving activity data to demonstrate off-cycle emission reductions that occur in the real-world. Such comments overlook the language and intent of the GHG regulations.

The whole purpose of the off-cycle credit program is to recognize and "provide incentive for manufacturers to develop new technologies that provide significantly greater emissions reductions off-cycle than over the 2-cycle test." 77 Fed. Reg. at 62,836. To streamline the process for obtaining credits and encourage the early introduction of off-cycle technologies, EPA created a pre-defined credit menu which provides conservative credit values for various technologies, including start-stop, and does not require any testing for manufacturers to obtain. "EPA agrees that the credits on the pre-defined list are based on conservative estimates of real world off-cycle CO2

[7] It is important, however, that EPA retain a path for manufacturers differing from these averages to demonstrate a benefit with real world data.

[8] *See Development of a Worldwide Harmonized Light Duty Driving Test Cycle (WLTC), Draft Technical Report* at 1-2, GRPE-67-03 (November 2013), *available at* http://www.unece.org/fileadmin/DAM/trans/doc/2013/wp29grpe/GRPE-67-03.pdf.

and fuel consumption benefits." 77 Fed. Reg. at 62,833. Accordingly, in promulgating the 2017-2025 rulemaking, EPA specifically retained the alternative demonstration option for manufacturers to request additional credits beyond the pre-defined menu values: "the ability of manufacturers to generate credits beyond or in addition to those included in the pre-defined technology list ***based on manufacturer test data*** remains part of the off-cycle credits program under both the MYs 2012-2016 and MY 2017-2025 programs." 77 Fed. Reg. at 62,835 (emphasis added).[9]

Moreover, EPA contemplated that manufacturers would submit driving activity data to support alternative demonstration pathway applications. To determine overall emissions reductions for certain off-cycle technologies, EPA reasoned that manufacturers would need to "determine not only the emissions impacts during operation but also real-world activity data to determine how often the technology is utilized during actual, in-use driving on average across the fleet." 77 Fed. Reg. at 62,838. As required by subsection (d), MB utilized a combination of "test procedures and analytical approaches to estimate the effectiveness of the technology for the purposes of generating credits." *Id*. Specifically, MB followed the methodology that EPA used to estimate the pre-defined credit values for start-stop, as suggested by the Agency in the rulemaking. *See id*.

One comment, by ACEEE, incorrectly asserted that MB offered "no evidence that its vehicles have lower GHG emissions as a result of the way they are used." (ACEEE Comment at 2). To the contrary, MB conducted A/B testing to demonstrate that its start-stop technology results in a significant CO2 emissions improvement during the idle periods over the test cycle and provided statistically valid field test data demonstrating how often MB vehicles idle in the real world. If the idle periods of the FTP were longer, the CO2 emissions improvement seen on the A/B testing would increase. It is axiomatic that the more a vehicle idles, the more opportunity exists for the engine to be shut off and emissions to be reduced. EPA acknowledges this correlation between start-stop emissions benefit and idle time: "start-stop technologies enable a vehicle to turn off the engine when the vehicle comes to a rest, and then quickly restart the engine when the driver applies pressure to the accelerator pedal. The benefit of this system is that it largely eliminates fuel consumption at idle. The EPA FTP (city) test does contain short periods of idle, but not as much idle as is often encountered in real world driving." Final Joint TSD at 5-84. MB has provided ample evidence to demonstrate how often its vehicles encounter idle in the real world. Although MB currently lacks real-world data to demonstrate start-stop activation percentage during those idle periods, the Company has provided the Agency with its best engineering analysis consistent with EPA practice and procedures to estimate start-stop effectiveness. It is simply untrue that MB has offered no evidence to support its request for GHG emission reductions credits.

[9] To the extent that CARB's comments implied that manufacturers should not be allowed to utilize subsection (d) to request credits that exceed the pre-approved default credit values in subsection (b), this would be inconsistent with final rulemaking, which clearly contemplates the ability to request additional credits—above the pre-defined credit menu—via an alternative demonstration application under subsection (d).

Finally, NRDC suggests that the real-world idle time fraction should be a value "specified for all manufacturers fleets because it is not dependent on vehicle technology." (NRDC Comment at 2). This assertion ignores the fact that idle time is dependent on vehicle operation, as described above and previously acknowledged by EPA. Although overall U.S. idle time will be relatively similar across manufacturers, each manufacturer's idle time will be specific to its customer demographic. To be clear, Mercedes is not seeking to use its real-world idle time to demonstrate that MB deserves more credits than other manufacturers whose vehicles operate in the same regions of the country. Rather, MB provides its real-world idle fraction to distinguish from EPA's conservative idle fraction estimate and because the Agency requires manufacturer specific data under subsection (d).

IV. STATISTICAL VALIDITY OF MB'S REAL-WORLD DATA

Five of the commenters (ICCT, ACEEE, UCS, NRDC and CARB) raised generalized statistical issues with no analytical support regarding MB's idle time data, as well as the independent data collected by the Progressive Snapshot Program. As demonstrated in Attachment A to the Petition, MB's average idle fraction of 23.8% is statistically representative of MB's U.S. vehicles as well as MB's U.S. driver demographic. The idle fraction from the Progressive Snapshot Program for MB vehicles was submitted for the sole purpose of supporting the idle fraction collected by MB during its U.S. field test. (*See* Petition, Attachment A at 18-20). The robust sample size of the Progressive data available for over 17,000 MB vehicles, from MYs 1997-2012, from 44 states within the U.S., validates the MB field test data and negates any potential concerns regarding MB's idle time data. Nevertheless, responses to all of the statistical issues raised in the comments are provided in Rebuttal Attachment 1 hereto, entitled *Responses to Public Comments on Petition Attachment A: Statistical Assessment of Idle Time Fraction Calculation in Mercedes-Benz Vehicles* (Nov. 25, 2013).

V. ISSUES RELATED TO USE OF EPA'S METHODOLOGY

Four commenters (ICCT, CARB, ACEEE and NRDC) raised objections to MB's use of EPA's basic methodology, modified to reflect MB-specific operational dynamics, to calculate its off-cycle credits for start-stop. These comments suggested (1) that manufacturers should not be allowed to utilize EPA's methodology in an alternative demonstration application (CARB, ICCT); (2) that MB did not implement EPA's methodology correctly (ACEEE); or (3) raised specific objections to EPA's methodology that are more appropriately considered in future rulemaking proceedings. As described further below, MB appropriately utilized EPA's methodology—with adjusted values to account for MB specific technology—to calculate its start-stop credits.

A. Manufacturers Can Rely on EPA's Methodology from the Joint TSD

The GHG regulation allows for, and encourages, use of EPA's methodology. In developing the pre-defined credit option, EPA was conservative in the values the Agency used to derive the default credits, but the methodology is sound and was the subject of notice and comment. In the final rulemaking, EPA specifically stated that, in

their demonstrations, manufacturers would be able to "apply the same type of methodologies used by EPA" as the basis for the Agency's default values in the Joint TSD Chapter 5. 77 Fed. Reg. at 62,838. Thus, suggestions that manufacturers should not be allowed to utilize EPA's methodology developed for the default credit program (*see, e.g.*, ICCT Comment at 10) have already been rejected by the Agency and would need to be raised anew in future notice and comment rulemaking.

B. MB Accurately Utilized EPA's Methodology

The basic methodology utilized by MB is summarized in MB's Petition at Section III, 11-27. As acknowledged by EPA, MB followed a "similar methodology to the one EPA described in the TSD for the MY2017-2025 rule, but with unique inputs for idle time and stop-start system effectiveness which includes parameters related to Mercedes' unique control strategy for its stop-start system." 78 Fed. Reg. at 60,277.

One comment, by ACEEE, suggested that MB's calculation contained mathematical errors and should be revised. (*See* ACEEE Comment at 3). The methodology used to calculate both the on-cycle percentage of idle time and the off-cycle emissions credit is the exact same approach as presented in the final Joint TSD (at 5-84 to 5-89). In the final Joint TSD, EPA addressed this methodology in detail and highlighted modifications from the proposed rule that were made to take into consideration comments made during the review period, including comments by ICCT that led EPA to change the weighted idle rate of the combined cycle to 10.7%. *See* Joint TSD at 5-85.[10] Thus, the credit calculation in MB's Petition, at 24-25, is a correct application of EPA's methodology/formula, as adopted through notice and comment rulemaking and specified in the final Joint TSD, and does not contain mathematical errors.

Two comments, by CARB and NRDC, suggested that manufacturers should not be able to utilize EPA's methodology to demonstrate higher values for start-stop, due to higher idle fraction, without taking into consideration potential corresponding increases in emissions that might result from the higher idle time fraction. (*See* NRDC Comment at 2; CARB Comment at 2). In response, MB notes that the GHG regulations do not provide for such a concept and no other credits for off-cycle technologies take this into account. MB followed the framework established by EPA in the final Joint TSD through public notice and comment rulemaking. The only difference is that MB utilized a different value for its real-world idle fraction that represents MB's vehicles actual operations. EPA's methodology did not attempt to perform such a calculation of

[10] In the final rule, EPA acknowledged ICCT's comment on the proposed rule that "when applying the FTP/HWY weighting of 55%/45%, this produces a weighted idle rate of 10.7%, not 9% used in the TSD." Joint TSD at 5-85. EPA decided that for "the 10.7% 2-cycle idle rate, when we consider the amount of time to reach proper operating engine temperature, a small portion of the FTP was eliminated. Our in-house test data showed that the average time to reach 90% maximum engine coolant was on average 324 seconds, and due to this, eliminating the first two idle periods of the FTP. As a result, the idle rate we used for the 2-cycle test was 10.0% instead of the 10.7% suggested by the [ICCT]." *Id*. at 5-86.

"concomitant effects" and MB, likewise, should not be so required. Moreover, the premise of NRDC and CARB's assertions is flawed. Higher or lower average speeds, without consideration of driving patterns (*e.g.*, maximum speed, accelerations and decelerations) do not necessarily translate into higher or lower GHG emissions. Finally, the difference between the MB test vehicles and the certification cycle average speeds is not material: the average speed of MB's 29 test vehicles was 29.3 mph, while the certification cycles have an average speed of 33.3 mph.

C. Specific Issues Regarding EPA's Methodology Are More Appropriately Raised in Future Rulemaking Proceedings

ICCT raised several objections to MB's use of EPA's methodology, including several that were submitted and rejected during the GHG rulemaking. Concerns about EPA's methodology, as finalized in the Joint TSD, are appropriate for consideration either in a new rulemaking or in the mid-term review for MY 2022-2025 standards.

Specifically, ICCT asserts that there are "a number of fundamental errors in the method EPA used to calculate the amount of in-use idle time that is eligible for stop/start operation" (ICCT Comment at 7-8), and that "EPA's methodology to assess the amount of stop/start activity in the real world is far too optimistic." (ICCT Comment at 9). Consequently, ICCT suggests that in evaluating MB's Petition EPA should disavow the Agency's own methodology and should apply ICCT's methodology to MB's data and dramatically decrease MB's start-stop credits. Such disregard of EPA's existing program and unilateral application of ICCT's assertions would be arbitrary and capricious. In promulgating the regulation, EPA rejected many of ICCT's proposals and EPA should disregard them now. To the extent EPA's believes ICCT's comments with regard to EPA's methodology for calculating GHG credits have merit, these issues are more appropriately raised and considered in the mid-term review.

Moreover, several of ICCT's specific assertions with regard to ICCT's suggested methodology are inaccurate or inappropriate. Specifically, ICCT relies heavily on a 1993 study to argue that EPA should utilize 140°F as the engine warm up temperature rather than 104°F. This assertion ignores the significant technological improvements that have occurred since 1993 to enable faster engine warm-up. ICCT also inappropriately analyzed the 1993 data to derive the 140°F average.[11] Additionally, ICCT inaccurately assumes that warm-up times for engines in ambient temperatures below 40°F will take 20% longer than EPA estimated. This assumption is based on no data and fails to recognize that complex engine control strategies could compensate for colder ambient temperatures and still accomplish engine warm-up just as quickly as under warmer ambient temperatures. ICCT's suggested changes to EPA's methodology are unsupported and unwarranted at this time.

[11] Specifically, ICCT appears to have taken a straight average of the catalyst temperature data after they were parsed into cold, warm and hot categories, and without accounting for the frequency distribution of VMTs within those categories. (ICCT Comment at 8). This is an inappropriate application of the data from Appendix E, Table E-1 in the 1993 preliminary report.

Finally, to confirm MB's engineering analysis submitted with the Petition—which applied EPA's methodology to estimate start-stop effectiveness—MB reviewed data from its 29 vehicle study, specifically with regard to temperature. The results demonstrate that in the real-world, MB vehicles warm up even faster than assumed in the Petition (and in EPA's methodology) and that MB's credit application is therefore very conservative. As provided in the Petition, *see* Attachment H at 6-7, the MB system has temperature criteria for transmission oil and engine coolant. Specifically, the transmission oil must reach 20°C, while the engine coolant must reach a temperature between 40°C and 70°C, depending on the outside temperature, as described in the Petition. To confirm the assumptions utilized in EPA's methodology and applied in MB's Petition, MB reviewed the amount of time it took the test vehicles to reach the necessary engine coolant and transmission oil temperature criteria. Specifically, MB evaluated the number of engine starts observed at specific outside temperatures in the 29 vehicle study, along with the average time it took to reach the necessary temperatures of the engine coolant and transmission oil. MB then divided all times into the same temperature zones as EPA's VMTs (i.e., cold, mid, hot), and calculated a weighted average of warm-up time in each temperature zone. The average time for each temperature was then multiplied by the number of starts observed at that temperature. These results, by temperature zones, were then added together and divided by the total number of starts for each temperature zone. This led to the following weighted results:

Temperature zones	°F	°C	Time to Warm-Up Assumed in Petition	Time to Warm-Up Observed in Survey
Cold	<40°F	<4.4°C	300s	186s
Mid	41<°F<80	5<°C<26.7	170s	37s
Hot	>80°F	>26.7°C	170s	30s

This analysis confirms that, in the real world, MB vehicles heat up faster than was assumed using EPA's methodology in the Petition. Accordingly, MB's engineering analysis utilized in its credit application, based on EPA's methodology from the Joint TSD, is a conservative approach for estimating start-stop effectiveness in the real-world.

VI. MB-SPECIFIC TECHNOLOGY

Several of the comments, including those by ICCT, ACEEE, UCS and NRDC, raised technical considerations regarding MB start-stop technology and credit calculations. For the most part, these comments either overlooked information provided in MB's Petition or did not fully account for the system parameters of MB's start-stop technology. Following below are responses to the technology related questions. MB is confident that EPA has all of the information necessary to approve its Petition.

A. Definition of Idle Period

One comment asked for clarification of how MB defined an idle period. (ICCT at 6). For its 2010-2011 U.S. field test, MB defined an idle period as the following:

Step 1: ignition must be on

Step 2: engine rpm has to be >100 /min (ensures that the engine is running)

Step 3: vehicle speed <0.062 mph (start of the idle period)

Step 4: vehicle speed ≥0.062 mph (end of idle period)

Using these parameters, MB collected data on idle periods as near to zero speed as the data logging equipment would allow, which was as soon as the vehicle speed dropped below 0.062 mph (or 0.1 km/h), and stopped recording data as idle once the vehicle speed exceeded this virtually-zero level. When vehicle speed is less than 0.062 mph, it is clearly a period of idle. For the vehicle speed to be less than 0.062 mph the brake must be engaged. Once the brake is released, and with no accelerator input, the engine idles at 600-700 rpm, which results in a vehicles speed of 1-5 mph, depending on road conditions. Such periods of slow moving (or "creeping"), where the brake is not engaged, were not measured as "idle" for the MB field test. Because these creeping periods were excluded from MB's idle fraction, MB is not seeking any credit for them. Accordingly, MB's start-stop calculation accounts for "situations where a driver may creep forward when waiting at a stoplight" (CARB Comment at 3) and there is no need to adjust MB's credit request to account for them.

Furthermore, MB's start-stop system logic also addresses multiple "creeping" events. The MB start-stop system is designed to allow the engine to idle off (stop) up to four times in direct succession while a vehicle is only creeping and stopping and not exceeding the 5 mph threshold. (*See* Petition, Attachment H at 5). Once a vehicle reaches the 5 mph threshold, then the number of engine-off periods resets itself and another four stops in a row can be accommodated. As described above, in the real world vehicle speed can quickly exceed 5 mph. Consequently, MB's system logic addresses "creeping" events and MB does not need to further account for such events in its credit calculation.

B. AC System Cooldown

In MB's engineering analysis of start-stop system effectiveness, MB applied its start-stop system logic to EPA's methodology as described above. In its estimation, EPA had assumed that start-stop would not work when the AC is operating—and had removed all hot temperature VMTs greater than 80°F—but had acknowledged that manufacturers could employ technologies that permitted start-stop activation (and engine off) in hot temperatures while the AC was operating. *See* Joint TSD at 5-87 to 5-88. MB's climate control system does not disable MB's start-stop system and,

therefore, it would be inaccurate to assume that MB's start-stop system was not able to activate at all in hot temperature VMTs.

To estimate the effectiveness of MB's start-stop system in hot temperatures, while the AC is running and the climate control system is attempting to maintain cabin temperatures, MB conducted an FTP test under hot conditions that were created using the preparation procedures for the SC03 supplemental test procedure. Specifically, the test vehicle had an outside temperature of 95°F and an interior climate control system ***set point*** temperature of 72°F. (*See* Petition at 20-21). The interior temperature of the vehicle was between 95-96°F.[12] Under these conditions, the start-stop system operated 88% of the time, as compared to an FTP under normal test conditions. (*See id*.). MB believes this is the most consistent means of evaluating the impact of AC operation on start-stop effectiveness during idle periods. Since MB's A/B testing utilized the FTP test cycle, this "hot FTP" allowed for direct comparison.

In its comments, ICCT suggested that this "hot FTP" did not account for MB's ability to maintain cool cabin temperatures in the real world. (ICCT Comment at 6). As described above, MB believes this approach to be the most consistent and supportable means of evaluating and comparing impacts during idle periods. MB is not aware of any existing data that demonstrate start-stop effectiveness during AC operation and MB does not believe that data gathered on other test cycles would be appropriate to compare to the A/B testing conducted on the FTP. For example, the SC03 driving cycle, which is designed to evaluate emissions associated with AC use, is much shorter in duration (596 seconds) than the FTP cycle (1877 seconds), and only has four significant idle periods compared to the 15 stops on the FTP. Thus, the SC03 test cycle should not be used to compare impacts that occur during idle periods which are established with the FTP cycle. Nevertheless, in order to demonstrate that the 95°F testing conducted by MB was sufficient, MB also has conducted an SC03 test as well. During the SC03 test, the start-stop system was active for three out of the four idle periods, supporting an effectiveness estimate of at least 75% under hot conditions while the AC is running. Given the limited duration and number of idle periods in the SC03 test procedure, MB's engineering analysis of 88% effectiveness—which is based on the longer FTP cycle conducted under hot "SC03 like" conditions—is fully supported and a reasonable estimate of MB's start-stop effectiveness in hot temperature zone VMTs.

C. Battery State of Charge

Comments by ICCT suggest that MB's start-stop credit calculation must incorporate estimates of additional fuel consumption and CO2 emissions resulting from the need to recharge the battery due to increased electrical load on the battery while the engine is off (*e.g*., to run fans, etc.). ICCT is correct that the electrical load on a vehicle's battery does increase with a start-stop system. ICCT fails to recognize,

[12] The language in the Petition describing the test conditions may have confused some commenters not familiar with the SC03 test conditions. The interior temperature was not 72°F; rather that was the temperature to which the AC climate control was set. The interior temperature was nearly 96°F at the beginning of the hot FTP.

however, that recharging the battery does not necessarily require more engine power (or result in increased CO2 emissions). Specifically, MB vehicles equipped with start-stop systems also are equipped with an advanced battery management system consisting of a smart alternator and advanced controls. This system actively manages the battery state of charge ("SOC"). Importantly, this system also aggressively charges the battery during vehicle decelerations, which enables charging of the battery without the use of additional engine power or fuel consumption. Since MB's battery management system compensates for increased load from start-stop with negligible fuel use, MB's start-stop calculation does not account for increased emissions resulting from the increased load on the battery.

D. ECO Button

ACEEE, ICCT, NRDC and UCS commented on the ECO button feature on MB vehicles. Erroneously, these comments suggest that EPA could not or should not determine that start-stop is the predominant mode in MB vehicles, and that, therefore, EPA should reduce the credit amount awarded to MB. As described below, these comments are incorrect because they misunderstand the application of EPA certification policy guidance on predominance mode determinations and ignore the fact that EPA already has determined that start-stop is the predominant mode for MB vehicles. Moreover, these comments are merely anecdotal and based on no empirical evidence, while MB has field test data which demonstrate that European customers use the ECO button to disable the start-stop system less than 1% of trip time. (*See* Petition at 22). If accepted, these unsupported and incorrect comments regarding MB's ECO button feature will undermine EPA's implementation of certification policy and undercut the goals of the GHG off-cycle program to encourage the early introduction of innovative emissions saving technologies.

First and foremost, the comments regarding predominance mode indicate a fundamental misunderstanding of EPA's policy regarding predominance mode determinations and run counter to EPA guidance. In MB vehicles equipped with a start-stop system, start-stop is ***enabled*** as the ***default*** mode at every key start and has the potential to save fuel and emissions at every idle.[13] The ECO button feature is a "non-latching" technology, which means that to consistently deactivate start-stop, a driver would have to press the ECO button on every trip, as the start-stop system defaults into enabled mode at every key start and cannot be "permanently" disabled. Additionally,

[13] In the context of multimode and select shift transmissions, "EPA relies on guidance letter CISD-09-19 to guide the determination of what is 'representative of what may reasonably be expected to be followed by the ultimate purchaser under in-use conditions,'" when determining what constitutes a predominant operating mode under the test procedures at 40 C.F.R. Part 600. 77 Fed. Reg. at 62,888. According to this guidance, the predominant mode will be the "key-off" (default) mode for vehicles meeting certain criteria, including that a non-latching default mode has been established by the manufacturer such as with MB's start-stop. For vehicles not meeting the default criteria, the guidance policy permits, but does not require, a manufacturer to conduct an instrumented vehicle survey or on-board data collection to determine actual usage rates in support of a predominance mode determination.

the less than 1% of the time disablement estimate is consistent with EPA guidance defining the predominant mode to mean "at least 75% of drivers will have at least 90% of the vehicle shift operation performed in one mode and on average, 75% of vehicle shift operation is performed in that mode." 77 Fed. Reg. at 62,734 (citing CISD-09-19, Enclosure 1 at 2). Accordingly, start-stop enabled is the "predominant operating mode" for purposes of the "testing and calculation provisions in 40 CFR Part 600," consistent with the GHG definition of "engine idle start-stop" at 40 C.F.R. § 86.1869-12(b)(4)(iii).

Importantly, EPA already has determined that start-stop enabled is the predominant mode of MB vehicles for MY 2012-2014. *See Mercedes Benz Requests for Approval of Predominant Mode for Vehicles Equipped with Start-Stop Functionality for Fuel Economy Testing*, submitted to EPA Certification and Compliance Division, approved by C. Nevers 7/22/2011 (for MY 2012) and 5/14/2012 (for MY 2013), and J. Ball 2/25/2013 (for MY 2014). EPA's determination of MB's start-stop predominance was made by Compliance Division staff of EPA's National Vehicle and Fuel Emissions Laboratory, consistent with the driver selectable policy guidance and other predominance mode determinations. MB agrees that such predominance mode determinations are a downstream certification issue, and should remain so to ensure consistent application of the certification policy guidance. Such application is consistent with the regulatory definition of start-stop technology, which references the predominance mode determination made for testing procedures. *See* 40 C.F.R. § 86.1869-12(b)(4)(iii).

Application of the predominance mode guidance at the credit calculation stage, to degrade the base calculation of total potential credit using subsection (d) alternative methodology, is inappropriate and contrary to EPA policy. In the 2017-2025 GHG rulemaking, EPA "acknowledge[d] the similarities between the procedures under the existing policy in CISD-09-19 and the procedures used in the off-cycle program," and expressly stated that "the existing policy in CISD-09-19 has no bearing on the credit determinations in the off-cycle program." 77 Fed. Reg. at 62,735.

Nevertheless, at EPA's request, MB discounted its idle time to account for use of the ECO button in MB's analysis of start-stop system effectiveness for its alternative methodology calculation of GHG credit. MB relied on preliminary results from a 22 vehicle European field test which demonstrate that customers utilize the ECO button to disable the start-stop system less than 1% of trip time. (Petition at 22). In the absence of U.S. data on the ECO button feature, MB believes it is reasonable to reference field data from its European fleet. While offering only anecdotal statements and without any empirical evidence, several comments (by ICCT, NRDC, UCS and ACEEE) suggested that this 1% deactivation rate, based on European field data,[14] did not sufficiently take into account the frequency with which U.S. drivers would utilize the ECO button feature to disable the start-stop system. None of these commenters, including the ICCT, have

[14] Ironically, ICCT criticizes MB's use of European-based data for the ECO button, but then also references European studies on driving cycles in an effort to support its critique of MB's real-world U.S. idle fraction. (*See* ICCT Comment at 5).

provided data which would contradict MB's assessment that the start-stop enabled mode is the predominant mode. Mere anecdotal reports of driver dissatisfaction do not meet any statistically significant threshold.

One specific example of the unreliability of such anecdotes relates to a presentation by Strategic Vision that was cited by ACEEE. (ACEEE Comment at 2-3) (citing Strategic Vision Oct. 14, 2013 presentation to National Research Council entitled "Understanding The Impact Of New Technologies In Automotive"). Strategic Vision's presentation, and the qualitative survey responses utilized to prepare the presentation, cannot support ACEEE's suggestion that a high percentage of U.S. customers will disable start-stop if given the opportunity to do so. Specifically, the suggestions about start-stop usage in the Strategic Vision presentation, particularly at slide 38, were not based on quantitative data and were instead "extrapolated" from anecdotal and open-ended statements submitted by a small number of respondents to surveys sent out to 2011-2012 calendar year car buyers. Importantly, ***less than 2% of these respondents*** were Mercedes customers. Additionally, not all of the MB respondents to the Strategic Vision survey indicated a negative sentiment with regard to start-stop technology. In fact, many respondents were not even aware if their vehicle had start-stop or not, which makes it unlikely that they would seek to disable it. Consequently, the Strategic Vision presentation is limited in its value, particularly with regard to MB vehicles and customers. Such anecdotal conclusions should not be applied to further degrade MB's credit request beyond the 1% discount that MB already incorporated in its engineering analysis, which itself was based on the best available real-world field data and not anecdotes.

For this credit application, for MY 2012-2016 vehicles, MB accepts utilizing a discount of 1% to address the use of the ECO button feature in estimating start-stop effectiveness in the real-world. For future applications, for MY 2017 vehicles and beyond, determinations regarding the use of driver selectable technologies, such as non-latching disablement features, should be made at the certification level in accordance with previous predominance mode determinations and guidance.

VII. COMMENTS ON ADDITIONAL TESTING

A. Suggestions for Additional A/B Testing

One comment (by CARB) suggested that MB should be required to conduct additional A/B testing to account for different vehicle powertrains. (CARB Comment at 4). For the most part, MB agrees. The emissions benefit of start-stop technology is a function of the powertrain (engine and transmission) technology. It is not a function of the application type (*e.g.*, small car, large car, SUV, etc.). The A/B testing conducted by MB (*see* Petition at 23), evaluated the different powertrain configurations available with start-stop in the US at the time. For example, the C300, C350, E350, GKL350 and ML350[15] all use the same powertrain and will have the same start-stop emissions

[15] Currently, the ML350 does not have start-stop but is scheduled to incorporate the technology in MY 2015.

benefit on A/B testing. MB did not conduct A/B testing on all of these vehicles, and instead tested only the C and E 350 as representative of this powertrain group.[16] In addition, MB tested an AMG 8-cylinder truck as this was the only 8-cylinder truck equipped with start-stop available at the time.[17] MB agrees that, for MY 2012-2016 vehicle models with start-stop sold in the U.S. that have new or different powertrains not covered by the A/B testing already conducted, new A/B testing should be conducted to establish the emissions benefit for these powertrain configurations. Any necessary A/B testing will be done during the certification process.

B. Suggestions to Add an Actual Validation Requirement to EPA's Alternative Demonstration Credit Pathway

Several comments (including by ICCT, CARB, NRDC and ACEEE) suggested that EPA require manufacturers to conduct actual validation testing of real-world start-stop effectiveness, beyond certification and in-use verification testing, and that EPA retroactively revise the GHG credit amount based on the "validation" testing. Notwithstanding that this requirement is not included in EPA's 2012-2016 or 2017-2025 rulemaking and that it would be arbitrary and capricious to apply to MB's Petition, such a validation requirement would run counter to the intent and purpose of the GHG off-cycle program. As described above, MB is faced with a dilemma for its MY 2012-2016 vehicles with start-stop and other advanced off-cycle technologies: prior to MY 2013, very few vehicles were equipped with these technologies. Any new field testing for MY 2012-2016 start-stop vehicles would likely not be completed until after MY 2016. Thus, if EPA requires actual real-world data on start-stop effectiveness—as opposed to estimates based on best engineering analysis following EPA's methodology—then MB most likely would not be able to submit an alternative demonstration application for start-stop credits for MY 2012-2016 vehicles. Consequently, the incentive to incorporate this expensive and fuel saving technology into the U.S. fleet would not exist until MY 2017 and later.

Moreover, as EPA stated in the 2017-2025 GHG rulemaking, "approving a technology only to later disallow it could lead to a manufacturer discontinuing the use of the technology even if it remained a cost effective way to reduce emissions." 77 Fed. Reg. at 62,837. EPA explicitly declined to limit the application of certain off-cycle technology credits in its 2017-2025 rulemaking because the Agency believed that continuing to make off-cycle credits available "provides an incentive for manufacturers to continue to improve technologies without concern that they will become ineligible for

[16] MB tested two vehicle models for this powertrain. This is a function of the testing vehicles that were available as the A/B testing to support the Petition was conducted over time.

[17] Contrary to some informal questions raised after the comment period closed, which questioned the use of AMG vehicles for A/B testing, a larger engine displacement does not automatically correlate with a higher emissions improvement amount. For example, during A/B testing the 2.0l 4-cylinder engine exhibited a larger CO2 emissions improvement than the 3.5l 6-cylinder engine. Nevertheless, as additional powertrain configurations (engine displacement and transmission) equipped with start-stop become available (*e.g.*, SL in MY 2014 and ML in MY 2015), additional A/B testing can be performed.

credits at some future time." *Id*. Introducing a new requirement for "actual validation" of real world start-stop effectiveness (particularly for MY 2012-2016 vehicles) runs counter to EPA's goal of creating incentives for manufacturers to introduce emission reducing technologies early and to continue to improve them in future model years. Of course, after MY 2016, any petition for credits would have to be based on real-world testing with start-stop technology since the vehicle technology would be available throughout the MB's U.S. vehicle fleet. This does not, however, overcome the recognized benefits and program alternatives EPA relied upon to provide for use of engineering analyses to obtain off-cycle credits.

VIII. CONCLUSION

For all of the reasons stated in MB's Petition and supporting materials, and in the responses above, MB requests that its application for alternative demonstration methodology calculations of GHG credits for vehicles equipped with start-stop technology, high efficiency lighting, active seat ventilation and thermal control glazing technologies be approved for MY 2012-2016.

REBUTTAL ATTACHMENT 1

RESPONSES TO PUBLIC COMMENTS ON

PETITION ATTACHMENT A: STATISTICAL ASSESSMENT

OF IDLE TIME FRACTION CALCULATION

IN MERCEDES-BENZ VEHICLES

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During the public comment period, several organizations submitted comments on the Mercedes Benz (MB) Petition for determination of off-cycle credits under the Light-Duty Greenhouse Gas Emissions Program. The comments spanned a wide range – from conceptual comments on the structure and incentives of the procedures for off-cycle credits to specific technical comments and concerns related to the data and analysis supporting the Petition. Four organizations – the International Council on Clean Transportation (ICCT), the California Air Resources Board (ARB), the Natural Resources Defense Council (NRDC), and the Union of Concerned Scientists (UCS) – offered specific comments and concerns on the data and analysis supporting the determination of a 23.8% average idle time for MB vehicles.

The data supporting the MB idle fraction were collected in an in-use driving program conducted during 2010-2011 in which 30 MB vehicles were instrumented to collect a range of vehicle operation parameters over an average 13 month period of participation. Twenty nine of the vehicles completed the test program and contributed data for the determination of the average idle fraction. Attachment A to the Petition examined the methods of data collection and the idle time data, concluding that the estimated 23.8% average idle time is representative of the operation of the MB fleet in the U.S.

This response addresses the subset of the comments made by ICCT, CARB, NRDC, and UCS that are specifically critical of the data or the analysis presented in Attachment A to the Petition. Other comments raised by those organizations are not considered here. This response is not intended to constitute submission of a new Petition or a revision of the Petition or Attachment A.

1. ICCT Comments

Comment: ICCT argues (p. 3 ff) that there is a bias in the recruitment of participants for the MB in-use study in urban areas that results in overstating the average idle fraction of MB vehicles. While conceding that MB vehicles will tend to be operated in the urban areas where they are purchased, ICCT argues that the study "ignored" the migration of vehicles to rural areas over their lifetimes. They argue that the average idle fraction observed for MB vehicles should be adjusted downward.

Response: The fact is that the overwhelming majority of MB vehicles are both sold and operated in urban areas and that the large majority of MB vehicles are operated in large urban areas (> 1 million population). To demonstrate this fact, the analysis in Attachment A presented registration data for the top eight States[1] classified into Urban and Non-Urban areas and by population size within Urban area (Attachment A, p. 15). Rural areas are explicitly contained in these data, which include the "migration" of vehicles away from urban areas over their operating lifetimes in those States. While MB vehicles can be found in rural areas, their share of the MB

[1] The top eight States account for approximately two-thirds of MB sales and registrations and are indicative of the overall distribution of the MB fleet in the U.S.

population is very small (1.4% of registrations in the top eight States). The sampling in urban areas does not cause a bias in the study's results because this is where MB vehicles are located.

Further, the sample selection process did not "ignore" rural vehicles. There are no MB dealerships in rural areas, and MB vehicles registered in rural areas will be brought into dealerships (located in urban areas) for service from time to time. Rural vehicles had a proportionate chance of being selected if they were brought into the dealerships participating in the study. However, one would not expect a rural vehicle to be included in a 30 vehicle sample even if it were recruited by a nationwide mailing. The presence or absence of rural vehicles can have no material impact on the results of the study because their numbers are so small in the population.

Attachment A carefully examined whether the 29-car sample was representative of the MB fleet in the U.S. Section 5.1 showed that variation of the sample distribution by State and model class from MY2012 shares had no material impact on the average idle fraction. Section 5.2 used an analysis of urban traffic density (developed for EPA) to show that the sample faced very nearly the same degree of traffic density and congestion as the MB population in the top eight States; the minor difference that was observed was shown to have no material effect on the average idle fraction. Section 5.3 showed that independent data from the Progressive Snapshot program on idle fraction for MB vehicles was in almost exact agreement with the idle time observed in the MB study. Section 5.4 examined the demographics of vehicle owners to show that the sample was representative of all MB owners. Section 5.5 compared vehicle odometers to warranty data to show that the mileage accumulation rates of the sample were representative of MB vehicles. The 23.8% average idle fraction observed in the MB study ***is representative*** of the ***actual*** idle fraction for the MB U.S. fleet. There is no basis whatsoever to adjust the average idle fraction of MB vehicles downward.

Comment: ICCT says (p. 4 ff) that "Mercedes-Benz's reported idle times are far higher than found in the SFTP study, the MOVES estimate, data collected for development of the WLTC, and the Fiat EcoDrive study." ICCT goes on to argue that the MB idle fraction must be biased because it is higher than the Unified database created for test cycle development in several countries. A presumption of ICCT's argument is that EPA's lower estimate of real-world idle time is correct and the MB value is incorrect.

Response: MB made an extensive effort to vet its estimate of the average idle fraction as itemized in the prior response. Section 5.2 of Attachment A reports on an assessment of whether the degree of traffic density faced by the 29-car sample was representative of the average traffic density faced by the MB vehicle fleet. Table 7 and Figure 3 of the attachment show that the 29-car sample faced the same driving conditions as the MB fleet. Section 5.3 showed that independent in-use driving data from the Progressive Snapshot program for more than 17,000 late-model MB vehicles in 44 States agree almost exactly with the result of the MB in-use study. We cite this information again to make the point that all of the available information indicates

that the 23.8% average idle fraction observed in the MB study ***is representative*** of the ***actual*** idle fraction for the MB U.S. fleet.

With respect to ICCT's comparison to EPA's in-use estimate and the other studies, we do not find its comments and comparisons to be persuasive:

- With respect to WLTC, it should be recognized that the goal was to create a single, worldwide test cycle based on driving characteristics from many countries around the world. The WLTC data will not necessarily represent driving characteristics in any one country or for any one auto manufacturer and should not be used for comparison with the MB in-use data.
- With respect to the SFTP program, we do not agree with ICCT's statement that EPA's 2017-25 Joint TSD misstated the SFTP results. The 22% idle fraction that EPA cited is an average for the 3-Cities study overall and it appears to be consistent with ICCT's breakout of results for the four locations. (Joint TSD, at 5-86).
- The comparison of the MB idle fraction to that observed in Baltimore-Exeter is without merit. The MB idle fraction represents the average idle time for all of the locations where the MB vehicles were driven, including suburban, highway and other trips that took place over the 13-month average period of participation for each vehicle, irrespective of where the vehicles are garaged. The same will be true for the vehicles recruited at the Baltimore-Exeter site and the other locations cited by ICCT during the shorter time periods they were instrumented for those studies. None of the studies need to match urban, suburban, or rural driving or any other single comparison.
- In fact, the idle fractions for the four locations cited by ICCT are fully consistent with the MB in-use data once differences in traffic density are accounted for. Figure 3 of Attachment A (p. 18) places the average idle fractions for the EPA 3-Cities and the Kansas City study on the same graph with the MB data. The data points for the EPA studies follow the relationship between idle fraction and traffic density that is established by the MB in-use data.

Many of ICCT's comments are predicated on the assumption that EPA's idle fraction estimate is an accurate representation of idle time for the U.S. fleet and that the MB real-world result is wrong. The Kansas City and 3-Cities studies are two of the data sources used to characterize in-use driving for the MOVES model and, therefore, two of the sources underlying EPA's idle fraction estimate. These two studies, taken in four mid-size and large urban areas (Kansas City, Spokane, Atlanta and Baltimore), average 18% and 22%, respectively, and should be reasonably representative of the range in idle fraction that exists in urban areas. Although, for regulatory purposes, EPA may use a very conservative idle time to establish an industry-wide default value, even EPA data demonstrate a higher idle time value.

As part of this comment, ICCT asks how MB defined an idle period. MB collected data on idle periods as near to zero speed as the data logging equipment would allow, beginning when the vehicle speed dropped below 0.062 mph (or 0.1 km/h) and ending once the vehicle speed exceeded this virtual-zero amount. This is a reasonable and appropriate definition for idle period. In summary, there is no evidence that the MB idle fraction is biased high.

2. California Air Resources Board Comments

Comment: "CARB also has concerns with the methodology for vehicle selection …. Daimler indicated that, for California and Arizona, only vehicles sold and serviced at top-selling dealership were selected for the survey. … [B]ecause top-selling dealerships are likely to be located in highly urbanized areas, this would mean that most of the vehicles were operated primarily in densely-populated areas where there is more traffic, and consequently, more idle time for each vehicle relative to vehicles operated elsewhere in these states or nationwide. This bias may have resulted in significant overestimation of the fraction of operation spent at idle for a typical Daimler vehicle."

Response: Contrary to CARB's suggestion, an analysis of the data demonstrates that the MB in-use study is ***not*** biased in its representation of MB vehicles and the 23.8% average idle fraction ***is representative*** of the ***actual*** idle fraction of the MB U.S. fleet. As the analysis in Attachment A demonstrated, the overwhelming majority of MB vehicles are both sold and operated in urban areas and the large majority of MB vehicles are operated in large urban areas (> 1 million population). Section 5 of Attachment A examined the representativeness of the sample in a number of ways, with Section 5.2 examining the conditions of traffic density and congestion faced by all MB vehicles in the eight States covered. Using a traffic density index developed for EPA, it concluded that the very minor departure of the sample from the overall traffic density faced by the MB population had no material impact (only 0.08%) on the average idle fraction determined in the study (Attachment A, p. 18).

Further, these issues are of much less importance for California and Arizona, specifically, because the populations of these States are highly concentrated in urban areas, even if the States have large land areas that are non-urban. According to the 2010 Census, 95% of California's population and 90% of Arizona's population live in urban areas, compared to 81% for the U.S. overall[2].

Comment: "In addition to its survey, Daimler contacted Progressive Insurance to gather idle-time data from the Progressive Snapshot (Snapshot) program. ... Because this is an incentivized and voluntary program, participants in the Snapshot program are more likely to drive conservatively … and thus, may have different driving patterns than non-Snapshot users. As such, this does not provide a representative sample of national driving patterns. … the Snapshot

[2] See http://cber.cba.ua.edu/edata/census2010.html at the Center for Business and Economic Research, University of Alabama, 2010 Census of Populations Special Tabulations, Urban and Rural Population by State.

program is only implemented in 44 states. … there is not information regarding when the Snapshot program commenced in each of these states and if there was a representative distribution of vehicles among more urbanized and rural areas. The vehicles from the Progressive database may not have been randomly distributed and it is likely that they do not provide a representative national sample of vehicles."

Response: While reasons always can be found to worry about possible problems in datasets, the Snapshot program actually provides a strong and independent verification of the accuracy of the average idle fraction estimated in the MB study. The Snapshot data used in Attachment A are not a randomly distributed sample selected to "provide a representative national sample of vehicles." Rather, they are an enumeration of the more than 17,000 MY1998 and later MB vehicles in 44 States that participated in the Snapshot program. The data cover the periods since the Snapshot program began operation in each State, starting in 2008. Progressive is an online insurer and their programs are available in both urbanized and rural areas within the States.

Snapshot is an incentive program in which "unsafe drivers" will probably not have reason to participate voluntarily. Based on the data collected by the data-logger (time of day and vehicle speed) the unsafe driving that Progressive seeks to exclude will be characterized by: excessive speed, aggressive acceleration, and extensive night driving. High or low idle fractions are not among the characteristics defining unsafe driving, and the identified characteristics are only weakly correlated with idle time. Idle time is a driving characteristic that is largely determined by where driving is done (city vs. highway), how much traffic density exists where trips take place, and by ambient temperature influencing how long vehicles are idled to warm up. Thus, idle fraction is less affected by the owner/driver demographics that might be associated with unsafe driving than driving characteristics such as average speed and acceleration. Further, the demographics of MB owners are such that one would expect relatively few "unsafe drivers" compared to other makes (Attachment A, p. 21). For these reasons we believe that non-participation by "unsafe drivers" does not have a large affect on the MB average idle fraction in the Snapshot data.

Finally, if non-participation by "unsafe drivers" is a concern here, then it is probably a concern in all of the research efforts sponsored by federal and State agencies where vehicles are instrumented to collect data on in-use driving. There the issue would not be a personal financial disincentive, but rather concern over allowing a governmental agency to monitor and record data on unsafe (and potentially illegal) driving activity. If such is the case, then no one, including EPA and CARB, may have in-use data that account for the driving characteristics of "unsafe drivers".

While no data source is perfect, CARB cites only fears and not information to support its contention that the Snapshot data on MB vehicles are unrepresentative of MB vehicles overall. In fact, the large size and broad geographic coverage of the Snapshot data provide a unique insight to the driving characteristics of MB vehicles. In their comments, the Union of Concerned

Scientists encourages EPA to use data from Snapshot and another program to re-examine its own estimate of the average idle-time for the entire U.S. fleet. Snapshot's primary omission is that California is not among the 44 States it covers. Because of this, MB data for California were combined with Progressive data for 44 States to create a composite average idle fraction of 24.5% covering 45 States and 96% of MB sales. The 23.8% result of the MB study is a conservative estimate and does not over-estimate the actual idle fraction of all MB vehicles in the US. (Attachment A, p. 20)

3. NRDC Comments

NRDC's comment titled Idle VMT Fraction in Real-World Driving questions the 23.8% idle time determined in the MB study and argues that it should be weighted with other data and not be adopted in full. As responses to other comments have said, all of the available information indicates that the 23.8% average idle fraction observed in the MB study ***is representative*** of the ***actual*** idle fraction for the MB U.S. fleet. There is no valid reason to reduce this value by weighting it with other data. MB supports NRDC's call for EPA to continue rigorous studies on real-world idle fraction and is confident that future data on MB vehicles will be consistent with the 23.8% idle fraction in the MB study.

4. Union of Concerned Scientists Comments

The Union of Concerned Scientists (UCS) offers specific criticisms of the data and analysis used in determining the average idle fraction beginning on p. 4 under the heading *Idle Time Availability.* Many of the specific criticisms are without merit and reveal a lack of understanding of the data and analysis that support the Petition. Specific criticisms and responses are given below.

Comment: "The Mercedes-Benz fleet includes over 300,000 vehicles sold annually in the U.S., meaning the sample size is less than 0.002% of the more than 1.5 million vehicles for which Mercedes-Benz is seeking off-cycle credits"

Response: Statistical sampling is conducted to obtain data on a small number of individuals that can be used to draw scientifically valid conclusions regarding the population from which they come. Whether a dataset is of adequate size is gauged in comparison to the variance that exists in the population. Statements regarding a sample's coverage of the population are without merit.

Comment: UCS continues in its comments to itemize differences in the distributions of the sample compared to the population for C Class and California vehicles for the purpose of arguing that the sample is unrepresentative of all MB vehicles.

Response: The MB in-use study was conducted during 2010 and 2011 using a design that was based on MY2008 and (part year) MY2009 sales distributions. The comparisons made in Attachment A are to MY2012 sales distributions, which were chosen as being more

representative of the future sales to which the credit will apply. Every sample varies from the distribution of the population it was designed to represent (due to sampling fluctuations) and the MB sample will further differ from MY2012 data due to changes in the sales distributions over time.

For this reason, Section 5 of Attachment A examined the representativeness of the study in detail and specifically with respect to whether the observed variations from the MY2012 sales distributions had any material effect on the overall average idle fraction. Section 5.1 examined the sample distributions by State and model class (the issues cited by UCS). In this, the sample was re-weighted to match the MY2012 distributions by State and by model class. In no case was the average idle fraction changed by more than ±0.5% (Attachment A, pp, 12-13).

Section 5.2 examined the sample's representativeness with respect to traffic density and congestion, showing that departures from the traffic density and congestion faced by the MB were very small and had no material effect on the idle fraction. Section 5.3 compared the 23.8% result of the MB study to a much larger dataset from the Progressive Snapshot program that estimated a 23.9% average idle fraction for MB vehicles in 44 States. Section 5.4 examined the representativeness of the sample with respect to owner demographics. Section 5.5 examined the representativeness with respect to mileage accumulation. In all cases, the analysis found that the sample is representative of the MB U.S. fleet. The 23.8% average idle fraction ***is representative*** of the ***actual*** idle fraction of the MB U.S. fleet.

Comment: "Table A-2 in Attachment A of the submitted support documentation is nearly entirely greyed out, indicating that of the 112 subpopulations identified (defined by location and vehicle model), just 29 (or 26%) have even a single representative, and just one subpopulation has more than a lone surveyed vehicle to serve as an indicator."

Response: UCS misunderstands the purpose and meaning of this table. The table was requested by EPA to determine whether the allocation of sample size by model class and geographic locations had left out significant concentrations of vehicles in other locations. That is, had MB made a wise and careful choice in determining where to sample the model classes? The white cells are where one or more vehicles of the model class were sampled; the gray cells are where no vehicles of the model class were sampled. The value reported in each cell is the expected number of vehicles one would allocate to each cell given the planned sample size of 30 and the sales distributions by model class and State. Reading across the rows, MB allocated the planned sample to the locations where each model class was most likely to be found, making the sample allocation as representative as possible of all MB vehicles.

It is without merit for UCS to complain that only 26% of the 112 subpopulations were sampled. No survey or study ever samples its population in all possible locations. As an example, public opinion polls taken during election years typically have samples of 500-600 respondents obtained through random digit dialing nationwide. There are some 3,077 counties and parishes

in the U.S. If each respondent were located in a different county, a poll would sample at most 20% of the subpopulations, yet opinion polling before an election is often found to predict the winner. It is the size of the sample in relation to the population variance that determines whether a survey's sample is adequate. There is neither a need to cover all subpopulations nor is it possible.

Comment: "Furthermore, these regions represent less than 70% of all Mercedes-Benz sales nationally, and those surveyed also live exclusively in urban areas, which has a significant impact on idle time, as pointed out in Section 5.2, Attachment A, of the support documentation."

Response: The MB study selected eight States to cover a large share of the MB U.S. fleet and to give balanced coverage of regional and seasonal factors. That the participating vehicles were garaged exclusively in urban areas is because MB vehicles are garaged almost exclusively in urban areas. (See Table 6, Attachment A, p. 15) Section 5.2 used an EPA study prepared to support development of the MOVES model that demonstrated one urban area is much like another in terms of the development of the roadway system and the level of traffic density once the total population of the urban area is accounted for. This means there is not a need to cover every State and city in order to obtain a representative sample; covering 70% of sales nationally is actually a good result. Further, Section 5.3 examined independent data from the Progressive Snapshot program to confirm the MB estimate of the idle fraction. Combining data from the MB study and the Snapshot program, a composite average idle fraction of 24.5% was developed, covering 45 States and 96% of MB sales. <u>The 23.8% result of the MB study is a conservative estimate and does not over-estimate the actual idle fraction of all MB vehicles in the US</u>.

Comment: "While attempts were made to aggregate across models and locations to show that accurate appropriation would have less than a 2% effect on the idle fraction, it is not sufficient given that such a significant fraction of vehicle types are completely ignored in the selected sample. Typically a surveyed subpopulation would itself be expected to be sufficiently representative – in its survey work, Mercedes- Benz is implicitly considering its drivers as sufficiently uniform in driving behavior to be considered entirely in aggregate, ignoring any systematic deviations according to vehicle type or location by not collecting any data in the vast majority of these potential subpopulations. This is inconsistent with its statements in Section 5.2, Attachment A, of the submitted documentation where it is recognized that traffic congestion and driving behavior differs significantly by location"

Response: This comment is without merit. Based on the data and analysis presented in response to the preceding comments, we believe that a fair and reasoned reading of Attachment A leads to the conclusion that <u>the 23.8% result of the MB study is a conservative estimate and does not over-estimate the actual idle fraction of all MB vehicles in the US</u>.

Comment: "A further concern about the small sample size lies in the wide variety of observed idle times. Even within a subpopulation (i.e., consider only California Mercedes-Benz drivers), significant deviation from average behavior is observed (i.e., from 11.04% to 37.10%). Thus, sampling over such a small dataset will lead to substantial error."

Response: The size of a sample can be judged only in relation to the variance in the population, and its adequacy is best gauged by the confidence interval of the estimate. The average idle fraction of 23.8% has a 95% confidence interval equal to ± 2.4%. (Attachment A, Section 4, p. 11.) This means there is only a 5% chance that the estimated idle fraction varies from the true average by more than ± 10% (i.e., 2.4% / 23.8%). There is a two-in-three chance (a one sigma confidence interval) that it differs by no more than ± 5% (i.e., 1.2% / 23.8%) from the average. This is a very good result within the arena of environmental policy. Many (perhaps most) policy matters are decided based on evidence that is subject to greater uncertainties. Not many of the inputs that characterize in-use driving in the MOVES model will have confidence intervals this small.

Comment: UCS presents a calculation of the 95% confidence interval based on its formula at the top of page 3, concluding that the 95% confidence interval is "quite large" although UCS notes that "this interval does not overlap the EPA assumed value of 13.76%".

Response: The UCS formula for the weighted standard error is incorrect. If the term t_i were redefined to equal $N \cdot f_i$ where f_i is the fraction of total operating hours in the sample that each vehicle contributed, then the UCS formula would correctly give the variance S^2 of the idle fraction distribution. Then, the standard error of the average idle fraction would be computed as S/sqrt(N). In addition to the formula error, UCS inflates the apparent size of the 95 confidence interval by dividing its total width by the average to get an error of "… more than 20% of the weighted average." This is a misuse of statistics because the true average will not be 20% away from the weighted average (except with 0.01% probability). In fact, it will not be more that ± 10% away 95% of the time. The response to the immediately preceding comment gives the correct statement and interpretation of the uncertainty in the average idle fraction estimated using the MB in-use data.

Comment: The UCS comments move into a discussion of the work done to compare the result of the MB study to data from the Progressive Insurance Company. In this, UCS says "there are some concerns that this dataset may include drivers that are self-selected for certain behaviors because of their participation in the "Pay As You Drive" Progressive Insurance program." UCS goes on to argue that the Progressive "Pay As You Drive" data on MB vehicles are not representative of the MB fleet.

Response: The Progressive Insurance data used in Attachment A are from the Snapshot program. Programs like Snapshot are sometimes called "pay as you drive" because they rate drivers based on their actual driving profile. As a result, we believe that UCS actually refers to

the Progressive Snapshot program in its comment. In regard to the UCS comment regarding bias, we want to note that the Snapshot program is one of two independent data sources that UCS itself encourages EPA to use to re-evaluate its estimate of the U.S. average idle time (UCS comment, p. 5). If the Snapshot data are appropriate for that purpose, then they are also appropriate for estimating the MB average idle time, as was done in Attachment A.

CARB also commented on the potential for bias in Snapshot because "unsafe drivers" do not have an incentive to participate; please see the full response to this comment given in Section 2. In brief, idle fraction is less affected by the owner/driver demographics that might be associated with unsafe driving than other driving characteristics such as average speed and acceleration. Further, the demographics of MB owners are such that one would expect relatively few "unsafe drivers" compared to other makes (Attachment A, p. 21). For these reasons we do not believe that non-participation by "unsafe drivers" has a large affect on the MB average idle fraction in the Snapshot data. Finally, no one may have data that accounts for the driving characteristics of "unsafe drivers" due to their likely reluctance to participate in any program where their driving will be monitored and recorded.

Comment: "While the consistency across model types and agreement with the smaller Mercedes-Benz study validates the study to a degree, questions still remain about the representativeness of the sample set. The precision of the Progressive values improve significantly on the Mercedes-Benz survey – assuming the same variance as above, the confidence interval would be approximately ±0.1%, providing sufficient level of precision for the GHG credit calculations. However, because there is little detail on the characteristics of the surveyed population in the Progressive dataset as it compares to the general public, it is not clear that this is representative of the entire consumer population. Thus, while the value may be more precise, that does not mean it is more accurate."

Response: We agree with UCS that the consistency across model types and the agreement between the MB and Progressive data help to validate the MB study and that the Progressive Snapshot data improve on the precision of the overall result. With regard to there being "… little detail on the characteristics of the surveyed population in the Progressive dataset as it compares to the general public …" it should be remembered the Progressive Snapshot data used in Attachment A cover all MB vehicles (and only MB vehicles) that participated in the Snapshot Program. The data will reflect the broad range of MB demographics and the full range of where the vehicles are driven, be that in urban, suburban or rural areas, over the period of Snapshot instrumentation. It does not matter how the drivers compare to the general public or whether the data is representative of the entire consumer population. It matters only how it represents all MB drivers and vehicles (addressed in Section 2 under the CARB comments). While potential problems always can be found with any dataset, it is significant that the Progressive Snapshot program is one of two data sources that UCS encourages EPA to use for determining the average idle fraction of the U.S. fleet. It should be of sufficient accuracy to do the same for MB vehicles.

Comment: "While the Progressive Insurance data provides a greater level of certainty in estimating idle time for Mercedes-Benz drivers, neither it nor the data collected by Mercedes-Benz addresses the potential for idling behavior to change over time. Furthermore, it is not known whether this data is representative of all drivers or specific to Mercedes-Benz."

Response: EPA's program for off-cycle credits addresses the potential for changes in the factors influencing off-cycle emission credits by re-determining the credit values every five years. Traffic density and congestion in cities, the locations where MB owners live and operate their vehicles and ambient temperatures (affected warm-up times) are the primary factors influencing the average idle fraction. These factors change relatively slowly over time (if at all). We believe that a redetermination of the credits every five years will adequately account for such changes.

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