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ENVIRONMENTAL PROTECTION AGENCY
40 CFR Parts 9, 59, 60, 85, 86, 88, 89, 90, 91, 92, 94, 1027, 1033, 1036, 1037, 1039, 1042, 1043, 1045, 1048, 1051, 1054, 1060, 1065, 1066, 1068, and 1074
[EPA–HQ–OAR–2019–0307; FRL-10018-52-OAR]
RIN 2060-AU62

Improvements for Heavy-Duty Engine and Vehicle Test Procedures, and other Technical Amendments

AGENCY: Environmental Protection Agency (EPA).
ACTION: Final rule.

SUMMARY: The Environmental Protection Agency (EPA) is amending the test procedures for heavy-duty engines and vehicles to improve accuracy and reduce testing burden. EPA is also making other regulatory amendments concerning light-duty vehicles, heavy-duty vehicles, highway motorcycles, locomotives, marine engines, other nonroad engines and vehicles, and stationary engines. These amendments affect the certification procedures for exhaust emission standards and related requirements. EPA is finalizing similar amendments for evaporative emission standards for nonroad equipment and portable fuel containers. The amendments increase compliance flexibility, harmonize with other requirements, add clarity, correct errors, and streamline the regulations. Given the nature of the amendments, they will have neither significant environmental impacts nor significant economic impacts for any sector.

DATES: This final rule is effective on [INSERT DATE 30 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]. The incorporation by reference of certain publications listed in this regulation is approved by the Director of the Federal Register as of [INSERT DATE 30 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER].

ADDRESSES: The EPA has established a docket for this action under Docket ID No. EPA-HQ-OAR-2019-0307. All documents in the docket are listed on the www.regulations.gov web site. Although listed in the index, some information is not publicly available, e.g., CBI or other information whose disclosure is restricted by statute. Certain other material, such as copyrighted material, is not placed on the Internet and will be publicly available only in hard copy form. Publicly available docket materials are available either electronically in www.regulations.gov or in hard copy at Air and Radiation Docket and Information Center, EPA Docket Center, EPA/DC, EPA WJC West Building, 1301 Constitution Ave., N.W., Room 3334, Washington, DC. Note that the EPA Docket Center and Reading Room were closed to public visitors on March 31, 2020, to reduce the risk of transmitting COVID-19. The Docket Center staff will continue to provide remote customer service via email, phone, and webform. The telephone number for the Public Reading Room is (202) 566–1744, and the telephone number for the Air Docket is (202) 566-1742. For further information on EPA Docket Center services and the current status, go to *https://www.epa.gov/dockets*.

FOR FURTHER INFORMATION CONTACT: Alan Stout, Office of Transportation and Air Quality, Assessment and Standards Division, Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; telephone number: (734) 214-4805; email address: stout.alan@epa.gov.

SUPPLEMENTARY INFORMATION:

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I. General Information

Does this Action Apply to Me?

This action relates to companies that manufacture, sell, or import into the United States new heavy-duty engines or Class 2b through 8 trucks, including combination tractors, vocational vehicles, and all types of buses.[1] Vocational vehicles include municipal, commercial, and recreational vehicles. Additional amendments apply for different manufacturers of light-duty vehicles, light-duty trucks, highway motorcycles, stationary engines, and various types of nonroad engines, vehicles, and equipment.[2] Regulated categories and entities include the following:

NAICS Codes[A]	**NAICS Titles**	**Examples of Potentially Regulated Entities**
333618, 336111, 336112, 336120, 336211, 336212, 336611, 336999	Other Engine Equipment Manufacturing, Automobile Manufacturing, Light Truck and Utility Vehicle Manufacturing, Heavy Duty Truck Manufacturing, Motor Vehicle Body Manufacturing, Truck Trailer Manufacturing, Ship Building and Repairing, All Other Transportation Equipment Manufacturing	Motor vehicle manufacturers and engine manufacturers
811111, 811112, 811198, 423110	General Automotive Repair, Automotive Exhaust System Repair, All Other Automotive Repair and Maintenance, Automobile and Other Motor Vehicle Merchant Wholesalers	Commercial importers of vehicles and vehicle components
335312, 811198	Motor and Generator Manufacturing, All Other Automotive Repair and Maintenance	Alternative fuel vehicle converters
326199, 332431	All Other Plastics Product Manufacturing, Metal Can Manufacturing	Portable fuel container manufacturers

[A] North American Industry Classification System (NAICS)

This list is not intended to be exhaustive, but rather provides a guide for readers regarding entities likely to be regulated by this action. If you have questions regarding the applicability of this action to a particular entity, consult the person listed in the FOR FURTHER INFORMATION CONTACT section.

What Action Is the Agency Taking?

This action amends the regulations that implement our air pollutant emission standards for engines, vehicles and mobile equipment. The amendments include corrections, clarifications, and flexibilities for multiple types of vehicles, engines and equipment.

The majority of these amendments modify existing test procedures for heavy-duty highway engines and vehicles. These test procedure changes improve accuracy, and in some cases, reduce test burden. They mainly apply for measurement of greenhouse gas pollutants

[1] "Heavy-duty engine" and "heavy-duty vehicle," are defined in 40 CFR 1037.801.
[2] "Light-duty vehicle" and "light-duty truck" are defined in 40 CFR 86.1803-01.

(primarily CO_2), though some apply for criteria pollutants (such as NOx), as well. See Section II.A.

Additional heavy-duty highway amendments update EPA regulations to enhance implementation of existing emission standards. For example, some changes reduce the likelihood that manufacturers would need to duplicate certification efforts to comply with EPA, Canadian, and Californian standards. Some amendments make it easier for manufacturers to more fully account for the emission benefits of advanced emission control technology, which could provide them the opportunity to generate additional emission credits. These heavy-duty highway amendments are described in Section II.B.

This rule includes other amendments that are generally administrative or technical in nature and include amendments for nonroad engines and vehicles, stationary engines, and portable fuel containers. These amendments are described in Section III. Perhaps the most visible administrative amendment is the elimination of hundreds of pages of obsolete regulations, which is described in Section III.B.

EPA published a proposed rule on May 12, 2020 (85 FR 28140). This final rule follows from that proposal, with several adjustments that reflect EPA's consideration of comments received. Most of the proposed revisions from that notice are addressed in this final rule. EPA is also issuing a new notice of proposed rulemaking to supplement the earlier proposed rule, published in the Proposed Rules section of today's Federal Register, titled "Improvements for Heavy-Duty Engine and Vehicle Test Procedures," docket number EPA–HQ–OAR–2019–0307; FRL-10018-51-OAR. In the supplemental proposal, EPA proposes further amendments concerning only certain specific aspects of GEM (see Section II of the preamble to the supplemental proposal).

The proposed rule included requests for comment on a wide range of issues, including some broad areas where we were interested only in gathering information for potential future rulemaking(s). This preamble does not include a discussion of those comment areas where we are not taking any action in this final rule. The "Improvements for Heavy-Duty Engine and Vehicle Test Procedures, and other Technical Amendments Response to Comments" document ("Response to Comments") in the docket for this rulemaking includes a summary of the input received from commenters and EPA's responses.[3]

In addition, we have prepared a docket memo with redline text to highlight all the changes to the regulations in the proposed rule.[4] This is especially helpful for reviewing provisions that we are removing from the Code of Federal Regulations. For obsolete provisions we are removing, see especially 40 CFR 1027.105, 1033.150, 1042.145, 1045.145, 1048.145, 1051.145, 1054.145, and 1054.625. We prepared additional docket memos to show regulatory changes after the proposed rule.[5]

What are the Incremental Costs and Benefits of this Action?

[3] EPA, "Improvements for Heavy-Duty Engine and Vehicle Test Procedures, and other Technical Amendments Response to Comments," December 2020, Docket EPA-HQ-OAR-2019-0307, Publication Number: EPA-420-R-20-026.

[4] "Redline Document Showing Proposed Changes to Regulatory Text in the Heavy-Duty Greenhouse Gas Amendments", EPA memorandum from Alan Stout to Docket EPA-HQ-OAR-2019-0307, March 2020.

[5] "Redline Version of EPA's Final Regulatory Amendments for Heavy-Duty Greenhouse Gas Standards and other Programs", EPA memorandum from Alan Stout to Docket EPA-HQ-OAR-2019-0307, December 9, 2020.

This action is limited in scope and does not include amendments that have significant economic or environmental impacts. EPA has therefore not estimated the potential costs or benefits of this Final Rule (and we did not for the proposal).

II. Heavy-Duty Highway Amendments

A. Test Procedures and Compliance Model Changes

Since the promulgation of the Phase 2 regulations, manufacturers have been revising their internal test procedures to ensure they will be able to comply with the new requirements that begin in model year 2021. In doing so, they have identified several areas in which the test procedure regulations could be improved (in terms of overall accuracy, repeatability and clarity) without changing the effective stringency of the standards.

EPA is making numerous changes to the test procedure regulations to address manufacturers' concerns and other issues we have identified. These changes are described below. The list includes numerous editorial changes that simply correct typographical/formatting errors or revise the text to improve clarity. Although these amendments are being made primarily in the context of heavy-duty engines and vehicles, the amendments to part 1065 will also apply to nonroad engines, and the amendments to part 1066 will also apply to light-duty vehicles. Since these amendments are mostly editorial or adding flexibility, they will not adversely impact these other sectors.

1. 40 CFR Part 1036 Test Procedures

EPA proposed several updates to the testing and measurement provisions of 1036 subpart F, and Appendices of part 1036 related to how to measure emissions from heavy-duty engines and requested comment on general improvements to the engine test procedures and compliance provisions (85 FR 28141). This section presents the changes we are adopting to engine test procedures after consideration of comments received. Additional details on some of these and other engine testing and measurement amendments or clarifications requested by commenters and our responses are available in Chapter 2 of our Response to Comments. Amendments to other subparts of part 1036 (i.e., amendments not directly related to test procedures) are discussed in Section II.B.

These updates are primarily for the purposes of adding flexibility and reducing variability in test results. Additional information that led to and supports these changes arose from a test program at Southwest Research Institute (SwRI) that was jointly funded by EPA and the Truck and Engine Manufacturers Association (EMA).[6]

We are generally finalizing revisions as proposed; however, some revisions include further changes and clarifications after consideration of public comments to better ensure clarity, accuracy and consistency with the intent of the proposed rule.

- Section 1036.501(g) – Providing a new paragraph (g) to specify duty cycles for testing MY 2016 – 2020 engines, including additional clarifications to the proposed amendment to refer to the steady-state duty cycle as the Supplemental Emission Test ("SET") rather than the Ramped Modal Cycle ("RMC") to avoid confusion as steady-state cycles are run as RMCs in many standard setting parts, and to change a reference for the Federal Test Procedure ("FTP") duty cycle from Appendix II of 40 CFR part 1036 to 40 CFR

[6] Sharp, Christopher A., et al., "Measurement Variability Assessment of the GHG Phase 2 Fuel Mapping Procedure", Final Report, Southwest Research Institute, December 2019.

1036.510 because 40 CFR 1036.510 gives an overview of the duty cycle and provides the reference to Appendix II of 40 CFR part 1036.

- Section 1036.501(h) – Renumbering existing paragraph (g) concerning testing of MY 2021 and later engines as new paragraph (h), modifying paragraph (h)(1) to address restarting the engine during dynamometer testing for engines with stop-start technologies, and adding paragraph (h)(3) (shown as (h)(2) in the proposed rule) to cross-reference transient test cycle specifications, including additional clarifications in final paragraph (h)(2) to refer to the Supplemental Emission Test cycle to avoid confusion as steady-state cycles are run as RMCs in many standard setting parts and in paragraph (h)(2)(ii) that weighting factors for the Supplemental Emission Test are to be applied to CO_2 to calculate the composite emission result.
- Section 1036.503 – Migrating §1036.510 to new 1036.503, renumbering existing paragraph (d) as new paragraph (c), updating paragraphs (b) and (c)(1)-(3) and adding (c)(4)-(5) and (d), including provisions to specify that the engine manufacturer must provide idle speed and torque to the vehicle manufacturer and to provide additional direction on handling data points for a low speed governor where the governor is active. We further modified proposed paragraph (b) to denote that there are four methods to generate fuel maps with the addition of the hybrid powertrain and hybrid engine testing procedures and to more clearly explain which method(s) apply to which application, paragraphs (b)(1) and (b)(2) to add more specificity to which referenced paragraphs in 1036.535 are applicable, paragraph (b)(3) to clarify that the option in 1037.520(d)(2) is only allowed for hybrid powertrain testing and not powertrain testing in general, and added paragraph (b)(4) to include a method to perform hybrid engine testing. We also further updated paragraph (c)(1) to clarify how to measure torque curve for engines that have an RESS and for those that don't.
- Section 1036.505 – Adding paragraph (b) to give direction on both engine and powertrain testing and modifying Table 1 to include vehicle speed and grade parameters to facilitate the hybrid powertrain testing option. We further modified the proposed language in this section by: adding a new paragraph (b)(2)(v) to calculate curb mass for hybrid powertrain testing as this calculation is needed to determine the linear equivalent mass of rotational moment of inertias in clarified paragraph (b)(vi), adding reference speed determination requirements for powertrain testing in paragraph (c)(2)(i) and (ii) to address underspeed conditions in the hybrid powertrain SET testing, including a removal of default A, B, and C SET speeds and calculation of the A and B speeds based on C speed, modifying Table 1 further to include vehicle speed and grade parameters to facilitate the hybrid powertrain testing option so the road grade equation is now vehicle speed-dependent to address vehicle underspeed concerns corresponding to the determination and use of vehicle C speed, and replacing ramped modal cycle with supplemental emission test for the reason discussed in the first bullet of this subsection of the preamble.
- Section 1036.510 – Providing a new section regarding transient testing of engines and hybrids to facilitate hybrid certification for both GHG and criteria pollutants.
- Section 1036.525(a) –Adding a clarification in the final rule that the hybrid engine testing procedure in this section applies only for model year 2014 to 2020 hybrid engines since the new hybrid powertrain and hybrid engine test procedure being adopted in this rulemaking will apply for model year 2021 and later engines.

- Section 1036.525(d)(4)(i) – Editorial revisions to equation and the addition of example calculations.
- Section 1036.527 – Adding a section to provide a means to determine powertrain systems rated power and continuous rated power, to facilitate the hybrid and conventional powertrain testing options. This test procedure is applicable for powertrain testing defined in 40 CFR 1037.550 for both the engine and vehicle standards. We further modified the proposed language, including modifying how the test is carried out by reducing the number of test intervals from 9 to 1, paragraph (e) to address the determination of P_{sys} for speed and torque measurements at different locations, with new paragraphs (g) and (h) to provide an improved method for determining continuous rated power and vehicle C speed, and addressed typographical errors.
- Section 1036.530(a), (b)(1)(i) and (ii), and (b)(2)(i) and (ii) – Updating carbon mass fraction determination to allow analysis by a single lab only to facilitate on-line analysis from pipeline supplied natural gas and adding ASTM method for determination of test fuel mass-specific energy content for natural gas. We have further modified the proposed language by clarifying in paragraph (a) that IRAF is applied to CO_2 emission results for all duty-cycles, not just cycle average engine fuel map results, and updating paragraph (b) to require test fuel mass-specific energy content and carbon mass fraction to be analyzed by at least three different labs and the median of all the results to be used in the calculation. We are also adding a recommendation that you screen your results to determine if additional observations are needed by performing an outlier test and provided critical values for this check. The critical values were determined as 1.27 times the method reproducibility R. The R value used for fuel mass-specific energy content is 0.234 which is the published R value for ASTM D4809 and the R value used for carbon mass fraction is 1.23, which was based on analysis of the fuel survey data for ASTM D5291 that was used in the Fuel Mapping Variability Study at SwRI.
- Section 1036.530 Table 1 – Updating footnote format in table.
- Section 1036.535 – Generally updating to improve the engine fuel mapping test procedures based on the jointly funded EPA-EMA test program. The overall result of these updates is to reduce the variability of the emission test results to reduce lab-to-lab variability. We further modified the proposed language by adding paragraph (h) to describe how EPA will determine the official fuel consumption rate during a confirmatory test, based on carbon balance results, updating paragraph (b)(7)(iv) to require validation of test intervals that were complete prior to a lab equipment or engine malfunction, updating the variable description for w_{Cmeas} in paragraph (b)(8) to make clear that you may not account for the contribution to α, β, γ, and δ of diesel exhaust fluid or other non-fuel fluids injected into the exhaust, and clarifying regulatory text and correcting paragraph references.
- Section 1036.540 – Generally updating to improve the cycle-average engine fuel mapping test procedure as a result of the jointly funded EPA-EMA test program at SwRI. The overall result of these updates is to reduce the variability of the emission test results to reduce lab-to-lab variability. We further modified the proposed language in a few ways by adding paragraph (b)(4) to address the ability of gaseous fueled engines with single point fuel injection to pass alternate cycle statistics to validate the transient duty cycle in 40 CFR part 1037, Appendix I, by adding paragraph (e)(2) to describe how EPA will determine the official fuel consumption rate during a confirmatory test, based on

carbon balance results, by deleting the requirement for EPA to use an average of indirect measurement of fuel flow with dilute sampling and direct sampling for fuel mapping as EPA will now perform the carbon balance verification in 40 CFR 1065.543, and by generally adding some clarifying text.

- Section 1036.543 – Adding a section to address carbon balance error verification. This is a result of the jointly funded EPA-EMA test program. The overall result of these updates is to reduce the variability of the emission test results to reduce lab-to-lab measurement variability.
- Section 1036.801 – Adding a definition for hybrid engine to correspond with the addition of the hybrid powertrain test procedures to part 1036. Modifying the definition from the proposed language to provide examples of hybrid engine architecture and hybrid energy storage systems.
- Section 1036.801 – Adding definitions for "hybrid powertrain" and "mild hybrid" in the final rule. These definitions are needed as a result of adding hybrid powertrain test procedures to part 1036, subpart F including mild hybrid certification where engine testing can use a transmission model. The definitions make clear what hybrid architectures are covered by each of these terms.
- Section 1036.801 – Updating definition of "steady-state" to clarify that fuel map and idle tests are steady-state tests.
- Section 1036.805(b) – Updating quantity and quantity descriptions, including some changes to those proposed to ensure consistency throughout the part.
- Section 1036.805(c) and (d) – Updating table introductory sentence and column headings in the table to be consistent with format in other parts.
- Section 1036.805(e) – Updating acronyms and abbreviations, including some changes to those proposed to ensure that the table contained all that were used throughout the part.
- Section 1036.805(f) – Adding gravitational constant, including an updated value for the gravitational constant based on consideration of comments received on the proposal.
- Part 1036 Appendix I – Adding a new Appendix I to provide a historic summary of previous emission standards which EPA originally adopted under 40 CFR part 85 or part 86, that apply to compression-ignition engines produced before model year 2007 and to spark-ignition engines produced before model year 2008.
- Part 1036 Appendix II(a) – Adding a new paragraph (a) of Appendix II to specify transient duty cycles for the engine and powertrain testing described in § 1036.510.
- Part 1036 Appendix II(b) – Adding a new paragraph (b) of Appendix II to migrate over the spark-ignition FTP duty cycle from part 86, which includes no changes to the FTP duty-cycle weighting factors or the duty-cycle speed values from the current HDDE FTP duty cycle that applies to criteria pollutant regulation in paragraph (f)(1) of 40 CFR part 86, Appendix I, a change to the negative torque values, and migration of the HDDE FTP drive schedule to paragraph (b) of 40 CFR part 1036, Appendix II, to add vehicle speed and road grade to the duty-cycle to facilitate powertrain testing for compliance with the HD Phase 2 GHG standards. The change to negative torque values is the removal of and footnoting of the negative normalized vehicle torque values over the HDDE FTP duty-cycle. The footnote denotes that these torque points are controlled using closed throttle motoring, which would then match how negative torque values have been controlled in the HDDE FTP. This change also reflects the way that engine manufacturers are already controlling to negative torque from spark-ignition engines and harmonizes the

methodology with the HDDE FTP, with no effect on stringency. The spark-ignition engine denormalization equation in 40 CFR 86.1333(a)(1)(ii) includes division by 100 which equates it to the denormalization equation in 40 CFR 1065.610(c)(1) (Equation 1065.610-3), with no effect on stringency. We have further modified the proposed language in this section by updating the road-grade coefficients to reflect additional refinement of the road-grade development process that is described in Section II.A.7 of the preamble.

- Part 1036 Appendix II(c) – Adding a new paragraph (c) of 40 CFR part 1036, Appendix II to migrate over the compression-ignition FTP duty cycle from part 86, which includes no changes to the HDDE FTP weighting factors or the duty-cycle torque values from the duty cycle that currently apply to criteria pollutant regulations in paragraph (f)(2) of 40 CFR part 86, Appendix I, a change to the speed values that does not influence the ultimate denormalized speed, and migration of the HDDE FTP drive schedule to add vehicle speed and road grade to the duty-cycle to facilitate powertrain testing for compliance with the Phase 2 GHG standards. The change to speed values takes the normalized vehicle speeds over the HDDE FTP duty-cycle and multiplies them by 100/112 to eliminate the need to divide by 112 in the diesel engine denormalization equation in 40 CFR 86.1333(a)(1)(i). This eliminates the need for use of a denormalization equation and allows commonization (between compression- and spark-ignition engines) of the use of the denormalization equation in 40 CFR 1065.610(c)(1) (Equation 1065.610-3), with no effect on stringency. We have further modified the proposed language in this section by updating the road grade coefficients to reflect additional refinement of the road grade development process that is described in Section II.A.7 of the preamble.

2. 40 CFR Part 1037 Test Procedures

EPA proposed several updates to the testing and measurement provisions of 1037 subpart F related to how to measure emissions from heavy-duty vehicles and determine certain GEM inputs and requested comment on general improvements to the vehicle test procedures and compliance provisions (see 85 FR 28142). This section presents the changes we are adopting to vehicle test procedures after consideration of comments received. Chapter 2 of our Response to Comments includes additional details on some of these amendments, as well as other testing and measurement amendments or clarifications requested by commenters and our responses. Amendments for other subparts of part 1037 (i.e., amendments not directly related to test procedures) are discussed in Section II.C.15. We are generally finalizing revisions as proposed; however, some revisions include further changes and clarifications after consideration of public comments to better ensure clarity, accuracy and consistency with the intent of the proposed rule.

- Section 1037.501(i) –Adding paragraph (i) to note that the declared GEM inputs for fuel maps and aerodynamic drag area typically includes compliance margins to account for testing variability; for other measured GEM inputs, the declared values are typically the measured values without adjustment.
- Section 1037.510(a)(2) —Updating the powertrain testing procedure used to generate GEM inputs to reduce the variability of the emission test results and to improve lab-to-lab measurement variability consistent with the results from the jointly funded EPA-EMA test program at SwRI.
- Section 1037.510 Table 1—Updating footnote format in table.

- Section 1037.510(d)—Clarifying the reference to specifically refer to paragraphs "(b) and (c)" of § 1066.425.
- Section 1037.510(e)-- Clarifying to specifically state that the use of cruise control is optional.
- Section 1037.515 Table 2—Correcting a table entry to include the proper mathematical symbols in response to a comment by CARB.
- Section 1037.515 Table 3—Updating footnote format in table.
- Section 1037.520—Updating a reference to reflect the updated version of the GEM model released in conjunction with this rulemaking.
- Section 1037.520(b)(3)(i)—Adding a reference to §1037.525 to clarify how to determine a high-roof tractor's aerodynamic test results in response to a comment request from EMA.
- Section 1037.520 Table 4 – Correcting a typographical error in a tractor aerodynamic test result C_dA value for Bin III low-roof cabs.
- Section 1037.520 Table 5—Correcting a typographical error in a tractor input C_dA value for Bin II High-Roof Sleeper Cabs.
- Section 1037.520(c) – Adding a clarification to §1037.520(c)(6) and updating the GEM user guide to clarify that a time- and load-weighted average be applied to calculate the rolling resistance of tires installed on liftable axles, given that tires on liftable axles are only in contact with the ground when the axle is in a deployed state in response to a comment from EMA.
- Section 1037.520 Table 6 – Updating footnote format in table.
- Section 1037.520 Table 7 – Clarifying that the nonwheel-related weight reductions from alternative materials applied to tractors for non-suspension crossmembers is for a set of three.
- Section 1037.520 Table 8 – Adding two footnotes to address how weight reduction values apply and what values to use for medium HDVs with 6x4 or 6x2 axle configurations. Also see Section II.C.3.
- Section 1037.520(f)—Updating a cross-reference.
- Section 1037.520(g)—Adding and clarifying which vehicle characteristics need to be reported, including providing a better description in paragraph (g)(2)(iv) of the 6x4D drive axle configuration as well as qualifying conditions for use of this configuration. After considering comments received by Allison and Ford, we are further modifying this paragraph by noting in paragraph (g)(1), and similarly in §1037.231(b)(7), that available forward gear means the vehicle has the hardware and software to allow operation in those gears and providing in paragraph (g)(2)(i) that the 4x2 drive axle configuration is available to vehicles with two drive axles where one of them is disconnectable and designed to be connected only when used in off road or slippery road conditions and based on a qualifying condition.
- Section 1037.520(h)—Adding provisions to determine appropriate vehicle idle speed based on vehicle service class and applicable engine standard, including in the final rule a clarification that the 750 rpm value applies to Light HDV and Medium HDV *vocational* vehicles and providing an idle speed value of 700 rpm for Medium HDV *tractors*, corresponding to the idle speed used to set the standards for those vehicles, in response to a comment from EMA. These final provisions incorporated in a new table format, with an

updated footnote noting the appropriate adjustable idle speed to choose if an engine cannot operate at the idle speed specified in the table.

- Section 1037.520(i) – Adding that a manufacturer can characterize a torque converter, in addition to an axle and transmission, which will improve the accuracy of GEM by replacing default GEM values with more representative values.
- Section 1037.520(j)(2)—Removing a superfluous reference to tractors in paragraph (j)(2)(i); clarifying paragraph (j)(2)(iii) in response to a comment from EMA to indicate how to demonstrate the performance of high-efficiency air conditioning compressors.
- Section 1037.520(j)(4) Table 9—Including additional combinations of idle reduction technologies and their corresponding GEM input values.
- Section 1037.520(j)(5) – Correcting typographical error that transposed school and coach bus GEM inputs.
- Section 1037.525—See Section II.A.6 for a description of comments and final revisions to this section.
- Section 1037.528—Replacing the phrase “primary procedures” with “reference method” for tractors and “alternate procedures” with “an alternate method” for trailers to maintain consistency with terminology used throughout subpart F.
- Section 1037.528(c)—Clarifying that the conditions listed in paragraph (c) apply to each run separately.
- Section 1037.528(e)—Removing requirement that the anemometer be “electro-mechanical” to rely instead on the specifications outlined in the existing reference to SAE J1263.
- Section 1037.528(g)(3)—Clarifying that the measured air direction correction is “from all the high-speed segments.”
- Section 1037.528(h)(3)(i)—Clarifying how to account for measurement noise near the 2 mile/hour boundary.
- Section 1037.528(h)(6)—Adding a definition of ΔF_{TRR} to the introduction of paragraph (h)(6) to clarify the required calculations; relocating the proposed direction to determine the difference in rolling resistance between 65 mph and 15 mph for each tire and to use good engineering judgment when measuring multiple results to paragraph (v) with the corresponding ΔF_{TRR} equation.
- Section 1037.528—Updating equation 11 and the corresponding example to include the appropriate variable to represent inflation pressure variable with a lowercase “*p*”.
- Section 1037.528—Updating equation 13 to include appropriate units for the ambient temperature variable.
- Section 1037.528 – Updating equation 14 to replace a “+” with a “-” to correct a typographical error.
- Section 1037.528(h)(12)—Updating a variable name to provide consistency with updates made to §1037.525.
- Section 1037.532—See Section II.A.6 for a description of comments and final revisions to this section.
- Section 1037.534 – Updating equation 6 and the corresponding example to include the appropriate variable to represent increments by italicizing the “i”.
- Section 1037.540 – Updating equations 1, 2, and 3 to include the appropriate variable to represent increments by italicizing the “i”.

- Section 1037.540 Table 1 – Updating footnote format in table; updating a parameter name.
- Section 1037.540(e) and (f) – Removing incorrect cross-reference to §1036.540(d)(5); adding reference to definition of standard payload.
- Section 1037.550 – Updating the powertrain testing procedure to reduce the variability of the emission test results and improve lab-to-lab variability consistent with the results from the jointly funded EPA-EMA test program at SwRI. We further modified this section to include an introduction paragraph and reorganized paragraphs with new paragraph headings to improve navigation. Additional modifications to this section in the final rule include clarifying in paragraph (a)(3) options available to create the models for powertrain testing, adding clarifications in several paragraphs to address where the torque and speed are measured based on powertrain setup, adding a new paragraph (f)(2) to address testing of hybrid engines using the transmission model in GEM, modifying paragraph (b) to give additional clarification on how to set the engine idle speed, adding a new paragraph (f)(2) for testing with torque measurement at the engine's crankshaft and how to calculate the transmission output rotational speed, updating paragraph (j)(2) to describe how to transition between duty cycles if the preceding cycle ends at 0 mi/hr, adding a new paragraph (j)(5) to describe how to warm up the powertrain, adding a new paragraph (o)(2) to describe how EPA will determine the official fuel consumption rate during a confirmatory test, based on carbon balance results, and updating paragraphs (o)(3) through (o)(5) to better define when a vehicle is not moving, moving the text from paragraph (p) into paragraph (o)(1), moving the text of paragraph (q) to the general provisions as a new paragraph (a)(5). The final rule includes additional revisions regulatory text to provide greater clarity and more carefully describe the procedures.
- Section 1037.551(b) – Updating a reference.
- Section 1037.555 – Updating equations 1 and 3 to include the appropriate variable to represent increments by italicizing the "i"; updating a parameter name in Table 1 for consistency in this part.
- Section 1037.560 – Clarifying that it is optional to drain gear oil after the break in period is complete, providing the option of an alternative temperature range to provide international harmonization of testing, editing the P_{loss} (i.e., power loss) variable description to improve the readability, and adding paragraph (h) to describe how to derive axle power loss maps for untested configurations in a family. We further modified this section in the final rule by clarifying in paragraph (a) that for tandem axles that can be disconnected, testing both single-drive and tandem axle configurations includes 4x4 axles where one of the axles is disconnectable; adding a new paragraph (h)(4) and modifying (h)(5) to address comments regarding results when multiple gear ratios are tested and one of the points is above the linear regression line, which could cause the regression values to understate power loss, to clarify that you must add the difference between the datapoint and the regression line to the intercept values of the regression line to mitigate this effect; and updating the use of the term "axle" to "axle assembly" throughout the section to provide consistency.
- Section 1037.565 – Providing an option to map additional test points to provide international harmonization of testing, including edits to improve the readability of the P_{loss} variable description, and adding paragraph (d)(4) and clarifying paragraphs (e)(6) and (7) regarding the gears the transmission is tested in. After considering comments

from Allison, ECJV, and EMA, we further modified this section by: updating the torque transducer accuracy requirements in paragraph (c) to link it to the highest transmission input torque or respective output torque; adding additional detail in paragraph (d)(1) on the maximum transmission input shaft speed to test, specifically the maximum rated input shaft speed of the transmission or the maximum test speed of the highest speed engine paired with the transmission. and the minimum idle speed to test, specifically 600 r/min or the minimum idle speed of the engines paired with the transmission; modifying paragraph (d)(2) in response to comments regarding transmission torque setpoints to optionally allow, in higher gear ratios where output torque may exceed dynamometer torque limits, the use of good engineering judgment to measure loaded test points at input torque values lower than specified (in this case GEM may need to extrapolate values outside of the measured map, however extrapolation time may not exceed 10% for any given cycle and you must describe in the application for certification how you adjusted the torque setpoints); modifying paragraph (e)(9) to allow the use of the maximum loss value achieved from all the repeats of the test points to calculate transmission efficiency if you cannot meet the repeatability requirements; adding a new (e)(11) clarifying what needs to be calculated for each point in the test matrix; modifying paragraph (g) and moving part of existing paragraph (g) to a new paragraph (h) to avoid a potentially never-ending cycle of repeat testing if repeatability requirements are not achieved. If the repeatability requirement is not met after conducting three or more tests, the maximum loss value may be used to calculate transmission efficiency, or you can continue to test until you pass the repeatability requirement.

- Section 1037.570 – Adding new section to characterize torque converters to allow a manufacturer to determine their own torque converter capacity factor instead of using the default value provided in GEM. The option to use the default value remains. The final rule includes updated regulatory text to provide greater clarity and more carefully describe the procedures. Final revisions do not change the proposed procedure; instead, they include updates to revise the section heading, reorganize paragraphs, ensure consistent terminology, and clarify measurement points.

3. 40 CFR Part 1065 Test Procedures

EPA proposed several updates to the testing and measurement provisions of 40 CFR part 1065 related to how to measure emissions from heavy-duty highway and nonroad engines and requested comment on general improvements to the engine test procedures and compliance provisions (see 85 FR 28142). This section presents the changes we are adopting primarily to reduce variability associated with engine test procedures after consideration of comments received. Chapter 2 of our Response to Comments includes additional details on some of these amendments, as well as other testing and measurement amendments or clarifications requested by commenters and our responses.

The regulations in part 1065 rely heavily on acronyms and abbreviations (see 40 CFR 1065.1005 for a complete list). Acronyms used here are summarized in Table II-1:

Table II-1 Summary of acronyms related to 40 CFR part 1065 that are referenced in these amendments

ASTM	American Society for Testing and Materials
CVS	Constant-Volume Sampler
DEF	Diesel Exhaust Fluid

ECM	Electronic Control Module
NIST	National Institute for Standards and Technology
NMC FID	Nonmethane Cutter with a Flame Ionization Detector
NMHC	Nonmethane Hydrocarbon
NMNEHC	Nonmethane Nonethane Hydrocarbon
RMC	Ramped Modal Cycle
THC FID	Flame Ionization Detector for Total Hydrocarbons

We are generally finalizing revisions as proposed; however, some revisions include further changes and clarifications after consideration of public comments to better ensure clarity, accuracy and consistency with the intent of the proposed rule.

- Section 1065.1(g) – Updating the test procedure URL.
- Section 1065.2(c) – Correcting a typographical error by replacing "engines" with "engine".
- Section 1065.130(e) – Revising to denote that a carbon balance procedure should be performed to verify exhaust system integrity in place of a chemical balance procedure.
- Section 1065.140(c)(6)(i) – Correcting a typographical error by replacing "dew point" with "dewpoint".
- Section 1065.140(e)(2) – Clarifying how to determine the minimum dilution ratio for discrete mode testing.
- Section 1065.145(e)(3)(i) – Removing the requirement to heat a sample pump if it is located upstream of a NOx converter or chiller and replacing it with a requirement to design the sample system to prevent aqueous condensation to better address concerns with the loss of NO_2 in the sampling system where methods other than heating the pump can be used to prevent condensation.
- Section 1065.170 – Updating to allow you to stop sampling during hybrid tests when the engine is off and allow exclusion of the sampling off portions of the test from the proportional sampling verification, and adding a provision for hybrid testing to allow supplemental dilution air to be added to the bag in the event that sampled volumes are too low for emission analysis.
- Section 1065.205 introductory and Table 1 – Revising and adding recommended performance specifications for fuel and DEF mass scales and flow meters to reduce fuel flow measurement error.
- Section 1065.220(a) introductory and (a)(3) – Updating the application of fuel flow meters to more correctly reflect how and what they are used for in 1065.
- Section 1065.225(a) introductory and (a)(3) – Updating the application of intake flow meters to more correctly reflect how and what they are used for in 1065.
- Section 1065.247 – Revising to add acronym for DEF throughout in place of "diesel exhaust fluid" and in paragraph (c)(2) account for any fluid that bypasses or returns from the dosing unit to the fluid storage tank.
- Section 1065.260(e) – Adding the word "some" as a qualifier for gaseous fueled engines with respect to using the additive method for NMHC determination.
- Section 1065.266(a) and (b) – Adding flexible fuel engines under the allowance to use FTIR and updating the URL for EPA method 320.

- Section 1065.275 – Deleting the URL and replacing with a reference to §1065.266(b).
- Section 1065.280(a) – Updating to reflect that there is no method in §1065.650 for determining oxygen balance and that you may develop a method using good engineering judgment.
- Section 1065.303 Table 1 – Updating the formatting and entries in the summary table to reflect revised requirements, including adding Fuel mass scale and DEF mass scale to the linearity verifications in §1065.307, updating the verification in §1065.341 to replace “batch sampler” with “PFD” as PFD is the preferred language, updating one footnote to include the PFD flow verification (propane check) as not being required for measurement systems that are verified by a carbon balance error verification as described in §1065.341(h) and adding two footnotes excluding linearity verification for DEF flow if the ECM is used and for intake air, dilution air, diluted exhaust, batch sampler, and raw exhaust flow rates flow if propane checks or carbon balance is performed. These are not new exemptions; they are simply relocated to the footnotes.
- Section 1065.307(c)(13) – Adding a clarification that the calculation used for arithmetic mean determination in §1065.602 uses a floating intercept.
- Section 1065.307(d)(4) – Revising to include DEF mass flow rate and to correct or account for buoyancy effects and flow disturbances to improve the flow measurement.
- Section 1065.307(d)(6)(i) – Revising to state that the span gas can only contain one single constituent in balance air (or N_2 if using a gas analyzer) as the reference signal for linearity determination.
- Section 1065.307(d)(7) – Revising to state that the span gas can only contain one single constituent in balance air (or N_2 if using a gas analyzer) as the reference signal for linearity determination.
- Section 1065.307(d)(9) – Expanding the paragraph to include fuel and DEF mass scales and requirements for performing the linearity verification on these scales.
- Section 1065.307(e)(3)(i) and (ii) – Editing to clarify the intent of the requirements.
- Section 1065.307(e)(3)(iii) through (xi) – Defining maximum flowrate for fuel and DEF mass scales and flow meters as well as maximum molar flowrate for intake air and exhaust flow meters and defining maximum for electrical power, current, and voltage measurement.
- Section 1065.307(e)(5) – Providing additional information surrounding requirements for using a propane check or carbon balance verification in place of a flow meter linearity verification.
- Section 1065.307(e)(7)(i)(F) and (G) – Adding transmission oil and axle gear oil to temperature measurements that require linearity verification.
- Section 1065.307(f) – Adding new paragraph (f) to denote that table 1 follows.
- Section 1065.307 Table 1 – Adding DEF flow rate, fuel mass scale, and DEF mass scale to measurement systems and updating the footnote format.
- Section 1065.307(g) – Adding a new paragraph (g) to denote that table 2 follows.
- Section 1065.307 Table 2 – Adding a new Table 2 to provided additional guidance on when optional verifications to the flow meter linearity verifications can be used.
- Section 1065.309(d)(2) – Updating to allow the use of water vapor injection for humidification of gases. After considering comments from EMA and Auto Innovators,

we further modified this section to make language consistent where water vapor injection was added as an alternative.

- Section 1065.320(b) – Deleting existing paragraph (b) and marking it "reserved" as this is now adequately covered in 1065.307.
- Section 1065.341 – Revising section heading, adding introductory text, revising paragraph (a) to clarify which subparagraphs apply to CVS and which apply to PFD, relocating some of existing paragraph (a) to paragraph (f) and reordering existing paragraphs (b) through (f) as paragraphs (a) through (e).
- Section 1065.341(g) – Revising to replace "batch sampler" with "PFD" throughout and editing to provide further clarification on the procedure.
- Section 1065.341(h) – Adding a new paragraph to reference Table 2 of §1065.307 regarding when alternate verifications can be used.
- Section 1065.342(d)(2) – Updating to allow the use of water vapor injection for humidification of gases. After considering comments by EMA and Auto Innovators, we further modified this section to make language consistent where water vapor injection was added as an alternative.
- Section 1065.350(d)(2) – Updating to allow the use of water vapor injection for humidification of gases. After considering comments by EMA and Auto Innovators, we further modified this section to make language consistent where water vapor injection was added as an alternative.
- Section 1065.355(d)(2) – Updating to allow the use of water vapor injection for humidification of gases. After considering comments by EMA and Auto Innovators, we further modified this section to make language consistent where water vapor injection was added as an alternative.
- Section 1065.360(a)(4) – Adding a new option to determine methane and ethane THC FID response factors as a function of exhaust molar water content when measuring emissions from a gaseous fueled engine. This is to account for the effect water has on non-methane cutters. We received a comment regarding whether the new regulatory text for the allowance is optional. The intent is that if you decide to use the option to determine the methane and ethane THC FID response factors as a function of exhaust molar water content, you must generate and verify the humidity as described in §1065.365(d)(12). Paragraph (a)(4) has been modified to make this clear.
- Section 1065.360(d)(12) – Adding a process to determine methane and ethane THC FID response factors as a function of exhaust molar water content when measuring emissions from a gaseous fueled engine. This is to account for the effect water has on non-methane cutters.
- Section 1065.365(a) –Removing chemical symbol for methane in parenthetical.
- Section 1065.365(d) – Adding a requirement to determine NMC FID methane penetration fraction and ethane response factor as a function of exhaust molar water content when measuring emissions from a gaseous fueled engine. This is to account for the effect water has on non-methane cutters.
- Section 1065.365(d)(9) –Adding C_2H_6 before "response factor" and "penetration fraction" to clarify, as intended, that these are the ethane response factor and ethane penetration fraction.
- Section 1065.365(d)(10), (11), and (12) – Adding a process to determine NMC FID methane penetration fraction and ethane response factors as a function of exhaust molar

water content when measuring emissions from a gaseous fueled engine. This is to account for the effect water has on non-methane cutters.

- Section 1065.365(f)(9) and (14) –Adding C_2H_6 before "response factor" and "penetration fraction" to clarify, as intended, that these are the ethane response factor and ethane penetration fraction. Adding CH_4 before "penetration fraction" to clarify, as intended, that this is the methane penetration fraction.
- Section 1065.370(e)(5) – Updating to allow the use of water vapor injection for humidification of gases. After considering comments by EMA and Auto Innovators, we further modified this section to make language consistent where water vapor injection was added as an alternative.
- Section 1065.375(d)(2) – Updating to allow the use of water vapor injection for humidification of gases. After considering comments by EMA and Auto Innovators, we further modified this section to make language consistent where water vapor injection was added as an alternative.
- Section 1065.410(c) –Replacing "bad engine" with "malfunctioning" in relation to engine components after considering a comment by Auto Innovators.
- Section 1065.410(d) – Updating to state that you may repair a test engine if the parts are unrelated to emissions without prior approval. If the part may affect emissions, prior approval is required.
- Section 1065.510(a), (b)(5)(i), (c)(5), and (f)(4)(i) – Moving provision for engine stabilization during mapping from §1065.510(a) to §1065.510(b)(5)(i), which lays out the mapping procedure, adding allowance in §1065.510(f)(4)(i) to specify CITT as a function of idle speed in cases where an engine has an adjustable warm idle or enhanced idle. We further modified this section in the final rule by adding a provision in §1065.510(c)(5) for hybrid powertrain testing to map negative torque required to motor the engine with the RESS fully charged.
- Section 1065.512(b)(1) and (2) – Updating procedures on how to operate the engine and validate the duty-cycle when an engine utilizes enhanced-idle speed. This also addresses denormalization of the reference torque when enhanced-idle speed is active.
- Section 1065.514(e) – Clarifying that a floating intercept as described in §1065.602 is used to calculate the regression statistics to harmonize with changes made to §1065.602 and further modifying paragraph (e)(3) in the final rule to change "standard estimates of errors" to "standard error of the estimate" for consistency with other parts.
- Section 1065.514 Table 1 – Updating a parameter name in the final rule for consistency with other parts.
- Section 1065.530(a)(2)(iii) – Adding instructions on how to determine that the engine temperature has stabilized for air cooled engines.
- Section 1065.530(g)(5) – Adding a new paragraph on carbon balance error verification if it is performed as part of the test sequence.
- Section 1065.543 – Adding a new section on carbon balance error verification procedure to further reduce measurement variability for the fuel mapping test procedure in part 1036. We have further modified this section in the final rule to make it optional to account for the flow of other non-fuel carbon-carrying fluids into the system as the overall contribution from any such fluids to the total carbon in the system is negligible.

- Section 1065.545 - Revising to clarify that a forcing the intercept through zero as described in §1065.602 is used to calculate the *SEE* to harmonize with changes to §1065.602.
- Section 1065.602(b), (c), (d), (e), (f), (g), (h), (j), (k) – Updating to include the appropriate variable to represent increments by italicizing the "i".
- Section 1065.602 Table 1- Updating footnote format in table.
- Section 1065.602 Table 2 – Correcting a typographical error where the N_{ref}-1 value should be "22" but was mistakenly listed as "20".
- Section 1065.602(h) – Defining the existing Equation 1065.602-9 as a least squares regression slope calculation where the intercept floats, i.e., is not forced through zero, designating this paragraph as (h)(1) and adding a new paragraph (h)(2) for Equation 1065-602-10, a least squares regression slope calculation where the intercept is forced through zero.
- Section 1065.602(i) – Editing to state that the intercept calculation Equation 1065.602-11 is for a floating intercept.
- Section 1065.602(j) – Defining the existing Equation 1065.602-12 (renumbered from 1065.602-11) as a *SEE* calculation where the intercept floats, i.e., is not forced through zero, designating this paragraph as (j)(1), adding a new paragraph (j)(2) for Equation 1065.602-13, a *SEE* calculation where the intercept is forced through zero, and further modifying paragraph (j) in the final rule to change "Standard estimate of error" to "Standard error of the estimate" for consistency with other parts.
- Section 1065.610(a)(1)(iv) - Updating to include the appropriate variable to represent increments by italicizing the "i".
- Section 1065.610(a)(2) – Clarifying that the alternate maximum test speed determined is for all duty-cycles.
- Section 1065.610(d)(3) – Adding provision to use good engineering judgment to develop an alternate procedure for adjusting CITT as a function of speed.
- Section 1065.640(a), (b)(3), and (d)(1) – Deleting a comma in (a), specifying that the least square regression calculation in (b)(3) is with a floating intercept, providing a conversion to kg/mol for M_{mix} in the example problem for (d)(1), and correcting an error in the example problem in applying Equation 1065.640-10 where M_{mix} was used with the wrong units.
- Section 1065.640(d)(3) – Providing additional guidance on how to calculate *SEE* for C_d to correspond with the changes made to §1065.602.
- Section 1065.642(b) – Correcting a cross-reference.
- Section 1065.642(c)(1) – Defining C_f.
- Section 1065.643 – Adding a new section on carbon balance error verification calculations to support the new §1065.543.
- Section 1065.650(b)(3) – Adding DEF to clarify what is needed for chemical balance calculations.
- Section 1065.650(c)(1) – Relocating transformation time requirement from §1065.650(c)(2)(i) to §1065.650(c)(1).
- Section 1065.650(c)(3) – Updating the equation to include the appropriate variable to represent increments by italicizing the "i".
- Section 1065.650(d) – Correcting cross-references.

- Section 1065.650(d)(7) – Updating to include the appropriate variable to represent increments by italicizing the “i".
- Section 1065.650(f)(2) - Adding DEF to clarify what is needed for chemical balance calculations.
- Section 1065.650(g) – Updating the equations to include the appropriate variable to represent increments by italicizing the “i" and correcting variable name from $e_{NOxcomposite}$ to $e_{NOxcomp}$.
- Section 1065.655 – Adding “DEF” to the section heading.
- Section 1065.655(a) and (c) introductory text – After considering comments by EMA, we modified this section to clarify that the inclusion of diesel exhaust fluid in the chemical balance is optional.
- Section 1065.655(c)(3) – Updating the $x_{Ccombdry}$ variable description to include injected fluid.
- Section 1065.655(d) – After considering comments by EMA, we modified this section to clarify that the inclusion of diesel exhaust fluid in the w_C determination is optional.
- Section 1065.655(e)(1)(i) – Clarifying the determination of carbon and hydrogen mass fraction of fuel, specifically to S and N content.
- Section 1065.655(e)(3) – Clarifying that nonconstant fuel mixtures also applies to flexible fueled engines.
- Section 1065.655(e)(4) – Updating to include the appropriate variable to represent increments by italicizing the “i".
- Section 1065.655(e)(5) – Adding new paragraph (e)(5) to denote that table 1 follows.
- Section 1065.655 Table 1 – Updating cross-reference.
- Section 1065.655(f)(3) – Restricting the use of Equation 1065.655-25 if the standard setting part requires carbon balance verification and including the appropriate variable to represent increments by italicizing the “j"; adding in the final rule a description of the variable for carbon mass fraction, as it was missing.
- Section 1065.655(g)(1) – Updating cross-reference.
- Section 1065.659(c)(2) and (3) – Adding DEF to clarify what is needed for chemical balance chemical balance calculations.
- Section 1065.660(a)(5) and (6) – Adding new paragraphs to those proposed codifying existing practice to calculate THC based on measurements made with FTIR for gaseous fueled engines. EPA intended in previous updates to part 1065 to allow the determination of NMNEHC and NMHC using FTIR from gaseous fueled engines, but the HD Phase 2 rulemaking inadvertently omitted instructional text in paragraph (a) on calculating THC using the two FTIR additive methods.
- Section 1065.660(b)(2) and (3) – Correcting typographical errors, including adding missing commas.
- Section 1065.660(b)(4) – Correcting a typographical error for the chemical formula of acetaldehyde in a variable.
- Section 1065.660(c)(2) – Including NMC FID as allowable option in NMNEHC calculation and further modifying §1065.660(c) in the final rule adding additional information on performing the NMNEHC calculation and to correct typos in variables.
- Section 1065.660(d) – Adding missing parentheses.

- Section 1065.665(a) – Deleting the variable and description for $C_{\#}$ as it is not used in any calculation in this section.
- Section 1065.667(d) – Adding DEF to clarify what is needed for chemical balance description.
- Section 1065.675(d) – Editing variable descriptions to refer to a humidity generator rather than a bubbler (accommodates both a bubbler and humidity generator).
- Section 1065.695(c)(8)(v) – Adding carbon balance verification.
- Section 1065.701(b) – Updating name of California gasoline type.
- Section 1065.701 Table 1 - Updating footnote format in table.
- Section 1065.703 Table 1 – Updating to correct units for kinematic viscosity and updating footnote format in table.
- Section 1065.705 Table 1 – Updating to correct units for kinematic viscosity and updating footnote format in table.
- Section 1065.710 Table 1 – Editing format for consistency and updating footnote format in table.
- Section 1065.710 Table 2 – Editing format for consistency, adding allowance to use ASTM D1319 or D5769 for total aromatic content determination and ASTM D1319 or D6550 for olefin determination because the dye used in ASTM D1319 is becoming scarce and an alternate method is needed, and updating a footnote format in table.
- Section 1065.715 Table 1 - Updating footnote format in table.
- Section 1065.720 Table 1 - Updating footnote format in table and revising Table 1 after considering a comment by EMA to specify ASTM D6667 instead of ASTM D2784 as the reference procedure for measuring sulfur in liquefied petroleum gas. We requested comment on amending the regulation to replace ASTM D2784, which has been withdrawn by ASTM without replacement, received comment from EMA and agree that ASTM D6667 is a suitable method. EPA is similarly changing other regulatory provisions to specify ASTM D6667 as the reference procedure for fuel manufacturers measuring sulfur in butane (see 40 CFR 1090.1350).
- Section 1065.750 Table 1 - Updating footnote format in table.
- Section 1065.790(b) – Adding a NIST traceability requirement for calibration weights for dynamometer, fuel mass scale, and DEF mass scale.
- Section 1065.905 Table 1 - Updating footnote format in table.
- Section 1065.910(a)(2) – Adding a revision in the final rule to change the requirement to use 300 series stainless steel tubing to connect the PEMS exhaust and/or intake air flow meters into a recommendation because there are other materials that are equally suitable for in-use testing other than stainless steel tubing.
- Section 1065.915 Table 1 - Updating footnote format in table.
- Section 1065.1001 – Adding a definition for enhanced-idle.
- Section 1065.1001 – Clarifying definition of test interval as duration of time over which the mass of emissions is determined.
- Section 1065.1005(a) - Updating footnote format in table and parameter names for consistency with other parts.
- Section 1065.1005(c), (d) and (e) – Updating to ensure column headings use terminology consistent with NIST SP-811.

- Section 1065.1005(a) and (e) – Updating tables of symbols and subscripts to reflect revisions to part 1065.
- Section 1065.1005(f)(2) – Adding molar mass of ethane and updating footnote format in table.
- Section 1065.1005(g) – Updating acronyms and abbreviations for ASTM, e.g., and i.e.
- Section 1065.1010(b)(23) and (43) - Incorporating by reference ASTM D6667 into the regulations instead of ASTM D2784, consistent with replacing ASTM D2784 with ASTM D6667 as the reference procedure for measuring sulfur in liquefied petroleum gas in §1065.720, as explained above in this section. EPA is similarly specifying ASTM D6667 as the reference procedure for fuel manufacturers measuring sulfur in butane.

4. 40 CFR Part 1066 Test Procedures

EPA proposed several updates to the testing and measurement provisions of 40 CFR part 1066 related to how to measure emissions from light- and heavy-duty vehicles and requested comment on general improvements to the vehicle test procedures and compliance provisions (see 85 FR 28144). This section presents the changes we are adopting to vehicle test procedures after consideration of comments received. Chapter 2 of our Response to Comments includes additional details on some of these amendments, as well as other testing and measurement amendments or clarifications requested by commenters and our responses.

We are generally finalizing revisions as proposed; however, some revisions include further changes and clarifications after consideration of public comments to better ensure clarity, accuracy and consistency with the intent of the proposed rule.

- Section 1066.1(g) – Updating the URL.
- Section 1066.135(a)(1) – Revising to widen the range for verifications of a gas divider derived analyzer calibration curve to 10 to 60% to ease lab burden with respect to the number of gas cylinders they must have on hand and revising to make the midspan check optional as the part 1066 requirement for yearly linearity verification of the gas divider has provided more certainty of the accuracy of the gas blending device.
- Section 1066.210(d)(3) – Changing the value for acceleration of Earth's gravity from a calculation under 40 CFR 1065.630 to a default value of 9.80665 m/s^2 because the track coastdown doesn't take place in the same location that the dynamometer resides. Therefore, best practice is to use a default value for gravity.
- Section 1066.255(c) –Clarifying that the torque transducer zero and span are mathematically done prior to the start of the procedure.
- Section 1066.260(c)(4) – Correcting an error in the example problem result.
- Section 1066.265(d)(1) – Correcting example equation to replace a subtraction sign that was a typographical error with a multiplication sign.
- Section 1066.270(c)(4) – Correcting units for force in mean force variable description and correcting example problem solution.
- Section 1066.270(d)(2) – Adding corrections in the final rule of typographical errors on maximum allowable error where error tolerances were indicated as "±", but paragraph is clear that the allowable error is a maximum value as Equation 1066.270-2 determines error as an absolute value. Therefore, the error values are positive and not a positive and negative range.
- Section 1066.275 – Extending the dynamometer readiness verification interval from within 1 day before testing to an optional 7 days prior to testing if historic data from the

test site supports an interval of more than 1 day. Adding corrections in the final rule of typographical errors in paragraph (d)(1) and (2) on allowable error where error tolerances were indicated as "±", but paragraph is clear that the allowable error is a maximum value as Equation 1066.270-2 determines error as an absolute value. Therefore, the error values are positive and not a positive and negative range.

- Section 1066.405 – Updating heading to include "maintenance".
- Section 1066.405(a)-(c) – Designating existing text as paragraph (a), adding new paragraphs (b) and (c) to address test vehicle inspection, maintenance and repair, consistent with 1065.410, and, after considering a comment by Auto Innovators, replacing "bad engine" with "malfunctioning" in relation to engine components in paragraph (b).
- Section 1066.420 Table 1 - Updating footnote format in table and, after considering comments from Auto Innovators and VW, clarifying that SC03 humidity tolerance is an "average" value consistent with 40 CFR 86.161-00(b)(1) and inadvertently not carried over in part 1066. All SC03 capable test cells have been designed to meet the humidity requirement in 86.161-00 which is on an average basis.
- Section 1066.605 – Correcting a typographical error in paragraph (c)(4) where NMHC should read NMHCE and editing Equation 1066.605-10 adding italics for format consistency.
- Section 1066.610 – Editing Equation 1066.610-4 adding italics for format consistency.
- Section 1066.710(c) – Clarifying to reflect how HVAC control systems operate in vehicles and how they should be operated for the test. Further modifying paragraph (c)(1)(i)(A) in the final rule to state that for automatic temperature control systems that allow the operator to select a specific temperature, set the air temperature at 72 °F or higher, which the vehicle then maintains by providing air at that selected constant temperature. Further modifying paragraph (c)(2) in the final rule to state that for full automatic temperature control systems that allow the operator to select a specific temperature, set the air temperature at 72 °F, which the vehicle then maintains by varying temperature, direction and speed of air flow. Clarifying terminology is consistent with EPA compliance guidance CD-2020-04.
- Section 1066.801 Figure 1 – Updating to reflect that the initial vehicle soak, as outlined in the regulations, is a 6-hour minimum and not a range of 6 to 36 hours.
- Section 1066.835(a) – Clarifying that the last drain and fill operation is after the most recent FTP or HFET measurement (with or without evaporative emission measurements).
- Section 1066.835(f)(2) – Deleting the word "instantaneous" to reflect that the SC03 temperature and humidity tolerances in paragraph (f)(1) are not all instantaneous in response to comments received from Auto Innovators and VW. This was an inadvertent error in part 1066.
- Section 1066.930 – Adding a period to the end of the sentence.
- Section 1066.1005(a) – Updating a parameter name to be consistent with use in other parts.
- Section 1066.1005(c) and (d) – Updating to ensure column headings use terminology consistent with NIST SP-811.
- Section 1066.1005(f) – Updating footnote format in table.

5. Greenhouse Gas Emissions Model (GEM)

EPA proposed several updates to the GEM model related to how to measure emissions from heavy-duty engines and requested comment on whether the differences in GEM would impact the effective stringency of the standards and, if so, whether either GEM or the regulations need to be revised to address the changes (see 85 FR 28145, May 12, 2020). This section presents the changes we are adopting to GEM after consideration of comments received. Additional details on these and other amendments or clarifications requested by commenters and our responses are available in Chapter 2 of our Response to Comments.

GEM is a computer application that estimates the greenhouse gas (GHG) emissions and fuel efficiency performance of specific aspects of heavy-duty (HD) vehicles. GEM is used to determine compliance with the Phase 2 standards from several vehicle-specific inputs, such as engine fuel maps, aerodynamic drag coefficients, and vehicle weight rating. GEM simulates engine operation over two cruise cycles, one transient cycle, and for vocational vehicles, idle operation. These results are weighted by GEM to provide a composite GEM score that is compared to the standard.

EPA proposed to update GEM, in a revised version 3.5 to replace the current version 3.0, and requested comment on whether the differences in GEM would impact the effective stringency of the standards and, if so, whether either GEM or the regulations need to be revised to address the changes. We received one comment on the proposal on this topic from the California Air Resources Board (CARB), stating the importance of GEM results being consistent with the current program standards to ensure stringency is maintained and recommending that EPA revise GEM to maintain this consistency.

After considering the comment and further evaluating the performance of GEM 3.5 with the input files used to set the Phase 2 vehicle standards, EPA is finalizing GEM version 3.5.1 applicable for MY 2021 vehicles that includes the changes proposed in version 3.5 as well as changes that correct three errors in the GEM 3.5 code. The following changes were proposed in version 3.5 and are finalized in version 3.5.1 to allow additional compliance flexibilities and improve the vehicle simulation:

- Corrected how idle emission rates are used in the model.
- Increased the allowable weight reduction range to 25,000 pounds.
- For powertrain input, added an input for powertrain rated power to scale default engine power.
- Recalibrated driver over speed allowance on cruise cycles from 3 mph to 2.5 mph.
- Revised engine cycle generation outputs with corrected engine cycle generation torque output from model based on simulated inertia and rate limited speed target.
- Added scaling of powertrain simulation default engine and transmission maps based on new rated power input.
- Changed interpolation of fuel map used in post processing to be consistent with one used in simulation.
- Corrected accessory load value on powertrain test when coasting or decelerating.
- Added torque converter k-factor input option.
- Cycle average cycles: added flag for points that are to be considered "idle."
- Improved handling of large input tables.
- Allow hybrid engine input.

The three additional changes in GEM 3.5.1 correct the following errors in GEM 3.5 code: (1) A typographical error, where GEM used a weighting factor of 0.25 instead of 0.23 for the HHD Multipurpose vehicle subcategory; (2) an idle map error when the cycle average fuel mapping procedure is used for all three drive cycles; and (3) a functional error that unnecessarily required transmission power loss data when using the option to enter a unique (instead of default) k-factor for the torque converter. The GEM version we are releasing with and incorporating by reference in this final rule is identified as "3.5.1."

EPA is also issuing a supplemental proposal published in the Proposed Rules section of today's Federal Register, titled "Improvements for Heavy-Duty Engine and Vehicle Test Procedures," docket number EPA–HQ–OAR–2019–0307; FRL-10018-51-OAR. This supplemental proposal provides notice and opportunity for comment on a proposed further updated version of GEM for MY 2022 and later, proposes to allow use of the updated model for MY 2021 for demonstrating compliance with the Phase 2 standards, including obtaining a certificate of conformity and submitting end-of-year reports, and requests comment on whether this version of GEM should be required for MY2021 end-of-year reports. This proposed revised version in the supplemental notice includes corrections, clarifications, additional flexibilities, and adjustment factors to the Greenhouse gas Emissions Model (GEM) compliance tool for heavy-duty vehicles after consideration of comments received on the proposed rule. The supplemental notice proposes limiting the use of GEM 3.5.1 to MY 2021 vehicles only, except where this MY 2021 data can be used for carryover requests for certificates of conformity for MY 2022 and future years for qualifying vehicles under §1036.235(d); however, manufacturers would still need to use GEM 3.8 for end-of-year reporting for MY 2022 and future years.

EPA is finalizing GEM 3.5.1 after considering comments, further evaluating the performance of GEM 3.5.1 with the input files used to set the Phase 2 vehicle standards, considering the corrections and improvements made in GEM 3.5.1, and identifying potential additional corrections and improvements for GEM. Evaluation of GEM 3.5.1 indicated that there was some difference in output 96results for both tractor and vocational vehicles when compared to GEM 3.0. To assess the magnitude of any differences between using GEM 3.0 and GEM 3.5.1, we repeated the process used in 2016 to calculate the numerical level of the vehicle standards, replacing GEM 3.0 with GEM 3.5.1. On average, the differences in the resulting standards from using GEM 3.5.1 instead of GEM 3.0 are decreases of 0.09 percent and 0.54 percent for the tractor and vocational vehicle standards, respectively. The tractor standards resulting from GEM 3.5.1 ranged from 0.29 percent below to 0.15 percent above the GEM 3.0 standards. The vocational vehicle standards resulting from GEM 3.5.1 ranged from 0.32 percent above to 1.45 percent below the GEM 3.0 standards. A summary of the process taken to calculate the vehicle standards using GEM and a comparison of the results generated by GEM 3.0 and GEM 3.5.1 are provided in a docket memo.[7]

We are finalizing GEM 3.5.1 without adopting adjustment factors in the related test procedures.[8] In the same memo noted previously, we compare the GEM 3.8 results to those from GEM 3.0. In the supplemental notice, EPA proposes GEM 3.8 and corresponding adjustment factors to adjust the results to more closely match the results produced by the original GEM 3.0 version and we intend to issue a final rule before the start of model year 2022. If finalized as proposed, we would limit the potential impact on effective stringency due to a change in GEM

[7] Sanchez, James, Memorandum to Docket EPA-HQ-OAR-2019-0307. Process of Using GEM to Set Vehicle Standards. December 4, 2020.

[8] Greenhouse gas Emissions Model (GEM) Phase 2, Version 3.5.1, December 2020. A working version of this software is also available for download at https://www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-emissions-model-gem-medium-and-heavy-duty.

versions to model year 2021 only, which should have a minimal impact on the effective stringency and environmental benefits of the overall Phase 2 program.

6. Aerodynamic Test Procedures

EPA proposed several updates to the testing and modeling provisions of 1037 subpart F related to aerodynamic testing and requested comment on general improvements to the aerodynamic test procedures and compliance provisions (see 85 FR 28147). This section presents the changes we are adopting to aerodynamic test procedures after consideration of comments received. Additional details on these and other aerodynamic amendments or clarifications requested by commenters and our responses are available in Chapter 2 of our Response to Comments.

a. Aerodynamic Measurements for Tractors

The aerodynamic drag of a vehicle is determined by the vehicle's coefficient of drag (C_d), frontal area, air density and speed. The regulations in §1037.525 allow manufacturers to use a range of techniques, including wind tunnel testing, computational fluid dynamics, and constant speed tests. This broad approach is appropriate given that no single test procedure is superior in all aspects to other approaches. However, we also recognized the need for consistency and a level playing field in evaluating aerodynamic performance. To address the consistency and level playing field concerns, EPA adopted an approach that identified coastdown testing as the reference aerodynamic test method, and specified a procedure to align results from other aerodynamic test procedures with the reference method by applying a correction factor ($F_{\text{alt-aero}}$) to results from alternative methods (§1037.525(b)). We are adding a sentence to the introductory text of §1037.525 to clarify that coastdown testing is the "reference method for aerodynamic measurements".

In the proposed rule, we proposed to separate paragraph §1037.525(b)(1) into a paragraph (b)(1) defining $F_{\text{alt-aero}}$ and a new paragraph (b)(2) allowing manufacturers to assume $F_{\text{alt-aero}}$ is constant for a given alternate method. We are finalizing two separate paragraphs and the subsequent renumbering of the remaining paragraphs as proposed except as explained here. Our proposed update to the definition of $F_{\text{alt-aero}}$ in Equation 1037.525-1 and the related text in §1037.525(b)(1) inadvertently removed the definition of effective yaw, ψ_{eff}, which is used throughout §1037.525 and incorrectly replaced the C_dA variables measured at ψ_{eff} with wind-averaged C_dA values, as noted in comment by EMA. We agree that Equation 1037.525-1 should continue to be based on the definition from HD GHG Phase 2 final rule such that $F_{\text{alt-aero}}$ is a function of the coefficient of drag areas at the effective yaw angle. We are finalizing (b)(1) with the same Equation 1037.525-1 as the current requirement but with the updated variable names throughout §1037.525 (and where referenced in §1037.525(h)(12)(v)) to more clearly relate the drag areas to the defined effective yaw variable, as recommended by EMA.[9] We are also adding a "Where:" statement to Equation 1037.525-1 to define the variables in that equation and are restoring the existing language we proposed to remove that defines the effective yaw angle to apply for Phase 1 and Phase 2 compliance.

We proposed and received no adverse comments on two additional changes in §1037.525(b). In paragraph (b)(3), we proposed and are finalizing removal of the sentence "Where you have test results from multiple vehicles expected to have the same $F_{\text{alt-aero}}$, you may either average the $F_{\text{alt-aero}}$ values or select any greater value." By removing this statement, we are

[9] The variables $C_dA_{\text{effective-yaw-coastdown}}$ and $C_dA_{\text{effective-yaw-alt}}$ are now $C_dA_{\text{coastdown}}(\psi_{\text{eff}})$ and $C_dA_{\text{alt}}(\psi_{\text{eff}})$, respectively.

allowing manufacturers the flexibility to propose a method for calculating their $F_{alt\text{-}aero}$ from multiple test vehicles that suits their unique compliance margin targets. In paragraph (b)(5), we proposed to add a statement that manufacturers may test earlier model years than the 2021, 2024, and 2027 model years specified and are finalizing additional clarifying text and a new example. We are finalizing two additional typographical edits correcting references to our renumbered paragraphs in the paragraph (b)(5). The reference to "paragraph (b)(2)" was corrected to (b)(3) and the reference to "this paragraph (b)(4)" was corrected to (b)(5). Finally, we are adding the phrase "drag area from your alternate method" to describe the previously undefined term, C_dA_{alt}.

EPA proposed a change to §1037.525(b)(7), to clarify that the use of good engineering judgment with respect to the specified tractor-trailer gap dimension "applies for all testing, including confirmatory and SEA testing". Both EMA and Volvo requested further clarification through use of an example. We are finalizing three clarifying changes to §1037.525(b)(7). First, we are adding a reference to the tractor-trailer gap specifications in §1037.501(g)(1)(ii), as requested. Second, we provide an example of good engineering judgment that could be applied to correct a difference between the specified and tested tractor-trailer gaps. Lastly, we clarify that the allowance applies "for certification, confirmatory testing, SEA, and all other testing to demonstrate compliance with standards."

We also proposed a provision to our regulations at §1037.525(b)(8) to encourage manufacturers to proactively coordinate with EPA to have compliance staff present when a manufacturer conducts its coastdown testing to establish $F_{alt\text{-}aero}$ values. Section 208 of the Clean Air Act provides EPA broad oversight authority for manufacturer testing. Being present for the testing would give EPA greater confidence that the test was conducted properly, and thus, would make it less likely that EPA would need to conduct aerodynamic confirmatory testing on the vehicle. Consistent with the intent of the proposed revision and EPA's authority under section 208, we are finalizing in §1037.525(b)(8) a provision that refers to the existing preliminary approval provisions of §1037.210 with the note that EPA may witness the testing. Section §1037.210 provides an established protocol for manufacturers to coordinate with EPA for testing.

EMA's comment requested additional modifications to the yaw sweep correction provisions in §1037.525(c), suggesting that coastdown results do not need to be corrected to wind-averaged and that all of paragraph (c)(2) was "unnecessary" because another regulatory provision "serves that function". Their request appears to be a misunderstanding of the existing regulations. Wind-averaged drag area (C_dA_{wa}) is a required input for GEM in Phase 2. Paragraph (c)(1) specifies how to calculate C_dA_{wa} when using an alternate test method and paragraph (c)(2) specifies how to calculate it for coastdown testing. EPA may use coastdown for confirmatory testing and manufacturers may choose to use coastdown testing for all aerodynamic testing. Consequently, paragraph (c)(2) is needed to properly calculate the wind-averaged input required by GEM in these situations. To address any potential confusion on the necessity of both paragraphs under the current regulatory text, we are finalizing three updates to §1037.525(c) as follows:

- Clarifying the use of the yaw correction provisions by revising paragraph (c) introductory text to add "as specified in §1037.520" and to remove the phrase "differences from coastdown testing" that only applies to paragraph (c)(1).
- Updating the text of paragraphs (c)(1) and (c)(2) to more clearly communicate that they are two separate options that apply based on which testing method is chosen.
- Adopting the updated drag area variable names from §1037.525(b).

b. Aerodynamic Measurements for Vocational Vehicles

We did not specifically propose changes to or request comment on our procedures for measuring aerodynamic performance of vocational vehicles in §1037.527. EMA commented that the existing provisions of §1037.527 to determine a ΔC_dA value for vocational vehicles refer to the trailer provisions in §1037.526; however, §1037.526 does not specify how to choose an appropriate baseline for vocational vehicles. EMA requested that manufacturers should be able to "choose an appropriate baseline vehicle for the technology and applications". We are not taking any final action on this issue at this time. However, we are providing a summary of the current provisions and their original intent in this preamble to assist manufacturers.

The current §1037.527(a) states that ΔC_dA is determined for vocational vehicles as follows: "Determine ΔC_dA values by performing A to B testing as described for trailers in §1037.526, with any appropriate adjustments, consistent with good engineering judgment." The A to B testing provisions for trailers are specified in §1037.526(a), where paragraph (a)(1) describes the baseline trailer, paragraph (a)(2) describes the general intent of the A to B test, and paragraph (a)(3) describes how to calculate the ΔC_dA from the test results.

We acknowledge that the reference to a "standard trailer" in §1037.526(a)(1) may cause confusion to vocational vehicle manufacturers, since it would be a challenge to identify a single "standard" vehicle to represent the range of vocational applications. However, the baseline trailer description in that paragraph equates to a trailer without aerodynamic components, which is the key aspect of that baseline description the regulatory cross-reference in §1037.527(a) applies to vocational vehicles. The trailer provision of §1037.526(a)(2) states that the general intent of the A to B test is to "demonstrate the reduction in aerodynamic drag associated with the improved design", which can be directly applied to vocational vehicles. The general process of calculating ΔC_dA in §1037.526(a)(3) could be applied to vocational vehicles as well, but its reference to test trailer and baseline trailer may cause confusion for reasons similar to those discussed for §1037.526(a)(1).

Similar to the trailer provision, a vocational vehicle's aerodynamic performance is based on a ΔC_dA value relative to a baseline vehicle. Manufacturers wishing to perform aerodynamic testing on their vocational vehicles are encouraged to coordinate with their Designated Compliance Officer and use the existing provision in §1037.527, including its reference to the description of how to do so for the trailer-specific provision in §1037.526. As noted in §1037.527(a), we expect manufacturers to make "appropriate adjustments" when applying the cross-referenced provision to vocational vehicle testing consistent with good engineering judgment. When followed, this should result in a manufacturer choosing an appropriate baseline vehicle, similar to the clarification requested by the commenter. For example, a manufacturer may choose an aerodynamic test method, determine a baseline C_dA value (in m^2) using a vehicle that represents a production configuration without the aerodynamic improvement, then repeat the same aerodynamic method for a test vehicle that is a nearly equivalent configuration but includes the aerodynamic improvement of interest. In this case, the manufacturer would calculate ΔC_dA by subtracting the measured drag area for the test vehicle from the drag area for the baseline vehicle. Calculating ΔC_dA in this manner would generally be consistent with the intent that the test "accurately demonstrate the reduction in aerodynamic drag associated with the improved design" for the vocational vehicle since any improvement to aerodynamic performance would be attributable to the aerodynamic technology on the test vehicle.

c. Computational Fluid Dynamics Procedures

We proposed one correction to our computational fluid dynamics (CFD) provisions of §1037.532 that replaced the incorrect "or" in paragraph (a)(1) with "and" to include yaw angles of +4.5° *and* –4.5°. EMA requested three additional modifications related to our CFD provisions. In §1037.532(a)(3), they requested that we clarify our specified Reynolds number of 5.1 million is based on the 102-inch trailer width as the characteristic length. We agree with this suggestion and updated the language in §1037.532(a)(3) for clarity that the Reynolds number is based on a 102-inch trailer width consistent with our specifications for a "standard trailer" in §1037.501(g)(1)(i). EMA also suggested the phrase "the General On-Road Simulation" in §1037.532(a)(4) be replaced with "an open-road simulation" to avoid confusion with SAE International's revisions of SAE J2966 to incorporate the impact of traffic. We agree that open-road simulation is representative of our initial intent and are updating the regulatory text of §1037.532(a)(4). See Chapter 2 of our Response to Comments for additional details.

EMA's third request was that we remove the requirement to set the "free stream turbulence intensity to 0.0 percent" in §1037.532(a)(5), and instead recommended we replace that requirement with a "uniform inlet velocity profile." EPA is not taking any final action on revision to that paragraph at this time. Furthermore, EPA disagrees with the requested change to paragraph (5). Turbulence intensity is a common parameter in CFD packages and, as described in Chapter 3.2.2.3 of the Final Regulatory Impact Analysis for the HD Phase 2 Rule, we evaluated a range of turbulence intensities and intentionally specified a value of zero to ensure consistency, stating that "Turbulence intensity must be 0.0 percent."[10] Manufacturers who wish to use alternative parameters and criteria related to their CFD models, which includes seeking to substitute the specified turbulence intensity with a uniform inlet velocity profile, continue to have the option to seek to do so through requesting EPA approval under §1037.532(f).

CARB requested EPA add provisions that set a requirement for a maximum limit of computational elements to perform Computational Fluid Dynamics (CFD) simulation, define a specific transient averaging methodology, quantify the uncertainty in using CFD simulation, and assess CFD simulation credibility. We are not taking any final action on these requests, but may consider the changes suggested by the commenter in an appropriate future rulemaking with notice and comment. See our complete response in Chapter 2 of our Response to Comments.

7. Hybrid Powertrain Test Procedures

As explained above in Sections II.A.1 and II.A.2, EPA proposed several updates to the hybrid powertrain test procedures that apply to engine and vehicle standards provisions in 40 CFR 1036.503, 1036.505, 1036.510, and 1036.527, 40 CFR part 1036, Appendix II, and 40 CFR 1037.550 related to how to perform hybrid powertrain testing and requested comment on general improvements to the hybrid powertrain test procedure provisions (see 85 FR 28152). This section further explains, in addition to the specific descriptions in Sections II.A.1. and II.A.2. above, the changes we are adopting to hybrid powertrain test procedures after consideration of comments received. Additional details on these and other hybrid powertrain testing and measurement amendments or clarifications requested by commenters and our responses are available in Chapter 2 of our Response to Comments.

a. Hybrid Test Procedures for Engine Standards

[10] US EPA, US DOT/NHTSA. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles - Phase 2: Regulatory Impact Analysis. EPA-420-R-16-900. August 2016. Page 3-41.

EPA worked with industry prior to proposal and also considered input provided during this rulemaking to develop a powertrain test procedure that includes the addition of a transmission model to GEM and options in GEM to test without the transmission present, using the model in its place to be used to certify a hybrid powertrain to the FTP and SET HD GHG Phase 2 greenhouse gas engine standards. The two primary goals of this development process were to make sure that the powertrain version of each test cycle was equivalent to the respective engine cycle in terms of positive power demand versus time and that the powertrain cycle had appropriate levels of negative power demand.

Our current regulations do not have a certification procedure for powertrain certification of heavy-duty hybrid vehicles to any engine standards. The powertrain certification test for certification to both the FTP and SET is carried out by following 40 CFR 1037.550 as described in 40 CFR 1036.505 and 1036.510 and is applicable for powertrain systems located in the P0, P1, P2, and P3 positions.

For this test procedure, EPA is finalizing addition of a vehicle speed and road grade profile to the existing HDDE FTP and HDOC FTP duty-cycles in 40 CFR part 1036, Appendix II, and to the SET in 40 CFR 1036.505. EPA also is finalizing vehicle parameters to be used in place of those in 40 CFR 1037.550; namely vehicle test mass, vehicle frontal area, vehicle drag area, coefficient of rolling resistance, drive axle ratio, tire radius, vehicle curb mass, and linear equivalent mass of rotational moment of inertias. Under the final test procedure, determination of system and continuous rated power along with the maximum vehicle speed (C speed) is also required using 40 CFR 1036.527. Under the final test procedure, the combination of the generic vehicle parameters, the engine duty-cycle vehicle speed profile, and road grade profile fully defines the system load and this is designed to match up the powertrain load with the compression-ignition engine vFTP, spark ignition engine vFTP, and vSET load for an equally powered engine.

The development of this test procedure was based on the process contained in Global Technical Regulation No. 4.[11,12] Generally speaking, the final test procedure is powertrain in the loop using a vehicle-based cycle (vehicle speed vs. time and grade vs. time). The final vehicle speed profiles were developed by following SAE 2012-01-0878.[13]

The engine operational profile for engines installed in vehicles depends on the entire vehicle setup, including the use of hybrid systems if applicable, thus the entire vehicle must be considered when certifying a powertrain. Given that heavy duty vehicles can vary quite a bit even though the powertrain configuration remains unchanged, testing of every conceivable configuration is not possible; therefore, a representative average vehicle, consisting of generic vehicle parameters, is used to provide a representative configuration for certification testing. Generic vehicle parameters were developed with the intent of maintaining the same system load

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[11] United Nations Economic Commission for Europe. Addendum 4: Global technical regulation No. 4. Test procedure for compression ignition (C.I.) engines and positive-ignition (P.I.) engines fueled with natural gas (NG) or liquefied petroleum gas (LPG) with regard to the emission of pollutants Amendment 3., March 12, 2015.

[12] Six, C., Siberholz, G., Fredriksson, J., Geringer, B., Hausberger, S. Development of an exhaust emission and CO2 measurement test procedure for heavy-duty hybrids (HDH). October 27, 2014. Available online at: https://wiki.unece.org/download/attachments/4064802/20141027_ACEA_Report.pdf?api=v2.

[13] Andreae, M., Salemme, G., Kumar, M., and Sun, Z., "Emissions Certification Vehicle Cycles Based on Heavy Duty Engine Test Cycles," SAE Int. J. Commer. Veh. 5(1):299-309, 2012, https://doi.org/10.4271/2012-01-0878.

for engines installed in conventional vehicles and hybrid systems with the same power rating to maintain comparability in terms of emissions.[14]

EPA is finalizing vehicle parameters for hybrid powertrain testing in place of those in 40 CFR 1037.550 to be used in the vehicle model in 40 CFR 1037.550(f). These final parameters can be found in 40 CFR 1036.505 (via reference from 40 CFR 1036.510 for FTP testing) and included vehicle test mass, M, vehicle frontal area, A_{front}, vehicle drag area, C_dA, coefficient of rolling resistance, C_{rr}, drive axle ratio, k_a, tire radius, r, transmission efficiency if the hybrid powertrain is being tested without the transmission, axle efficiency, Eff_{axle}, vehicle curb mass, M_{curb}, and linear equivalent mass of rotational moment of inertias, $M_{rotating}$. The requirements for the determination of these parameters were taken from the Global Technical Regulation (GTR) No. 4 referenced above.

Under the final test procedure, to align the system demands for conventional and hybrid engines, the generic vehicle parameters are defined as a function of the system's power rating. 40 CFR 1036.527 provides the procedure for determining the peak rated power, P_{rated}, and continuous rated power of the hybrid system, $P_{contrated}$, that goes into the vehicle test mass determination. These revisions also provide a procedure for the determination of the maximum vehicle speed (C speed), v_{refC}. In general, the process for determining both P_{rated} and $P_{contrated}$ is very similar to the GTR No. 4 hybrid system rated power determination procedure with a few exceptions. In the final 40 CFR 1036.527 procedure, the default axle efficiency is 0.955 because that is the default value in GEM. The determination of continuous rated power in the final EPA process versus the system rated power in the GTR No. 4 process is to address the lack of a steady state vehicle test cycle in GTR No. 4. The full throttle test to determine system rated power in GTR No. 4 lasts 50 to 150 seconds and GTR No. 4 determines rated power as peak power during these tests. While this process is appropriate for the FTP, the SET is 2400 seconds long and the extended operation at some high speed and load points can lead to some hybrid systems not being able to sustain peak power over the course of the test due to thermal limitations on the motor generator (generally due to material limitations) and limitations on the battery storage capacity and available usable energy. Under these scenarios, the hybrid system will typically derate the motor generator to thermally protect it, resulting in a sustained peak power that is lower than that determined using the GTR No. 4 process.

Under the final test procedure, the powertrain system rated power determination in 40 CFR 1036.527 includes the determination of both peak and continuous rated power. The peak rated power (P_{rated}) is used in the transient FTP test procedure, while the continuous rated power ($P_{contrated}$) is used in the steady-state SET test procedure. The vehicle C speed, v_{refC}, is also determined as a result of this process. This is the maximum vehicle speed at which P_{sys} equals $P_{contrated}$.

The final compression-ignition vFTP duty cycle vehicle speed profile was derived from the compression-ignition FTP vehicle duty-cycle developed in SAE 2012-01-0878. In this work, a vehicle FTP cycle and a vehicle SET cycle were created based on the transient diesel engine FTP and engine SET duty cycles. The vehicle cycles are the same duration and have similar power requirements and performance when compared to the engine cycles. The alignment of the engine and vehicle cycles maintain a consistency within vehicle and engine emissions evaluations. The compression-ignition FTP vehicle speed profile is not applicable to the spark-

[14] Six, C., Siberholz, G., Fredriksson, J., Geringer, B., Hausberger, S. Development of an exhaust emission and CO2 measurement test procedure for heavy-duty hybrids (HDH). October 27, 2014. Available online at: https://wiki.unece.org/download/attachments/4064802/20141027_ACEA_Report.pdf?api=v2.

ignition FTP vehicle speed profile due to differences in the engine duty-cycle lengths, speed profiles, and torque profiles. Thus, a separate vehicle speed profile had to be developed for the spark-ignition FTP duty cycle. Using the methodology in SAE 2012-01-0878, a vehicle speed profile was developed for the spark-ignition FTP duty cycle and a comparison between the two cycles can be found in Table II-2. The vehicle speed profiles can be found in Figure II-1 and Figure II-2.

Table II-2 Comparison Between HDDE FTP and HDOC FTP Vehicle Duty Cycle Metrics

Cycle Metric	Compression-Ignition FTP Vehicle Duty Cycle	Spark-Ignition FTP Vehicle Duty Cycle
Maximum acceleration (m/s^2)	1.55	1.47
Maximum deceleration (m/s^2)	-2.26	-2.15
Average speed (mph)	20.1	19.2
Maximum speed (mph)	60.6	60.8
Stop duration (%)	3.3	4.7
Distance (miles)	6.4	6.4

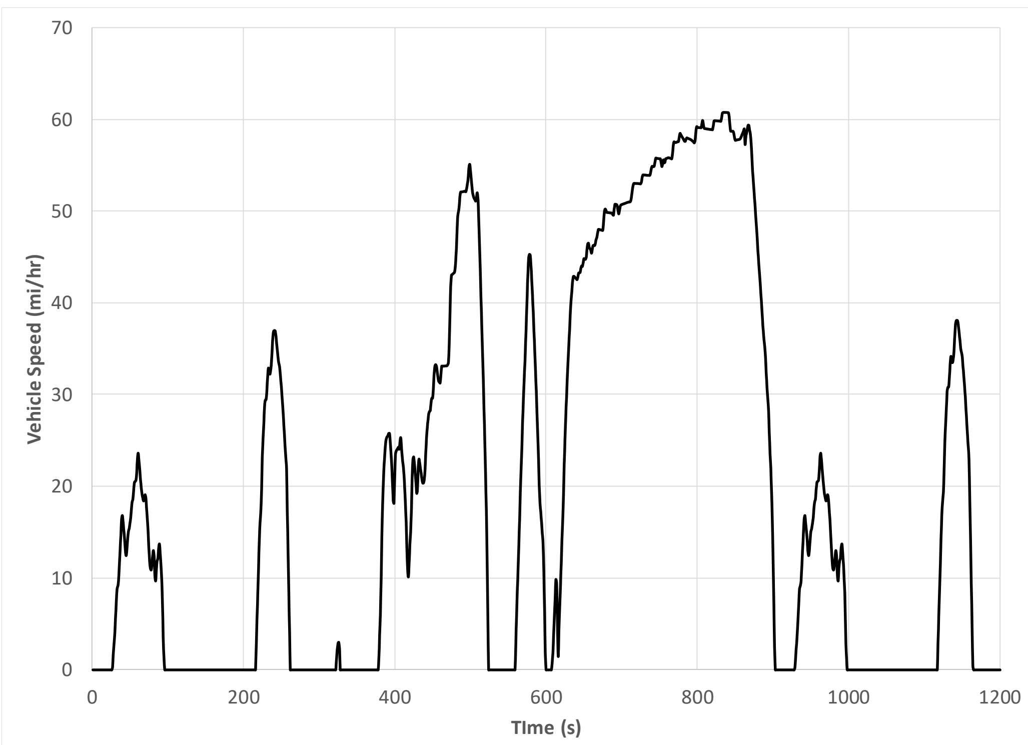

Figure II-1 Compression-Ignition FTP duty cycle vehicle speed profile.

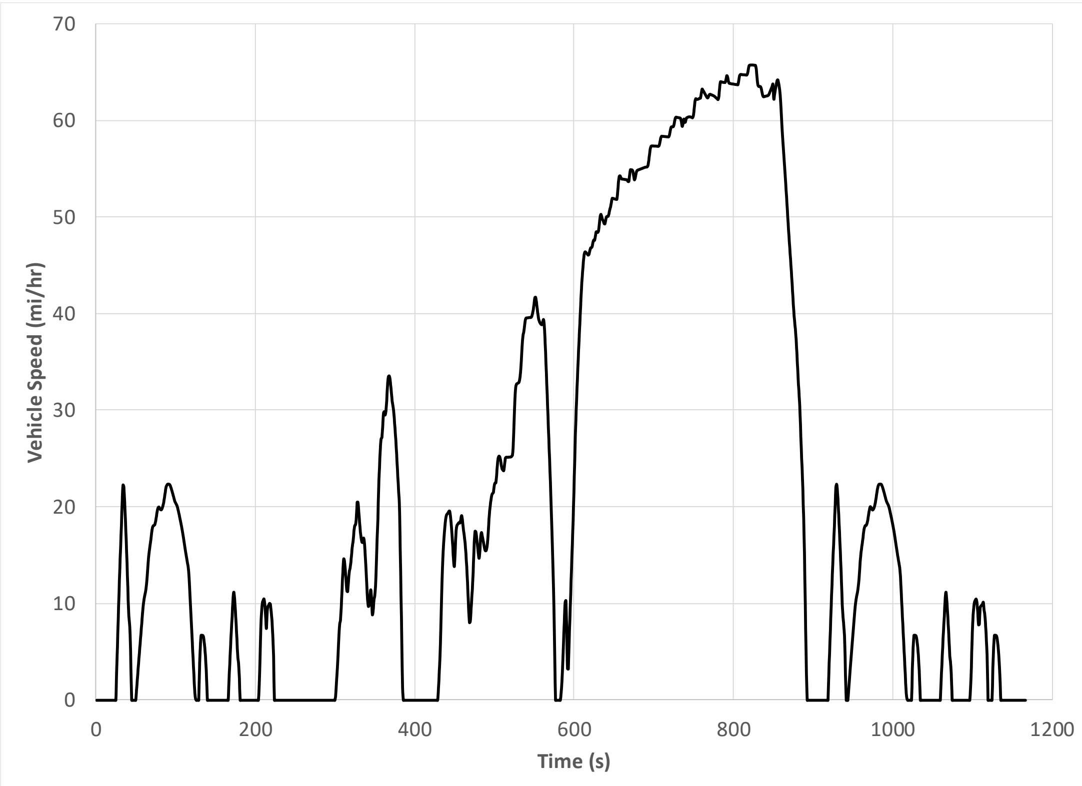

Figure II-2 Spark-Ignition FTP duty cycle vehicle speed profile.

The road gradient profile is designed to further align the powertrain system load for engines installed in conventional vehicles and hybrid systems to eliminate the deviations in cumulative work done between the engine and powertrain test. The grade profiles were developed to align the power versus time and cycle work of the vehicle profiles (compression-ignition vFTP, spark-ignition vFTP, and vSET) to the compression-ignition and spark-ignition FTPs, and SET. The general process was based on the development of the grade profile for the World Harmonized Vehicle Cycle (WHVC).[15] A reference normalized power curve was generated using denormalized torque and speed curves from 50 different compression-ignition engines with multiple engine ratings for the compression-ignition FTP, and SET. The denormalized curves were normalized individually for each engine based on the engine's rated power. The normalized power curves were then averaged to define the final reference normalized power curve. Ten different spark-ignition engine torque curves were used for the spark-ignition FTP. The duty-cycle velocity profile over time was then divided into multiple mini-cycles. Within each mini-cycle, a constant grade was defined in such a way that the energy calculated from the normalized power curve was matched for a given engine power rating. Power ratings between 100 and 500 kW were used to develop the compression-ignition vFTP, spark-ignition vFTP, and vSET duty-cycles. The average slope was calculated from the road grade profiles generated for the power ratings between 100 and 500 kW. The average fixed

[15] Six, C., Siberholz, G., Fredriksson, J., Geringer, B., Hausberger, S. Development of an exhaust emission and CO2 measurement test procedure for heavy-duty hybrids (HDH). October 27, 2014. Available online at: https://wiki.unece.org/download/attachments/4064802/20141027_ACEA_Report.pdf?api=v2.

slope was calculated for every time step along the drive cycle, and a second order polynomial was chosen for the FTP duty-cycles to describe correlation between, and account for the differences in, the average fixed and individual slopes based on the rated power (Prated) of the powertrain. The equation and coefficient descriptions follow:

Equation II-1

$$\text{Road Grade} = a \cdot P_{\text{rated}}^2 + b \cdot P_{\text{rated}} + c$$

Where a is error compensation in %/kW^2, b is error compensation in %/kW, and c is the average fixed slope pattern. Negative road grade is included in the profile to ensured that a representative amount of recuperation energy is provided by the test cycle for hybrid applications. This enables accurate cycle power/work alignment for all vehicles with the engine HDDE and HDOC FTP duty-cycles. Example vehicle road grade profiles for a 350 kW compression-ignition and 400 kW spark-ignition engine can be found in Figure II-3 and Figure II-4.

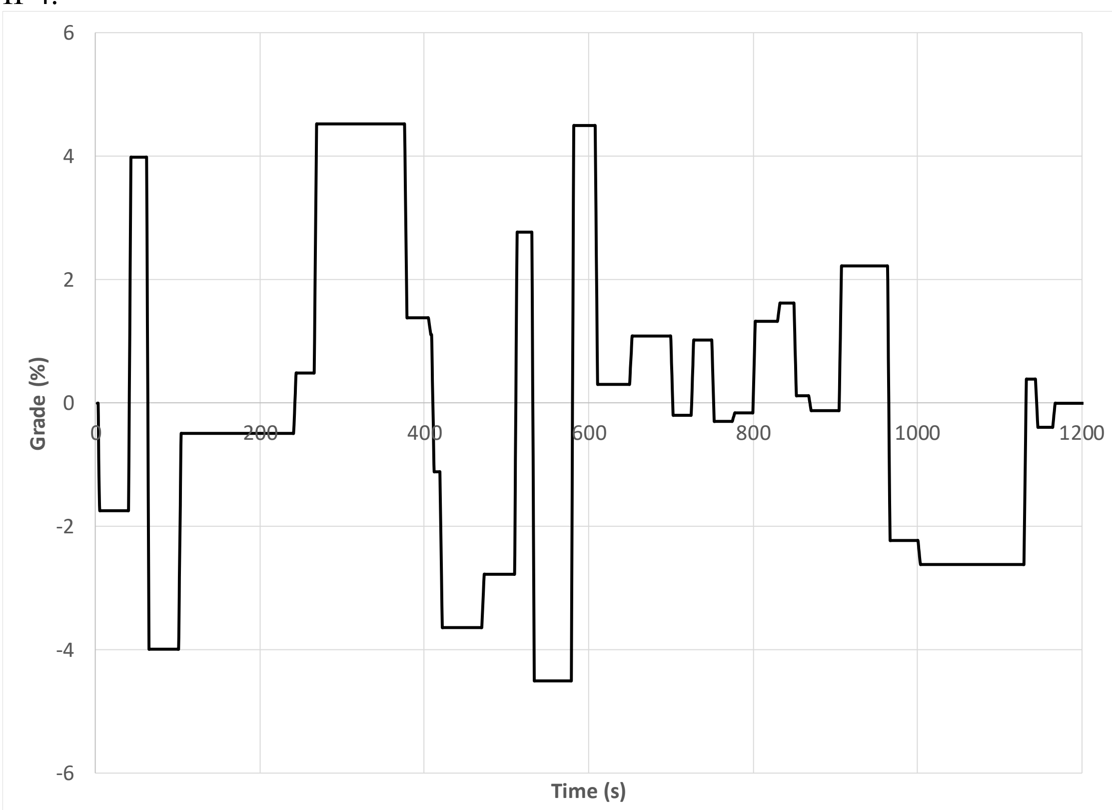

Figure II-3 Compression-Ignition FTP vehicle grade profile for a 350 kW engine.

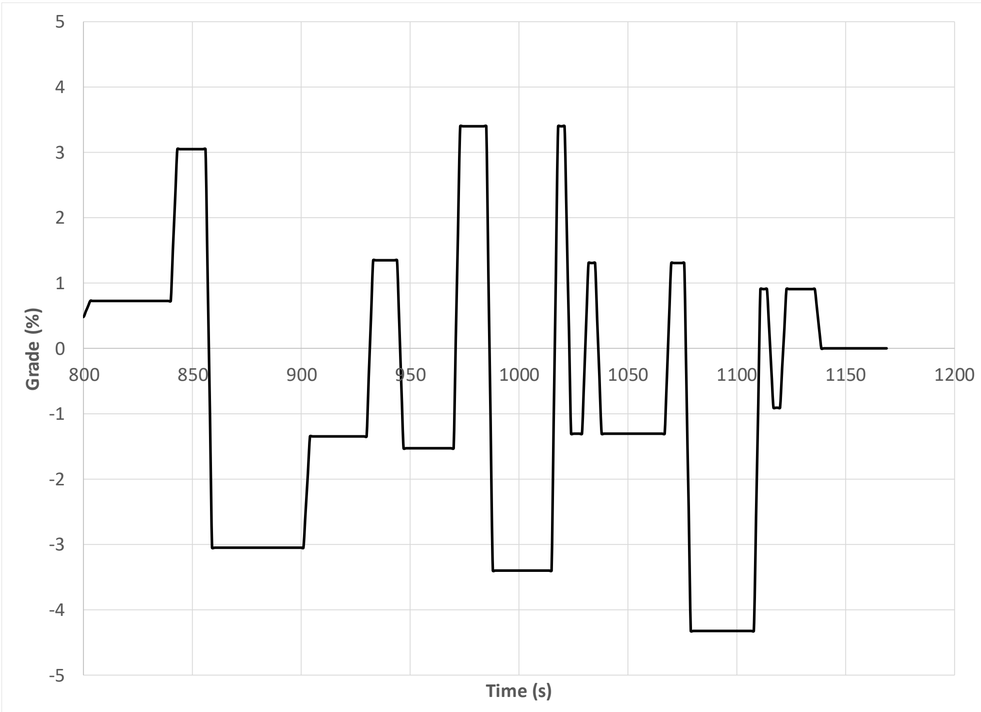

Figure II-4 Spark-Ignition FTP vehicle grade profile for a 400 kW engine.

During additional review of the development of the road grade profile for vSET included in the proposal, it became apparent that the powertrain might not be able to achieve the default vehicle C speed of 75.0 mph. To provide a representative maximum vehicle speed and vehicle A and B speeds that are scaled to the C speed in the final test procedure, the determination of vehicle C speed was added as an additional revision to 40 CFR 1036.527. This maximum achievable vehicle speed is used as the vehicle C speed in Table 1 of §1036.505 and A and B speed are calculated as described in 40 CFR 1036.505. The final test procedure replaces the proposed maximum vehicle C speed and the default vehicle A and B speeds in the proposed additions to Table 1 of §1036.505 with these calculated speeds. Adding the allowance to scale the vSET test speeds based on the vehicle maximum achievable speed required an accounting of the effect of these lower speeds on the road grade determination. This resulted in an expansion of the proposed second order polynomial equation for the vFTP to include vehicle speed in the final test procedure. The expanded equation and coefficient descriptions follow:

Equation II-2

$$Road\ Grade = a \cdot P_{\text{contrated}}^{3} + b \cdot P_{\text{contrated}}^{2} \cdot v_{\text{ref[speed]}} + c \cdot P_{\text{contrated}}^{2} + d \cdot v_{\text{ref[speed]}}^{2} + e \cdot P_{\text{contrated}} \cdot v_{\text{ref[speed]}} + f \cdot P_{\text{contrated}} + g \cdot v_{\text{ref[speed]}} + h$$

Where a is error compensation in %/kW^3, b is error compensation in %/kW^2·mi/hr, c is error compensation in %/kW^2, d is error compensation in %/(mi/hr)^2, e is error compensation in %/kW·mi/hr, f is error compensation in %/kW, g is error compensation in %/mi/hr, and h is the average fixed slope pattern. Negative road grade is included in the profile to ensure that a representative amount of recuperation energy is provided by the test cycle for hybrid applications. This enables accurate cycle power/work alignment for all vehicles with the engine SET duty-cycle.

The final test procedure also includes updates to the road grade coefficients for the compression-ignition and spark-ignition vFTP duty cycles from those proposed. EPA further reviewed the GTR No. 4 process and noted that the work in mini cycles number 4 and 6 was set to zero. This was a policy decision made during the GTR No. 4 process but is not appropriate for the generation of EPA's duty-cycles, which should include the actual work for these two mini cycles. While this improvement results in only a marginal difference from that proposed, it provides a more aligned comparison of work between the engine and vehicle duty-cycles. The result of this was included in the final test procedure in updated coefficients for the compression-ignition vFTP, spark-ignition vFTP, and vSET duty cycles (vSET improvements are in addition to the road grade coefficient updates already discussed). Figure II-5 and Figure II-6 show a comparison of the effect on work matching from changing the mini cycle work in mini cycles number 4 and 6 from zero to the actual work for a 300 kW engine. Note, this final test procedure is limited to hybrid powertrains to avoid having two different testing pathways for non-hybrid engines for the same standards.

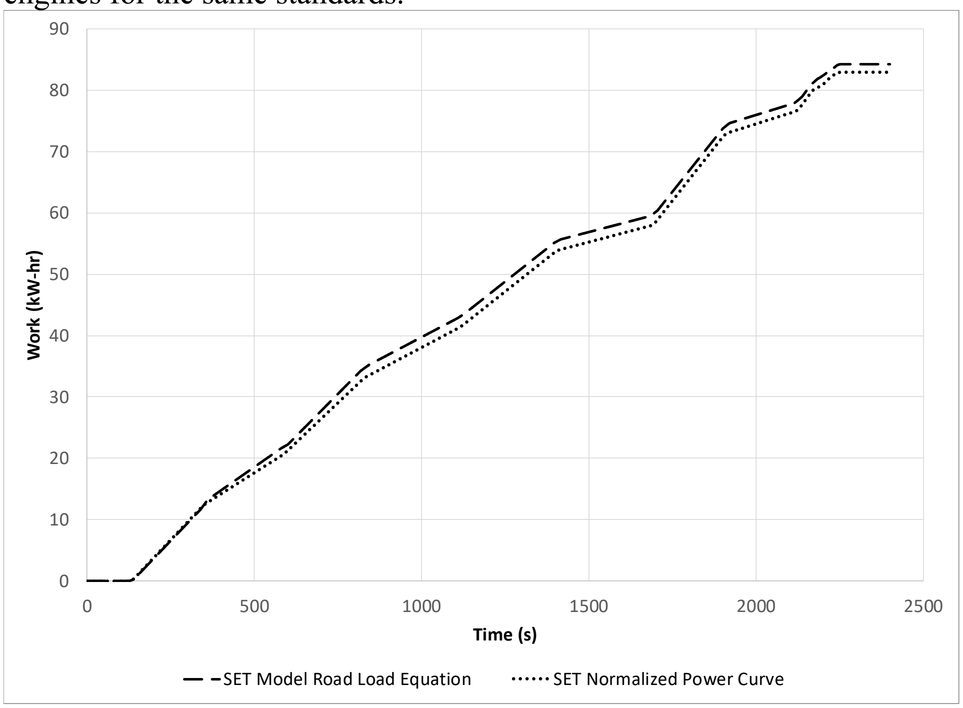

Figure II-5 Comparison of vSET work from the engine normalized power curve to the vehicle road load equation prior to code correction for a 300 kW engine.

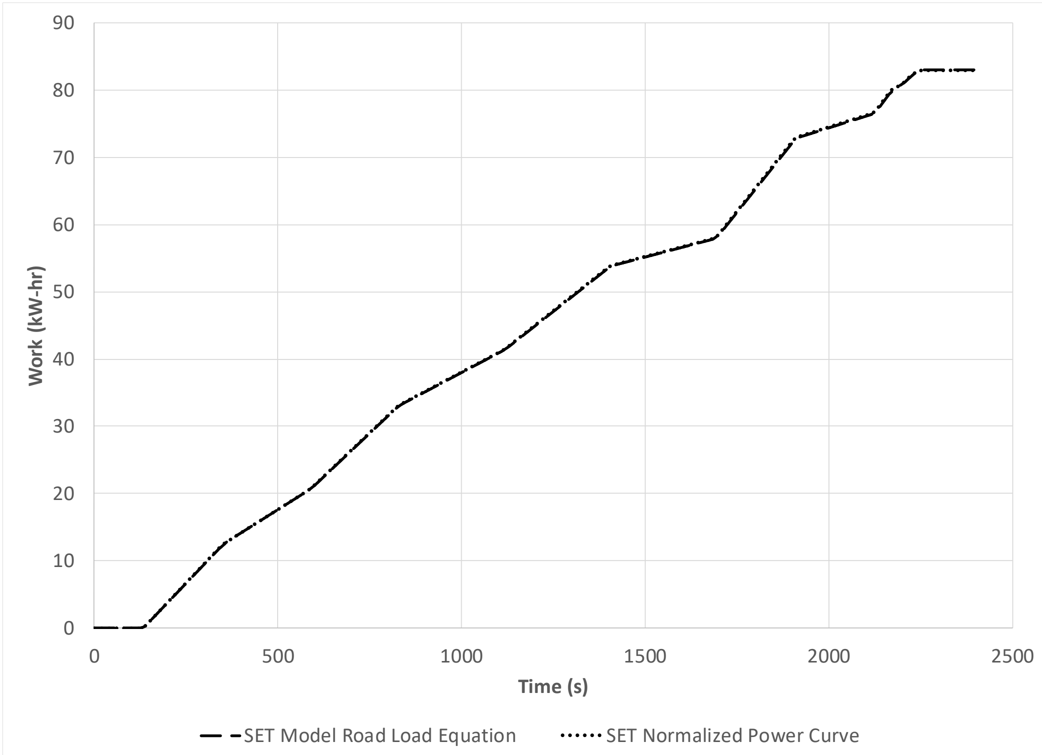

Figure II-6 Comparison of vSET work from the engine normalized power curve to the vehicle road load equation after code correction for a 300 kW engine.

b. Hybrid Test Procedures for Vehicle Standards

i. Hybrid Fuel Maps

We are finalizing an option, after consideration of comments received, to generate fuel maps for engine hybrids using the powertrain test procedure in 40 CFR 1037.550. This was done by updating the hybrid engine test procedures finalized in 40 CFR parts 1036.503, 1036.505, 1036.527, and 1037.550 and include the addition of a transmission model to GEM and options in GEM to test without the transmission present, using the model in its place.

ii. Mild Hybrid Certification

Under the Phase 2 regulations, manufacturers must conduct powertrain testing if they wish to take credit for hybrid systems, including mild hybrid systems. However, manufacturers have expressed concerns about the cost of powertrain testing and that the existing procedure may not measure improvements from certain mild hybrid systems. EPA requested comment on alternative means of evaluating mild hybrids noting that manufacturers have asked EPA to consider the following options:

- Allow manufacturers to test a powertrain and apply analytically derived scaling factors to others (e.g., scale by fraction of battery capacity or motor capacity) under 40 CFR 1037.235(h).
- Allow manufacturers to use international test procedures for battery capacity, motor power, and motor efficiency.

- Provide smaller credit (potentially with a volume limit and/or only for limited time) in exchange for less testing (e.g., reduced benefit when using the simplified model spreadsheet that is available under docket no. EPA-HQ-OAR-2014-0827-2109).

Commenters generally responded with support for EPA addressing mild hybrid certification but did not provide any concrete means to address concerns surrounding the cost of powertrain testing. In addition, commenters stated that the existing procedures in the proposal may not measure improvements from certain mild hybrid systems. This section presents the changes we are adopting to hybrid test procedures after consideration of comments received. Additional details on these and other hybrid test procedure amendments or clarifications requested by commenters and our responses are available in Chapter 2 of our Response to Comments.

After further consideration, including the lack of additional input on these mild-hybrid certification options, we have concluded that the engine hybrid test procedure proposed in this rule, is the best pathway for these hybrids. This will allow a manufacturer to test a mild hybrid engine without having to certify the hybrid with a transmission under the powertrain testing option. Finalizing these changes allows the test results to better reflect the performance of mild hybrid's that are not integrated into the transmission, without requiring that the transmission be part of the certified configuration. Finalizing this procedure also allows the test results to be used for additional appropriate vehicles, since the test results will not be limited to the transmission that was included during the test, as is required for non-hybrid powertrains utilizing 40 CFR 1037.550. This mild hybrid engine test procedure was finalize via additions to the hybrid powertrain test procedure revisions in 40 CFR parts 1036.503, 1036.505, 1036.510, 1036.527, and 1037.550 and includes the addition of a transmission model to GEM and options in GEM to test without the transmission present, using the model in its place.

B. Heavy-Duty Engine GHG Emission Standards and Flexibility

1. Revisions to Credit Provisions for Vocational Engine Emissions Standards

EPA proposed several updates to the credit provisions related to credit provisions for vocational engines and requested comment on these credit provisions (see 85 FR 28145). This section presents the changes we are adopting to vocational engine credit provisions after consideration of comment received. Additional details on comment on these credit provisions and our response are available in Chapter 2.4 of our Response to Comments.

In developing the baseline emission rates for vocational engines in the final Phase 2 rulemaking, we considered MY 2016 FTP certification data for diesel engines, which showed an unexpected step-change improvement in engine fuel consumption and CO_2 emissions compared to data considered in the proposed rule. The proposed baseline emission rates came from the Phase 1 standards, which in turn were derived from our estimates of emission rates for 2010 engines. The underlying reasons for this shift in the 2016 Phase 2 final rule were mostly related to manufacturers optimizing their SCR thermal management strategy over the FTP in ways that we (mistakenly) thought they already had in MY 2010 (i.e., the Phase 1 baseline).

As background, the FTP includes a cold-start, a hot-start and significant time spent at engine idle. During these portions of the FTP, the NOx SCR system can cool down and lose NOx reducing efficiency. To maintain SCR temperature, manufacturers initially used a simplistic strategy of burning extra fuel to heat the exhaust system. However, during the development of Phase 1, EPA believed manufacturers were using more sophisticated and efficient strategies to maintain SCR temperature. EPA's misunderstanding of the baseline technology for Phase 1 provided engine manufacturers the opportunity to generate windfall credits against the FTP standards.

For the Phase 2 final rule, EPA revised the baseline emission rate for vocational engines to reflect the actual certified emission levels. The Phase 2 vocational engine final CO_2 baseline emissions are shown in the table below. More detailed analyses on these Phase 2 baseline values of tractor and vocational vehicles can be found in Chapter 2.7.4 of the Phase 2 Final RIA.[16]

Table II-3 Phase 2 Vocational Engine CO_2 and Fuel Consumption Baseline Emissions

Units	HHD	MHD	LHD
g/bhp-hr	525	558	576
gal/100 bhp-hr	5.1572	5.4813	5.6582

EPA did not allow the carryover of Phase 1 vocational engine credits into the Phase 2 program, consistent with these adjustments to the baselines. Since this issue does not apply for RMC emissions, the restriction was applied only for engines certified exclusively to the FTP standards (rather than both FTP and RMC standards). We believed that allowing engine credits generated against the Phase 1 diesel FTP standards to be carried over into the Phase 2 program would have inappropriately diluted the Phase 2 engine program. However, this was in the context of unadjusted credits.

After further consideration, we now believe that it would not dilute the program if the credits were appropriately adjusted to more accurately reflect improvement over the true baseline levels.

Allowing the portion of the credits that represent actual emission improvements to be carried forward is consistent with our rationale from Phase 2. Thus, we are allowing in §1036.701(j), for the purpose of carrying Phase 1 credits into the Phase 2 program, and not compliance with Phase 1 standards, that manufacturers may recalculate the credits in their initial Phase 1 ABT vocational engine averaging set relative to the Phase 2 baseline engine values. The recalculated vocational engine credits for an ABT averaging set will be allowed into the Phase 2 engine program to the same extent as tractor engine credits. Cummins submitted a late comment (see Docket ID EPA-HQ-OAR-2019-0307-0066) requesting clarification of whether manufacturers would have the option of applying these vocational carryover provisions to one ABT averaging set but not another (i.e. that EPA would not require the recalculation of all averaging sets.) This final rule affirms that recalculation of vocational credits is to be applied to all engines within an individual ABT averaging set and that other averaging sets, such as tractors, are not affected by these vocational carryover provisions. EMA commented that manufacturers should be able to opt in to recalculating credits on an engine family by engine family basis, as applying this adjustment to all engine families could affect existing Phase 1 compliance for engines above the Phase 2 baseline value. However, EPA is only allowing this recalculation for the purpose of determining the amount of credit that can be carried into the Phase 2 program, and adjusting the credits for all the engine families a manufacturer chose to include in their initial ABT averaging set for Phase 1 program properly accounts for the net credits that can be carried forward. In the ABT program, all engine families within an averaging set are used in the calculation of credits, and manufacturers cannot pick and choose which engine families are used in that calculation.

[16] US EPA, US DOT/NHTSA. Greenhouse Gas Emissions and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles -Phase 2: Regulatory Impact Analysis, August 2016, EPA-420-R-16-900. See p. 2-76.

As noted in the Phase 2 final rule, allowing additional flexibility for compliance with engine standards does not cause any increase in emissions because the manufacturers must still comply with the vehicle standards (See 81 FR 73499, October 25, 2016). However, this flexibility could allow some manufacturers to find a less expensive compliance path.

2. Special Flexibility for Vocational Engines and Credits

EPA requested comment on several updates to the special flexibility provisions for vocational engines (see 85 FR 28145). This section presents the regulatory changes we are adopting after consideration of comments received. Additional details on comments received on these provisions and our responses are available in Chapter 2.4 of our Response to Comments.

In the existing regulations at 40 CFR 1036.150(p), EPA provided special flexibility for engine manufacturers that certify all their model year 2020 engines within an averaging set to the model year 2021 FTP and SET standards and requirements. Where 40 CFR 1036.150(p) applies, subparagraph (p)(1) specifies that GHG emission credits that manufacturers generate with model year 2018 through 2024 engines may be used through model year 2030, instead of being limited to a five-year credit life as specified in 40 CFR 1036.740(d). Note that under the Phase 2 final rule this provision in effect only applies to manufacturers of tractor engines, as under 40 CFR 1036.701(j) EPA did not allow the carryover of Phase 1 vocational engine credits into the Phase 2 program (81 FR 73499, October 25, 2016). Where 40 CFR 1036.150(p) applies, subparagraph (p)(2) specifies that manufacturers are also allowed to certify model year 2024 through 2026 tractor engines to alternative standards that are slightly higher than the otherwise applicable standards. Note that in the table of alternative standards in the Phase 2 final rule EPA included values for medium and heavy heavy-duty vocational engines, but these values are identical to the Phase 2 standards and not slightly higher due to our concerns about windfall credits if carryover of Phase 1 credits were allowed.

The applicability of 40 CFR 1036.150(p) is based on the choices manufacturers made when certifying their MY 2020 engines. Instead of certifying engines to the final year of the Phase 1 engine standards, manufacturers electing the alternative instead certified to the MY 2021 Phase 2 engine standards. Because these engine manufacturers reduced emissions of engines that would otherwise have been subject to the more lenient MY 2020 Phase 1 engine standards, there can be a net benefit to the environment. These engines do not generate credits relative to the Phase 1 standards but instead generate credits relative to the pulled ahead MY 2021 Phase 2 engine standards. Because the vehicle standards themselves are unaffected, the alternative MY 2024-2026 engine standards will not dilute or diminish the overall GHG reductions or fuel savings of the program. Vehicle manufacturers using engines subject to the alternative MY 2024–2026 standards would need to adopt additional vehicle technology (i.e., technology beyond that projected to be needed to meet the engine standards) to meet the applicable vehicle GHG standards. The result is that the vehicles would still achieve the same GHG emissions in use.

The proposed rule included an amendment to address the concern regarding Phase 1 windfall credits and requested comment on the possibility of a similar set of alternative standards for vocational engines. CARB and Volvo commented that they support these changes and flexibilities. Cummins commented opposing both the alternative MY 2024 through 2026 vocational engine standards and extending the life of credits generated from early compliance with Phase 2 vocational standards. ACEEE commented opposing extending the life of vocational engine credits generated in Phase 1, stating that doing so does not result in emission reductions but would increase emissions and reduce the rule's overall stringency. Cummins also commented that manufacturers had already developed and certified MY 2020 products without consideration of these changes, and even if post hoc recertification was possible, allowing them now would potentially be an advantage or disadvantage to individual manufacturers.

As discussed in section II.B.1, we are finalizing provisions on calculating credits relative to a baseline that addresses these windfall credit concerns, which also results in the extended credit life flexibility under 40 CFR 1036.150(p)(1) now being available to vocational vehicles that qualify under 40 CFR 1036.150(p). We are also finalizing a set of alternative standards for vocational engines, as shown in Table II-4.

Table II-4 Alternative Standards for Vocational Engines

Model Years	Medium Heavy-Duty Vocational (g/hp-hr)	Heavy Heavy-Duty Vocational (g/hp-hr)
2024-2026	542	510

The Phase 2 standards are implemented in three MY steps: 2021, 2024, and 2027. The largest step change in stringency occurs in MY 2024, where approximately two-thirds of the total numeric reduction in the MY 2021 through MY 2027 standards is achieved, with the remaining one-third occurring in MY 2027. For the alternative tractor engine standards, EPA reversed the magnitude of the MY 2024 and MY 2027 step changes, where the MY 2024 alternative standard represents one-third of the total numeric reduction and is slightly higher than the Phase 2 standard. The standards at the beginning (MY 2021) and ending (MY 2027) steps of the Phase 2 program remain the same in either case, and only the level of decrease in standard for MY 2024 changes with the alternative standards. EPA determined the alternative standards for vocational engines by adjusting the magnitude of the MY 2024 standard in the same manner as used to determine the alternative tractor engine standards in the Phase 2. The Phase 2 vocational engine standards decrease by 10 g/hp-hr between MY 2021 and MY 2027, with a 7 g/hp-hr step change in the MY 2024 standard (approximately two-thirds of the total numeric reduction) and a 3 g/hp-hr step change in MY 2027. For the alternative vocational engine standards in MY 2024-2026, we are adopting a 3 g/hp-hr reduction from the MY 2021 standard (from 545 to 542 g/hp-hr for medium heavy-duty and 513 to 510 g/hp-hr for heavy heavy-duty) instead of 7 g/hp-hr. EPA believes that allowing these slightly higher (approximately 0.7 to 0.8 % compared to the Phase 2 final rule) engine standards for vocational vehicles is justified, as the overall vehicle standards will still be met. Engine development and vehicle technology choices are pathways to meeting overall vehicle standards, as is the use of credits generated by early compliance. EPA's alternative engine standards provisions for vocational vehicles for MYs 2024-2026 allows manufacturers flexibility to choose the mix of engine and vehicle technologies that will comply with the standards. As noted in the Phase 2 final rule and this rule's proposal, EPA views this type of alternative as being positive from the environmental and energy conservation perspectives, as vehicle-level emission standards remain the same, but manufacturers are provided with significant flexibility on engine emission standards and credit life provisions that may reduce their compliance costs

Regarding the adverse comments received, including whether or not manufacturers had the opportunity to consider these changes prior to MY 2020, these changes correspond to the corrected approach to Phase 1 credit calculations explained in Section II.B.1 above. At the time of the Phase 2 final rule, we believed that allowing Phase 1 vocational engine credits, without adjustment, to be carried over to the Phase 2 program would result in "windfall" credits, or dilution of the benefits of the Phase 2 program, and we adopted restrictions to limit their use.

However, after the Phase 2 final rule we recognized that an alternative to restricting Phase 1 vocational engine credits because of windfall concerns would be to adjust credits earned in Phase 1 downward, relative to a baseline of the lower Phase 2 emissions standards, and in doing so, we would be extending to vocational engine manufactures the same flexibilities that were provided to tractor engine manufacturers. In this final rule we are allowing the vocational engine credits generated in Phase 1 to be adjusted downward and used in Phase 2 program through MY 2030, just as they were for tractors. In setting lower baseline emission values for Phase 1 vocational engine credits and providing the corresponding program flexibilities, EPA does not intend to advantage or disadvantage any manufacturer. Rather, we are removing restrictions that were applied only to vocational engines but no longer should be applied now that we are finalizing provisions that provide a proper accounting of the emission improvements realized by manufacturers who chose to certify their MY 2020 engines to the MY 2021 Phase 2 standards, so vocational and tractor engines are treated the same. In addition, the revised MY 2024-2026 alternative standards for vocational engines, while slightly higher than those in the Phase 2 final rule by 0.7 to 0.8 %, do not reduce the overall stringency of the Phase 2 program, but instead reflect the alternative standards we would have adopted in the Phase 2 final rule alongside the similar tractor provisions, and for the same reasons we finalized those tractor provisions, had we considered adjusting baseline emission rates used for calculating Phase 1 credits. Manufacturers that qualify to use the alternative MYs 2024–2026 engine standards accelerated their compliance with the more stringent MY 2021 Phase 2 standards by one model year. As we explained in the Phase 2 final rule, because the vehicle standards themselves are unaffected, these alternative engine standards will not dilute or diminish the overall GHG reductions or fuel savings of the program. Vehicle manufacturers using engines subject to the alternative MYs 2024–2026 standards will need to adopt additional vehicle technology (i.e., technology beyond that projected to be needed to meet the engine standard) to meet the applicable vehicle GHG standards. The result is that the vehicles using engines that comply with the alternative standards will still achieve the same overall GHG emissions in use. EPA believes that these alternative standards are appropriate, and allowing alternative engine standards for vocational vehicles that qualify is justified, for these reasons, and that vocational engine manufacturers who met the Phase 2 engine standards one year in advance of the MY 2021 implementation date should have the same flexibility as tractors to earn and use those credits through MY 2030.

3. Confirmatory Testing of Engines and Measurement Variability

EPA proposed updates to the procedure for confirmatory testing of the fuel mapping test procedure related to providing an interim 2% allowance during confirmatory testing of the fuel mapping test procedure finalized in the Phase 2 final rule and requested comment on "…whether it appropriately balances the impacts of testing variability for fuel maps" (see 85 FR 28146, May 12, 2020). This section presents the changes we are adopting to the confirmatory testing portion of the fuel mapping test procedure after consideration of comments received. Additional details on these comments and our responses are available in Chapter 2 of our Response to Comments.

During the Phase 2 rulemaking, manufacturers raised concern about measurement variability impacting the stringency of the engine GHG standards and fuel map requirements. As noted in the Phase 2 final rule, the final standards were developed to account for this. (81 FR 73571, October 25, 2016). Manufacturers raised particular concern about variability of fuel map measurements because neither they nor EPA had sufficient experience measuring fuel maps (in a regulatory context) to fully understand the potential impacts of measurement variability. We estimated the fuel map uncertainty to be equivalent to the uncertainty associated with measuring

CO_2 emissions and fuel consumption over the FTP and SET cycles, which we estimated to be about one percent. However, the Phase 2 final rule noted that we were incorporating test procedure improvements that would further reduce test result uncertainty. We also noted that "[i]f we determine in the future . . . that the +1.0 percent we factored into our stringency analysis was inappropriately low or high, we will promulgate technical amendments to the regulations to address any inappropriate impact this +1.0 percent had on the stringency of the engine and vehicle standards." (81 FR 73571, October 25, 2016)

In conjunction with this intention, EPA has worked with engine manufacturers to better understand the variability of measuring fuel maps using the test procedures and cycles specified by EPA in the Phase 2 final rule. Through that work, we identified several sources of variability that can be reduced by making small changes to the test procedures. EPA is adopting these changes, as explained in Sections II.A.1 through II.A.3 of this final rule.

SwRI performed emission measurements in multiple test cells and identified distributions of error for other test inputs such as measured fuel properties and calibration gas concentrations. SwRI then used a Monte Carlo simulation to estimate a distribution of errors in measured fuel maps.[17] After reviewing the results, EPA had several significant observations which we discussed in the proposal for this final rule and which EPA confirms in this final action:

1. The variability of measuring CO_2 and fuel consumption during fuel mapping is greater than the one percent assumed in the Phase 2 final rule. Variability from vehicles without idle test cycles is < 1.8% (1.68 to 1.8%), while variability from vehicles with idle test cycles is < 2.8% (2.0 to 2.79%).
2. The variability of measuring CO_2 and fuel consumption during the fuel mapping procedure is roughly the same as that of the FTP and SET cycles, 3.34% for the FTP and 1.99% for the SET.
3. Measuring CO_2 and fuel consumption at idle is particularly challenging.
4. The data obtained during the test program at SwRI did not include all the test procedure changes being adopted in 40 CFR parts 1036 and 1037 that will further reduce fuel mapping test variability and therefore the variability is likely to be lower than reported by the SwRI.

Manufacturers have indicated they are concerned about the possibility of EPA changing an official fuel map result as a consequence of EPA confirmatory testing where the measured maps were within an expected range of variability. In the context of the SwRI test program, EPA observed similarity between the range of variability of measuring fuel maps and the range of variability of measuring CO_2 and fuel consumption over the FTP and SET cycles (measurements for which EPA has already determined in both Phase 1 and Phase 2 that no such allowances are needed). These results indicate that there is no additional source of increased variability associated with the fuel mapping test procedure and suggest that manufacturers should be able to comply without any special provisions. Additionally, the data we have available indicates that the manufacturers may potentially over time be able to take advantage of the 2% allowance, resulting in a reduction in stringency of the standards. We anticipate that this would not happen over the next few model years, as manufacturers will need time to implement the revised test procedures adopted in this rule that will reduce the variability of the fuel map test procedure to levels at or below the variability of the FTP and SET test procedures.

[17] Sharp, Christopher A., et al., "Measurement Variability Assessment of the GHG Phase 2 Fuel Mapping Procedure", Southwest Research Institute, Final Report, December 2019.

After considering the comments received, we are adopting the limited transitional approach aimed at addressing the manufacturers' variability concerns. As manufacturers implement this rule's revised test procedures to reduce variability, we will analyze and compare a manufacturer's declared and measured fuel maps to those that result from our confirmatory testing, with the goal of ensuring the long-term integrity of the Phase 2 program. We are codifying the interim provision for model years 2021 and later in 40 CFR 1036.150, under which EPA will not replace a manufacturer's fuel maps during confirmatory testing if the difference between the EPA-measured fuel maps and the manufacturer's declared maps is less than or equal to 2.0 percent. We may revisit the interim 2% allowance in a future rulemaking.

EPA also intends to further review data and developments in this area. We intend to review this provision as we learn more about the impact of measurement variability on measured and declared fuel maps submitted during the certification process for future model years (including the full impact of the test procedure improvements that are intended to reduce measurement variability), which may inform whether we determine additional action is warranted in the future with respect to fuel mapping variability. We also intend to enter into a round robin study of criteria and GHG pollutant engine testing variability with interested engine manufacturers, with the involvement of the Truck and Engine Manufacturer's Emission Measurement and Testing Committee. This data will add to the existing knowledge regarding the variability of the FTP, SET and fuel mapping test procedures and may help inform if future action is needed to further improve the test procedures.

We are also finalizing an algorithm for comparing fuel maps. Because fuel maps are multi-point surfaces instead of single values, it would be a common occurrence that some of EPA's points would be higher than the manufacturer's while others would be lower. This algorithm was inadvertently proposed as an interim provision in 40 CFR 1036.150(q) along with the 2.0 percent variability allowance. The algorithm and fuel map comparison process during a confirmatory test is needed for confirmatory testing regardless of an allowance. Therefore, in this final rule the algorithm and all supporting text are located at 40 CFR 1036.235(c)(5). The limited interim 2.0 percent variability allowance is located at 40 CFR 1036.150(q).

EPA's measured fuel maps will be used with GEM according to 40 CFR 1036.540 to generate emission duty cycles which simulate several different vehicle configurations, generating emission results for each of the vehicles for each of the duty cycles. Each individual duty cycle result will be weighted using the appropriate vehicle category weighting factors in Table 1 of 40 CFR 1037.510 to determine a composite CO_2 emission value for that vehicle configuration. Note that the equation is being finalized to use values before rounding as this is consistent with the provisions in 40 CFR 1065.20 to not round intermediate values. When the process is repeated for the manufacturer's fuel maps, the average percent difference between fuel maps will be calculated as:

Equation II-3

$$difference = \left(\frac{\sum_{i=1}^{N} \frac{e_{\mathrm{CO2compEPA}i} - e_{\mathrm{CO2compManu}i}}{e_{\mathrm{CO2compManu}i}}}{N} \right) \cdot 100\ \%$$

Where:

i = an indexing variable that represents one individual weighted duty cycle result for a vehicle configuration.

N = total number of vehicle configurations.

$e_{CO2compEPAi}$ = unrounded composite mass of CO_2 emissions in g/ton-mile for the EPA confirmatory test.
$e_{CO2compManu}$ = unrounded composite mass of CO_2 emissions in g/ton-mile for the manufacturer declared map.

4. Other Minor Heavy-Duty Engine Amendments

EPA proposed three additional updates to the testing and measurement provisions of 40 CFR part 1036, related to measuring emissions from heavy-duty engines and requested comment on general improvements to the engine test procedures and compliance provisions (see 85 FR 28147). This section presents these three additional changes we are adopting to engine test procedures. Additional details on these and other engine testing and measurement amendments or clarifications requested by commenters and our responses are available in Chapter 2 of the Response to Comments.

- *Correcting the assigned N_2O deterioration factor in §1036.150(g)*. In the Phase 2 proposed rule, EPA proposed to lower the N_2O standard from 0.10 g/hp-hr to 0.05 g/hp-hr for model year 2021 and later diesel engines. In that context, we also proposed to lower the assigned deterioration factor (DF) from 0.020 g/hp-hr to 0.010 g/hp-hr for model year 2021 and later diesel engines. EPA explained in the preamble to the Phase 2 final rule that we were not finalizing the change to the standard (81 FR 73530, October 25, 2016), but inadvertently finalized the proposed DF change in the regulations. We proposed in this rulemaking to correct this error, consistent with EPA's clear statement in the Phase 2 final rule that we were not finalizing the change to the standard. However, given that finalizing the assigned DF of 0.01 g/hp-hr for N_2O in the regulations was an oversight on EPA's part in the Phase 2 final rule and that the Phase 2 final rule was inadvertently internally inconsistent, and after consideration of EMA's comment that manufacturers will not have time to correct or account for a change in the assigned DF in time for their MY 2021 certifications, we are deferring changing the assigned DF to 0.02 g/hp-hr until MY 2022 within the revisions finalized in this rulemaking.
- *Clarifying a reference to non-gasoline engine families in §1036.705(b)(5)*. The second sentence of §1036.705(b)(5) is intended to refer to non-gasoline engine families. However, the existing text is not clear. As written, it can be read to mean that gasoline engine families may not generate emission credits. EPA is adding "non-gasoline" to clarify the intended meaning.
- *Engine families.* We are revising §1036.230 to allow engine families to be divided into subfamilies with respect to CO_2. This allowance simplifies the certification process without changing the overall requirements.
- *Adding a summary of previously applicable emission standards as Appendix I of part 1036*. The new Appendix is being provided for reference purposes only regarding previously applicable emission standards and will cover regulatory text being deleted from 40 CFR part 86.

Except as noted above, we received no adverse comments on these proposed amendments and are adopting them without modification.

C. Heavy-Duty Vehicle GHG Emission Standards and Flexibility

1. Aerodynamic Compliance Provisions

In addition to the aerodynamic test procedure amendments described in Section II.A.6, we proposed several updates to §1037.150(s) as it relates to EPA's confirmatory testing of aerodynamic parameters and §1037.305 as it relates to our selective enforcement audit (SEA) procedures. We also requested comment on general improvements to the aerodynamic compliance provisions (see 85 FR 28147). This section presents the changes we are adopting to our confirmatory testing and SEA procedures after consideration of comments received. Additional details on these and other aerodynamic amendments or clarifications requested by commenters and our responses are available in Chapter 2 of our Response to Comments.

a. Confirmatory Testing for $F_{alt\text{-}aero}$

As described in 40 CFR 1037.235(c), EPA may perform confirmatory testing on a manufacturer's vehicles, including a vehicle tested to establish the $F_{alt\text{-}aero}$ value. The regulations also include an interim provision in §1037.150(s) that outlines how EPA may and when EPA will not replace a manufacturer's $F_{alt\text{-}aero}$ value based on confirmatory test results. This interim provision connects EPA's confirmatory testing to the audit procedures of §1037.305. In keeping with the principle that good engineering judgment[18] would generally call for more data rather than selecting a single value, and after consideration of comment, EPA is finalizing our proposed provision to require EPA to perform a minimum of 100 valid runs before replacing a manufacturer's $F_{alt\text{-}aero}$ value in confirmatory testing with some additional clarifications in §1037.150(s).

CARB commented in support of increasing the number of runs from SEA to 100 to limit false failures, but requested in comment to know the origin of the proposed minimum 100 valid runs for confirmatory testing. Our intent with the finalized requirement for 100 valid confirmatory runs is to maintain consistency with the existing regulatory language adopted in the Phase 2 final rulemaking for SEA testing. The existing §1037.305(a)(7)(iii) states: "The vehicle passes if you perform 100 coastdown runs and $C_dA_{wa\text{-}upper}$ is greater than and $C_dA_{wa\text{-}lower}$ is lower than the upper limit of the bin to which you certified the vehicle." Similarly, as noted below in Section II.C.1.b, we are also finalizing our corresponding proposed language in the audit procedures of §1037.305(a)(5) clarifying that manufacturers must perform a minimum of 24 runs to pass and a minimum of 100 runs to fail.

EMA requested additional modifications to §1037.150(s) regarding EPA's approach to calculating a new $F_{alt\text{-}aero}$ value in confirmatory testing. EMA suggested that the regulation more explicitly connect to the SEA procedures for pass/fail criteria and the coastdown procedures for calculating $F_{alt\text{-}aero}$. They also suggested we directly outline how EPA will replace a manufacturer's $F_{alt\text{-}aero}$. EMA suggested that EPA calculate two $F_{alt\text{-}aero}$ values and apply the average of those values to replace a manufacturer's value. We agree with EMA's suggestions to clarify the connections to the SEA procedures of §1037.305 and the coastdown test procedures of §1037.528 and we updated §1037.150(s) accordingly. While we generally agree that additional data is preferable, we are not committing to calculating multiple $F_{alt\text{-}aero}$ values, as requested by EMA, due to consideration of potential resource constraints; however, we have revised the regulatory language to allow for it. We also are not finalizing an approach to calculate the final $F_{alt\text{-}aero}$ when there are multiple values. Our revised §1037.150(s) states that

[18] Good engineering judgment is defined in 40 CFR 1068.30 as judgments made consistent with generally accepted scientific and engineering principles and all available relevant information. See 40 CFR 1068.5 for requirements regarding applying good engineering judgment.

EPA will "will generate a replacement value of $F_{alt\text{-}aero}$ based on *at least one* C_dA value and corresponding effective yaw angle".

Additionally, as noted in the proposal regarding §1037.150(s), we recognize that test conditions for coastdown testing are an important consideration. For our confirmatory testing, EPA intends to minimize the differences between our test conditions and those of the manufacturer and we proposed a note in §1037.150(s) stating our intent to test at similar times of the year. EMA requested additional regulatory language regarding our intent to test at the same location as well as time of year. We are expanding our proposed note in §1037.150(s) to include our intent to test at both the same time of year and the same location, subject to certain considerations. More specifically, we emphasize that the note in §1037.150(s) is not a commitment by the agency due to the limited number of coastdown test facilities, the challenges of scheduling time for testing, and our prerogative to choose an alternative facility if we have concerns about the original test location. Our revised language in §1037.150(s) states that we intend to test "at similar times of the year where possible and at the same location where possible and when appropriate."

b. Selective Enforcement Audits for Tractors

We proposed and received no adverse comments to three typographical edits to our aerodynamic testing audit procedures for tractors in §1037.305. We are finalizing those three edits as proposed and additional editorial edits as follows:

- §1037.305 – Replaced reference to 40 CFR 1068.420 with the range "40 CFR 1068.415 through 1068.425" as proposed.
- §1037.305(a) – Rephrased "whether or not a tractor fails to meet" to the more concise "whether a tractor meets".
- §1037.305(a)(2) – Corrected "coastdown effective" to "coastdown effective yaw angle" as proposed.
- §1037.305(a)(7) – Added a missing "m^2" following the bin value of 5.95 in the example as proposed. Editorial revisions to remove passive voice.

In comment, EMA suggested additional revisions to §1037.305(a) allowing manufacturers to apply good engineering judgment in their selective enforcement audit (SEA) testing if a production vehicle could not be configured to meet the trailer height specified in §1037.501(g)(1)(i). We accept that a future production vehicle may be designed such that it cannot be configured to match a trailer that meets our current definition of standard trailer. We are finalizing a broader revision to address all such scenarios where a production vehicle cannot be configured to match a trailer that meets our current definition of standard trailer, including but not limited to height, that will address EMA's specific concern with meeting the standard trailer's height requirements. We are adding language to clarify that a manufacturer may seek EPA approval to use an alternate or modified vehicle configuration, consistent with good engineering judgment, if EPA chooses to audit a production vehicle configuration that cannot meet any of the standard trailer requirements specified in §1037.501(g)(1).

As noted in Section II.C.1.a, we proposed and are finalizing a provision in §1037.150(s) to require EPA to perform a minimum of 100 valid runs before replacing a manufacturer's $F_{alt\text{-}aero}$ value in confirmatory testing. Similarly, we are finalizing our corresponding proposed language in the audit procedures of §1037.305(a)(5) clarifying that manufacturers must perform a minimum of 24 runs to pass and a minimum of 100 runs to fail. Finally, we received no adverse comments and are finalizing the proposed regulatory language in §1037.305(a)(7)(v) allowing manufacturers to continue testing and to generate additional data that EPA may consider in our pass/fail determinations.

2. Idle Reduction Technologies

EPA proposed several provisions related to idle reduction technologies. This section presents the changes we are adopting after consideration of the comments received. See Chapter 2 of our Response to Comments for further details, including additional idle reduction amendments or clarifications requested by commenters and our responses.

a. Extended-Idle Reduction for Tractors

The Phase 1 version of GEM gives credit for extended idle emission reduction technologies that include a tamper-proof automatic engine shutoff system (AESS), with few override provisions. Phase 2 GEM gives credit for a wider variety of idle reduction strategies, recognizing technologies that are available on the market today, such as auxiliary power units (APUs), diesel fired heaters, and battery powered units. For example, a tamper-proof AESS with a diesel APU would be credited with a 4 percent reduction in emissions, while an adjustable AESS with a diesel fired heater would be credited with a 2 percent reduction in emissions (81 FR 73601, October 25, 2016).

Our proposal to revise §1037.520(j)(4) to include GEM input values for combinations of these technologies received support from CARB, EMA, and Volvo and we are finalizing our proposed combinations of idle reduction technologies as shown in Table II-5. Adding these values to GEM reduces the compliance burden for manufacturers who would otherwise need to apply for off-cycle credits for these technology combinations. The values of these technology benefits were determined using the same methodology used in the Phase 2 final rule.

Table II-5 GEM Input Values For AES Systems

Technology	**GEM Input Values**	
	Adjustable	**Tamper-resistant**
Standard AES system	1	4
With diesel APU	3	4
With battery APU	5	6
With automatic stop-start	3	3
With fuel-operated heater (FOH)	2	3
With diesel APU and FOH	4	5
With battery APU and FOH	5	6
With stop-start and FOH	4	5

b. Idle Reduction Overrides

In 40 CFR 1037.660, we identify three idle reduction technologies (i.e., automatic engine shutdown, neutral idle, and stop-start) and specify how these systems must operate to qualify for

GEM credit. Included among those provisions are allowances for overriding these systems where it may damage the engine or create a safety issue for the vehicle occupants or service personnel. This section highlights the some of the idle reduction override provisions we are adopting, either as proposed or further revisions after consideration of comments received.

i. Automatic Engine Shutdown (AES) Overrides

While we did not specifically propose or request comment on AES overrides, New Flyer (a bus manufacturer) commented that the override condition for AES systems during servicing in §1037.660(b)(1)(ii) (cross-referenced under the existing regulations for vocational vehicles in §1037.660(b)(2)(i)) could pose a safety risk to maintenance personnel. They stated that maintenance personnel may not have a diagnostic scan tool required to deactivate the system and some maintenance may require longer than the current 60-minute limit before reactivation. New Flyer suggested an "open engine compartment" would be a more appropriate override condition.

After consideration of New Flyer's safety concern for vocational vehicles, we are revising §1037.660(b)(2) to allow a vocational vehicle's AES system to delay shutdown if necessary while servicing the vehicle without the scan tool requirement and time limit. Our final revision removes the cross-reference in §1037.660(b)(2)(i) to that particular provision in §1037.660(b)(1) and replaces it with a new provision in §1037.660(b)(2)(ii). Our new provision allows a delay in shutdown for vocational vehicles if the engine compartment is open and replaces the regulatory text regarding unsafe cab temperatures in the current paragraph §1037.660(b)(2)(ii), which is redundant with the existing cross-reference to paragraph (b)(1) in (b)(2)(i). For vocational vehicles, we believe an open engine compartment sufficiently indicates that a vocational vehicle is being serviced and automatic engine shutdown would provide limited environmental benefit. We are not taking final action to revise the tractor-specific provision of §1037.660(b)(1)(ii) to allow an open engine compartment as a condition for AES override, since the environmental benefits of AES on tractors occurs when these vehicles are parked for extended durations where an open engine compartment may not be a sufficient deterrent for the operator to circumvent the AES.[19]

We are finalizing editorial revisions to §1037.660(b) so the paragraphs consistently begin with "When". Additionally, we reordered the paragraphs of §1037.660(b)(1) to move the servicing provision previously located at §1037.660(b)(1)(ii) to paragraph (b)(1)(vi) such that the vocational vehicle AES provisions can continue to reference the range of relevant (b)(1) paragraphs in paragraph (b)(2)(i).

ii. Neutral Idle Overrides

EPA proposed and is finalizing a provision in §1037.660(b)(3)(ii) that would allow the neutral idle system to delay shifting the transmission into neutral if the transmission is in reverse gear (85 FR 28271, May 12, 2020). New Flyer requested an additional override when the vehicles is on a road grade of 6.0 percent or more to prevent the safety concern of vehicle rollback. EPA agrees with this safety concern and is finalizing a provision in §1037.660(b)(3)(iii) to allow a delay in neutral idle when the vehicle is on a grade greater than or equal to 6.0 percent. EMA requested additional overrides for "safety; thermal protection of the emissions aftertreatment; and maintenance of aftertreatment temperature within a range for adequate emissions control". EPA is not adopting EMA's suggested override conditions as we do not think that they would

[19] Tractor manufacturers have the option to request and we may approve additional override criteria as needed to protect the engine and vehicle from damage and to ensure safe vehicle operation, as stated in §1037.660(b).

likely be appropriate without more specific criteria. Manufacturers continue to have the option to justify the need for additional overrides for their individual systems and seek EPA approval through §1037.660(b).

iii. Stop-Start Overrides

We requested comment on a specific list of override conditions for stop-start systems (85 FR 28151, May 12, 2020). CARB expressed concern that additional overrides may compromise emissions and requested a requirement that manufacturers bring their proposed overrides to EPA for approval. We are not requiring a "case-by-case" approval process for these overrides, as suggested by CARB, but we note that, in the certification application provisions of §1037.205(b)(5), manufacturers are required to include a description of their idle reduction technology, including the override conditions of §1037.660. We believe this continues to be an appropriate level of oversight for these idle technologies and their associated override conditions.

EMA and New Flyer supported the inclusion of all override conditions listed in the proposed rule for comment, but their comments did not expand on the need for any of the individual conditions to be adopted. Each commenter requested additional override conditions and included the rationale for those requests. Our final revisions to §1037.660(b)(4) cross-reference the provisions for vocational vehicle AES (paragraph (b)(2)) and neutral idle (paragraphs (3)(ii) and (iii)) such that the new open engine compartment, reverse gear, and road grade provisions for those systems also apply for stop-start systems. EPA considered the original list and the commenters' additional suggested override conditions and we are adopting the following additional override criteria specific to stop-start systems to ensure safety and/or effective system operation as noted in §1037.660(b)(4):

- When the steering angle is at or near the limit of travel to avoid steering wheel kickback during engine start.
- When a wheel speed sensor failure may prevent the anti-lock braking system from detecting vehicle speed.
- When an automatic transmission is in "park" or in "neutral" with the parking brake engaged because the feature is intended to be used during driving operation.
- When a component failure protection mode is active, such as starter motor overheating, which may prevent the engine from restarting.
- When a fault is active on a system component needed to start the engine, which may prevent the engine from restarting.
- When the flow of diesel exhaust fluid is limited due to freezing, because an engine-off condition may further delay thawing and SCR operation.

It was not clear that the remaining override conditions suggested by commenters or presented for comment in the proposed rule pose a widespread concern for safety, vehicle operation, or serviceability, or could not be easily overridden by the driver, and we are not adopting those overrides in our final revisions. However, manufacturers continue to have the option to seek EPA approval for these or additional criteria they believe are needed to protect the engine and vehicle from damage and to ensure safe vehicle operation (see §1037.660(b)).

3. Weight Reduction

EPA proposed minor revisions to the weight reduction provisions (see 85 FR 28150). This section presents the changes we are adopting after consideration of comments received. See

Chapter 2 of our Response to Comments for additional details on some of these amendments, including other amendments or clarifications requested by commenters and our responses.

The regulations in 40 CFR 1037.520 include tables to calculate weight reduction values for using certain lightweight components. The sum of the weight reductions is used as an input to GEM. As noted in Section II.A.2, EPA proposed two changes to Table 8 of that section allowing manufacturers to use the heavy heavy-duty (HHD) values for medium heavy-duty (MHD) vehicles with three axles (i.e., 6x4 and 6x2 configurations) and adding a footnote to the table to clarify that the weight reduction values apply per vehicle (instead of per component) unless otherwise noted. We received no adverse comments to the proposed updates to Table 8 and we are finalizing the two changes.

We received comment from EMA requesting "a process for adding in other weight-savings technologies". As described in §1037.520(e)(5), this process is available in the existing off-cycle provisions of §1037.610 and no further action is needed or being finalized in this rule. EMA also requested clarification on the origin of certain weight reduction values for tires and recommended use of a "base" value for comparison. We note that all the values in Table 6 through Table 8 of §1037.520 were developed through notice and comment in the HD Greenhouse Gas Emissions Phase 1 and Phase 2 rulemakings based on information as described in the Regulatory Impact Analysis for the rules. We did not propose changes to the weight reduction tables and are not taking any final action at this time to update values to refer to a base weight, but manufacturers continue to have the ability to apply through our off-cycle process.

4. Self-contained air conditioning units.

We proposed a revision to §1037.115(e) to clarify that it is "intended to address air conditioning systems for which the primary purpose is to cool the driver compartment (85 FR 28151). This would generally include all complete pickups and vans, but not self-contained air conditioning or refrigeration units on vocational vehicles." CARB and New Flyer requested additional clarification on the phrase "self-contained". After consideration of submitted comments, we are finalizing a modified version of the proposed changes to §1037.115(e)(1) that incorporates some of the feedback from commenters. We are maintaining the proposed statement that this provision is intended for A/C systems that cool the driver compartment. We're clarifying that it generally applies to "cab-complete" pickups and vans (see definition at §86.1803-01) which is more appropriate for heavy-duty than "complete pickups and vans" as proposed. We are expanding the existing statement that the paragraph does not apply for self-contained A/C or refrigeration units by adding the phrases "used to cool passengers" and "used to cool cargo". Finally, we further clarify that a self-contained system for purposes of this provision is an "enclosed unit with its own evaporator and condenser even if it draws power from the engine."

5. Manufacturer Testing of Production Vehicles

The regulations require tractor manufacturers to annually chassis test five production vehicles over the GEM cycles to verify that relative reductions simulated in GEM are being achieved in actual production. See 40 CFR 1037.665. We do not expect absolute correlation between GEM results and chassis testing. GEM makes many simplifying assumptions that do not compromise its usefulness for certification but do cause it to produce emission rates different from what would be measured during a chassis dynamometer test. Given the limits of correlation possible between GEM and chassis testing, we would not expect such testing to accurately reflect whether a vehicle was compliant with the GEM standards. Therefore, §1037.665 does not apply compliance liability to such testing.

The regulation also allows manufacturers to request approval of alternative testing "that will provide equivalent or better information." Manufacturers have asked us to clarify this allowance and we proposed to revise §1037.665 to provide an example that the EPA may allow manufacturers to provide CO_2 data from in-use operation, and CO_2 data from manufacturer-run on-road testing, as long as the data allows for reasonable year-to-year comparisons and includes testing from non-prototype vehicles (85 FR 28148). We didn't receive any comments on the proposed changes to §1037.665, and we are finalizing changes to the regulation as proposed. To qualify, the vehicles would need to be actual production vehicles rather than custom-built prototype vehicles. Such vehicles could be covered by testing or manufacturer owned exemptions but would need to be produced on an assembly line or other normal production practices. Manufacturers would also need to ensure test methods are sufficiently similar from year to year to allow for a meaningful analysis of trends.

6. Vehicle Model Year Definition

For Phase 2 tractors and vocational vehicles, the vehicle's regulatory model year is usually the calendar year corresponding to the vehicle's date of manufacture. However, the Phase 2 regulations allow the vehicle's model year to be designated as the year before the calendar year corresponding to the vehicle's date of manufacture if the engine's model year is from an earlier year. We are amending as proposed the definition of model year in §1037.801 to allow vehicle manufacturers to extend the period during which a vehicle's certification is valid to account for this flexibility. This clarification more explicitly explains how vehicle manufacturers utilize this existing flexibility.

After promulgation of the Phase 2 final rule, it became apparent that the Phase 2 vehicle model year definition does not allow starting vehicle production before the start of the named year if the engine model year also begins in the earlier year. For example, if a manufacturer would start its 2024 engine model year in December 2023, the definition would not allow vehicles produced in 2023 to be model year 2024.

To address this issue, EPA is allowing the option for the vehicle's model year to be designated as the year after the calendar year corresponding to the vehicle's date of manufacture. This has the effect of allowing manufacturers to meet standards earlier with aligned engine and vehicle model years. Model years would still be constrained to reflect annual (rather than multi-year) production periods and include January 1 of the named year.

We did not receive comments on these proposed change to the definition of model year for vehicles. We are accordingly adopting the revised definition for model year in 40 CFR 1037.801 for tractors and vocational vehicles with a date of manufacture on or after January 1, 2021, as proposed, except that the final rule includes additional text to make explicit the requirement for the model year to be based on the manufacturer's annual production period for new models. This is consistent with the definition of model year for vehicles subject to Phase 1 standards in the same section.

7. Compliance Margins for GEM Inputs

The regulations at 40 CFR 1037.620(d) allow component manufacturers to conduct testing for vehicle manufacturers, but they do not specify restrictions for the format of the data. Vehicle manufacturers have raised concerns about component manufacturers including compliance margins in GEM inputs – in other words, inputting a value that is significantly worse than the tested result. They state that many component suppliers are providing GEM inputs with compliance margins, rather than raw test results. However, when stacked together, the compliance margins would result in inappropriately high GEM results that would not represent the vehicles being produced.

We proposed to note in 40 CFR 1037.501(i) that declared GEM inputs for fuel maps and aerodynamic drag area will typically include compliance margins to account for testing variability and that, for other measured GEM inputs, the declared values will typically be the measured values, and received comment requesting additional clarification and providing additional suggested revisions as described in Chapter 2 of the Response to Comments document. One commenter suggested that EPA finalize default allowance values at this time, however we lack adequate data to make a thorough determination on what these values should be. In addressing manufacturers' concern, it is important to distinguish between engine fuel maps (which are certified separately) and other GEM inputs that are not certified. As is discussed in Section II.B.3, certified engine fuel maps are expected to include compliance margins to account for manufacturing and test variability. However, EPA did not expect each of the other GEM input to have a significant compliance margin of its own. (Note that the aerodynamic bin structure serves to provide an inherent compliance margin for most vehicles.) Rather, we expected the certifying OEM to include compliance margins in their Family Emission Limits (FELs) relative to the GEM outputs.

For vehicle GHG standards, the primary role for FEL compliance margins is to protect against SEA failures. Without a compliance margin under the Phase 2 regulations, normal production variability would cause some vehicles to fail, which would require the testing of additional vehicles. Even if the family ultimately passed the SEA, it would probably require the manufacturer to test a large number of vehicles. However, because SEAs and confirmatory tests for particular components would not target GEM inputs for other components, a modest vehicle FEL compliance margin determined by the vehicle manufacturer, that accounts for the component input with the highest uncertainty used to determine the vehicle FEL, would be sufficient to cover the full range of uncertainty for all components.

While we are not adopting explicit changes with respect to compliance margins that were requested in comments, we are finalizing the revision in §1037.501(i) as with clarifying edits that, for other measured GEM inputs, the declared values are typically the measured values *without adjustment*, and finalizing a related provision after consideration of comments on this proposed revision and on conducting a confirmatory test and SEA for an axle or transmission apart from a specific vehicle. Specifically, the additional change clarifies this intent for confirmatory testing in 40 CFR 1037.235(c)(2) by stating that the results will only affect your vehicle FEL if the results of our confirmatory testing result in a GEM vehicle emission value that is higher than the vehicle FEL declared by the manufacturer.

These revisions further obviate a need for component-specific compliance margins and should thus further clarify that component-specific suppliers should be providing GEM inputs with raw test results, rather than values that include an associated compliance margin. While we do not believe that suppliers should normally include compliance margins when providing test data to OEMs for GEM inputs, we do believe they should provide to OEMs some characterization of the statistical confidence they have in their data. This allows the OEM to apply an appropriate overall compliance margin for their vehicle FEL. During a confirmatory test, EPA would compare the GEM results using our measured inputs with the declared FEL for the vehicles, which means that the compliance margin for measurement variability should be built into the FEL of the vehicle. Again, EPA notes that the certified engine fuel maps are expected to include small compliance margins to account for manufacturing and test variability.

Finally, none of this is intended to discourage suppliers and OEMs from entering into commercial agreements related to the accuracy of test results or SEA performance.

8. SEAs for Axles and Transmissions

Under 40 CFR 1037.320, a selective enforcement audit (SEA) for axles or transmissions would consist of performing measurements with a production axle or transmission to determine mean power loss values as declared for GEM simulations, and running GEM over one or more applicable duty cycles based on those measured values. The axle or transmission is considered passing for a given configuration if the new modeled emission result for every applicable duty cycle is at or below the modeled emission result corresponding to the declared GEM inputs. As described below, EPA is revising the provision regarding where an axle or transmission does not pass.

We believe special provisions are needed for axles and transmissions given their importance as compliance technologies and a market structure in which a single axle or transmission could be used by multiple certifying OEMs. Under the existing SEA regulations, if an axle or transmission family from an independent supplier fails a SEA, vehicle production could be disrupted for multiple OEMs and have serious economic impacts on them. We are finalizing a revision that will minimize the disruption to vehicle production.

Under the revised provision, if the initial axle or transmission passes, then the family would pass, and no further testing would be required. This is the same as under the existing regulations. However, if the initial axle or transmission does not pass, two additional production axles or transmissions, as applicable, would need to be tested. We are finalizing this revision as proposed, except we are finalizing additional changes to §1037.320(c) after consideration of comments received to the proposal in a couple respects. We further clarified that these additional production axels or transmissions to be tested could be different axle and transmission configurations within the family to cover the range of product included in the family. We also are finalizing an additional clarification in 40 CFR 1037.320(c) that further address how the results from the SEA will be used to determine if the manufacturer declared map should be replaced, by stating that if you fail the audit test for any of the axles or transmissions tested, the audit result becomes the declared map, also requiring revision of any analytically derived maps if applicable, and that these would become official test results for the family. In other words, this approach would correct the data used by the OEM for their end-of-year report.

After consideration of comments, we are also finalizing changes to 40 CFR 1037.320(b) to clarify that the test transmission's gear ratios and not the default ratios in 40 CFR 1036.540 should be used in GEM. After consideration of comment regarding the lack of an engine defined for use as a GEM input when a component-level SEA is being performed, we have specified the use of the default engine map in 40 CFR part 1036, Appendix III, and a default torque curve that we have added as Table 1 to 40 CFR 1037.520. The axle and transmission GEM inputs can now be determined based on the default map and torque curve. See Chapter 2 of the Response to Comments for further details on comments received and our responses.

9. Electric and Hybrid Vehicles in Vocational Applications

Prior to the proposal, manufacturers expressed concern that the Phase 2 regulations are not specific enough regarding how to classify hybrid vocational vehicles (see §1037.140). This is not an issue for tractors, which are classified based on GVWR. However, vocational vehicles are generally classified by the class of the engines. Obviously, this approach does not work for electric vehicle without engines. This approach could also misrepresent a hybrid vehicle that is able to use an undersized engine. To address these problems, we proposed changes to §1037.140(g)(1) to clarify that the classification for tractors where provisions are the same as vocational vehicles applies for hybrid and non-hybrid vehicles, and paragraph (g)(4) to clarify that Class 8 hybrid and electric vehicles are Heavy HDVs and all other vehicles are classified by GVWR classes. CARB and Tesla supported the regulation changes proposed in §1037.140(g). We did not receive any adverse comments on these proposed revisions and we are finalizing the proposed revisions with the addition of "electric" to paragraph (g)(1) for consistency with the rest of the section and an expanded clarification in paragraph (g)(4)(iii) that Class 8 hybrid and electric vehicles are considered Heavy HDV, *regardless of the engine's primary intended service class*.

CARB suggested tying certification provisions such as warranty and useful life to the vehicle GVWR to avoid allowing a downsized hybrid powertrain installed in a heavier vehicle weight class to have shorter useful life and emission warranty obligations. We note that useful life (§1037.105(e)) and warranty (§1037.120(b)) for vocational vehicles are defined by vehicle service class (i.e., Light HDV, Medium HDV, and Heavy HDV) and our final revision to §1037.140(g)(4) ensures all Class 8 hybrid and electric vehicles are classified in our heaviest weight class with the longest useful life and warranty periods. Consequently, any powertrain in a Class 8 vehicle, including a downsized hybrid, would be a Heavy HDV and subject to all corresponding certification provisions for Heavy HDVs.

We also requested comment on alternative approaches, such as specifying the useful life in hours rather than miles for these vocational vehicles or allowing electric vehicles to step down one weight class, with justification from the manufacturer. With respect to the potential alternative approaches we requested comment on, Ford supported specifying useful life in hours rather than miles for vocational vehicles. However, CARB raised questions on how the useful life in miles correlates to engine hours. Tesla encouraged EPA to continue to use a single, miles-based criteria for useful life. In addition, Ford expressed support for allowing electric vehicles to step down one weight class. We are not taking final action on any of the potential alternative approaches at this time. Regarding adopting useful life criteria based on engine hours, we currently lack the data required to link engine hours to miles for the range of vocational vehicles. Regarding potentially allowing electric vehicles to step down one weight class, we currently have concerns that this may allow for inappropriate useful life and warranty requirements.

§1037.140(g)(5) references §1037.106(f) in specifying that, in certain circumstances, you may certify vehicles to standards that apply for a different vehicle service class. We received comments from EMA and Volvo and agree with the commenters' suggestion to clarify how our revision to §1037.140(g)(1) regarding hybrid and electric tractors interacts with the cross-referenced §1037.106(f). Consistent with our explanation at proposal that the current requirements in §1037.140(g) applied to all tractors, we are also finalizing a corresponding clarification in §1037.106(f)(2) regarding Class 7 hybrid and electric tractor's ability to certify to the Class 8 standards, by adding a sentence that "[t]his applies equally for hybrid and electric vehicles." See Chapter 2 of the Response to Comments for further details on comments received and our responses.

10. Vocational Vehicle Segmentation

The Phase 2 regulatory structure applies the primary vocational standards by subcategory. Manufacturers are generally allowed to certify vocational vehicles in the particular duty-cycle subcategory they believe to be most appropriate, consistent with good engineering judgment.[20] This process for selecting the correct subcategory is often called "segmentation." Under this structure, EPA expects manufacturers to choose a subcategory for each vehicle configuration that best represents the type of operation that vehicle will actually experience in use. This is important because several technologies provide very different emission reductions depending on the actual in-use drive cycle. For example, stop-start would provide the biggest emission reductions for urban vehicles and much less reduction for vehicles that operate primary on long intercity drives.

Vocational vehicles are classified based upon the gross vehicle weight rating (GVWR) as defined in §1037.140(g). Once classified, manufacturers identify the intended regulatory subcategory duty cycles (i.e., Urban, Multi-purpose, or Regional) for each vocational vehicle configuration as indicated in §1037.140(h). There are constraints for vocational duty cycle and regulatory subcategory, specified in §1037.150(z).

Prior to the proposal, manufacturers raised concerns about the impact of this structure on their ability to plan for and monitor compliance. They suggested that more objective and quantitative "good engineering judgment" criteria would be helpful. In response to these concerns, EPA proposed an interim "safe harbor" provision in §1037.150(bb) for vocational vehicle segmentation. Under the proposal, manufacturers meeting the safe harbor criteria would be presumed to have applied good engineering judgment, and we explained that we thought the criteria were consistent with the intent of the Phase 2 program and would not allow manufacturers to reduce the effective stringency the standards.

The first principle of the proposed safe harbor was that any vehicle could be classified as Multi-purpose. The Multi-purpose duty cycle weighting factors include significant weightings for highway operation, lower speed transient operation, and idle. Thus, it would not generally overvalue an individual technology. The second principle of the proposed safe harbor was that vehicles not classified as Multi-purpose should not be exclusively Regional or Urban. We proposed a quantitative measure that evaluates the ratio of Regional vehicles to Urban vehicles within an averaging set. Specifically, we proposed that the ratio of Regional vehicles to Urban vehicles must be between 1:5 and 5:1. EPA requested comment on the proposed approach overall and the range of acceptable ratios.

CARB supported the proposed provision of allowing any vocational vehicle to be classified as Multi-purpose. However, both EMA and CARB questioned the ratios for vocational vehicle categories in the proposed provisions of §1037.150(bb). EMA commented that the proposed ratios were "arbitrary" and may not be represent a manufacturer's model mix during any specific year. Instead, EMA suggested that more appropriate "good engineering judgment" would be to base the vehicle category on "the duty cycle weighting under which it performs most efficiently in GEM." CARB commented that the ratio could inadvertently drive manufacturers to certify the vehicles with an inappropriate duty cycle and recommended all vehicles be certified as Multi-purpose unless the manufacturer could provide "good justification" for a Regional or Urban categorization.

We are finalizing a revision in §1037.140(h) and throughout §1037.150(z) to replace "duty cycle" with the term "regulatory subcategory" that more appropriately reflects the intent of classifying a vehicle and its connection to a standard. Additionally, after considering the comments, EPA is finalizing one principle of the safe harbor provision proposed as §1037.150(bb); specifically, the paragraph that allows manufacturers to select the Multi-purpose

[20] See 40 CFR 1068.5 for specifications on applying good engineering judgment.

subcategory for any vocational vehicle, unless otherwise specified in 1037.150(z).[21] As noted previously, selecting this subcategory and associated duty cycle would require technologies that reduce emissions across all operation (i.e., high speed, lower speed transient, and idle) and we believe it is an appropriate default duty cycle if a manufacturer is unsure of the final vehicle application when applying the good engineering judgment provision of §1037.140(h). We agree with the concerns expressed by CARB and EMA and are not finalizing the ratios of Regional to Urban vehicles in paragraph §1037.150(bb)(2) of the proposed safe harbor provision. Instead, as discussed further below, we continue to rely on the constraints listed in §1037.150(z) to guide manufacturers in identifying an appropriate duty cycle, with the addition of a Multi-purpose safe harbor.

§1037.150(z) outlines the constraints manufacturers apply when determining the appropriate vocational subcategory for their vehicles as described in §1037.140. Instead of adding a new paragraph (bb) as proposed, we are reordering §1037.150(z) and incorporating a new paragraph to allow the Multi-purpose classification. The modified §1037.150(z)(1) through (3) now include the current provisions that identify the vehicle configurations (designed for higher-speed cruise operation) for which manufacturers must select the Regional subcategory, specifically if certified based solely on testing with the high-speed Supplemental Emission Test, if certified as a coach bus or motor home, or if equipped with a manual transmission after MY 2024. Except where one of those existing three criteria for the Regional subcategory apply, a new paragraph §1037.150(z)(4) allows manufacturers to select the Multi-purpose subcategory for any vocational vehicle. The remaining renumbered paragraphs (z)(5) through (7) describe the current regulation's existing allowances for and limitations on selecting the Urban subcategory that are based on the most appropriate transmission configurations for lower speed, stop-and-go driving.

We continue to believe market forces will induce manufacturers to design their vocational vehicles such that their GHG emission performance (and fuel efficiency) is optimized for their customers' specific applications and, in most cases, it will be clear which subcategory and associated duty cycle is appropriate for a given vocational vehicle configuration. Consequently, the vehicles and their associated technology packages will also be relatively optimized for one of the vocational duty cycles available for compliance using GEM, as shown in Table 1 of §1037.510. Where it is unclear, we would evaluate whether a manufacturer has applied the good engineering judgment required under §1037.140(h) taking into consideration whether the subcategory selected is best suited for the vehicle as indicated by the totality of its powertrain options, vehicle features, and duty cycle performance under which it demonstrates the most favorable emissions result relative to the emission standard. We note that in our review of a manufacturer's good engineering judgment request, we reserve the right to require the use of a more appropriate duty cycle and subcategory. We will continue to monitor use of the good engineering judgment provision of §1037.140(h) and the constraints listed in §1037.150(z) and may re-evaluate our approach in the future if we determine it is necessary.

Thus, the final regulations include consideration of both EMA and CARB's suggestions. As noted previously, we would consider the duty cycle weighting under which the vehicle performs most efficiently in GEM in considering whether good engineering judgment was used, and have provided manufacturers of vehicles not subject to the constraints listed in §1037.150(z) with a clear pathway to certify those vehicles as Multi-purpose if they are otherwise unable to justify Regional or Urban duty cycle when exercising good engineering judgment.

[21] This portion of the proposed safe harbor provision was proposed as §1037.150(bb)(1).

In the proposed rule, we also requested comment on the need for the subcategory on the label. EMA commented that it is unnecessary and a complication and burden for manufacturers to identify whether the vehicle is in the Urban, Multi-Purpose or Regional subcategory on the label and requested that we "remove the requirements in §1037.135(c)(3) and (4)". CARB commented and encouraged EPA to require the subcategory be on the label because it would help consumers choose the appropriate certified vehicles for their intended vehicle operation cycles. After consideration of EMA's and CARB's comments, we are removing the requirement to explicitly state the regulatory subcategory on the emission label as specified in §1037.135(c)(4). In the Phase 2 final rulemaking, we concluded that it was unnecessary for the emission label to contain a comprehensive list of all emission components and that it is important to balance the manufacturers' "need to limit label content with the [the agencies'] interest in providing the most useful information for inspectors" (81 FR 73636, October 25, 2016). Since stating the regulatory subcategory on the label provides limited additional information inspectors could use to quickly determine if the vehicle is in its certified condition and the subcategory can be identified from the vehicle family name required by paragraph (c)(3), we believe it is appropriate to remove it as a requirement on the emission label. We are not revising the current requirement to print the standardized designation for the vehicle family name as required by §1037.135(c)(3), which ensures consistency between the label and other compliance provisions that require the vehicle family name. As such, the regulatory subfamily can continue to be identified from the family name, which should help address CARB's concern if a consumer chooses to use the emissions label when deciding to purchase a vehicle.

11. Early Certification for Small Manufacturers

Vehicle manufacturers that qualify as small businesses are exempt from the Phase 1 standards, but must meet the Phase 2 standards beginning January 1, 2022.[22] However, some vehicle families have been certified voluntarily to Phase 1 standards by small manufacturers. In an effort to encourage more voluntary early certification to Phase 1 standards, we proposed a new interim provision in §1037.150(y)(4) for small manufacturers that certify their entire U.S.-directed production volume to the Phase 1 standards for calendar year 2021 (85 FR 28150). Small manufacturers may delay complying with the Phase 2 standards by one year, and instead comply with the Phase 1 standards for that year, if they voluntarily comply with the Phase 1 standards for one full prior year. Specifically, small manufacturers may certify their model year 2022 vehicles to the Phase 1 greenhouse gas standards of §1037.105 and §1037.106 if they certify all the vehicles from their annual U.S.-directed production volume to the Phase 1 standards starting on or before January 1, 2021. If the small manufacturers do so, the provision allows these manufacturers to certify to the Phase 1 standards for model year 2022 (instead of the otherwise applicable Phase 2 standards). Early compliance with the Phase 1 standards should more than offset any reduction in benefits that would otherwise be achieved from meeting Phase 2 standards starting January 1, 2022.[23]

The provision we proposed also allows the Phase 1 vehicle credits that small manufacturers generate from model year 2018 through 2022 vocational vehicles to be used through model year 2027. Under the existing regulations, all manufacturers that generate credits under the Phase 1 program are allowed to use such Phase 1 vehicle credits in the Phase 2 vehicle averaging, banking, and trading program, but the credits are subject to the five-year credit life. As noted in

[22] See 40 CFR 1037.150(c)

[23] The magnitude of any impact on air quality would be small because of the low production volumes from these small business manufacturers.

the proposed rule, we believe the limit on credit life can be problematic for small manufacturers with limited product lines which allow them less flexibility in averaging, and the longer credit life will provide them additional flexibility to ensure all their products are fully compliant by the time the Phase 2 standards are fully phased in for model year 2027. We note that these Phase 1 emission credits are based on the degree to which the Family Emission Limit is below the Phase 1 standard.

We received no adverse comment to either proposal for small manufacturers in §1037.150(y)(4). Our final revisions include minor edits to the proposed credit-related provision in §1037.150(y)(4) to create a standalone sentence and moving the proposed provision that describes the certification flexibility for these small manufacturers to a new paragraph §1037.150(c)(4) where the applicable standards and implementation dates for qualifying small businesses are introduced.

12. Delegated Assembly

In 40 CFR 1037.621, EPA specifies provisions to allow manufacturers to ship incomplete vehicles and delegate the final assembly to another entity. Manufacturers previously expressed the concern that these "delegated assembly" requirements are too burdensome in some cases, particularly in cases such as auxiliary power units and natural gas fuel tanks. EPA requested comment on this issue and proposed a single clarifying edit in §1037.621(g). CARB encouraged EPA to maintain the existing delegated assembly provisions. We received no comments adverse these existing provisions or providing suggestions for updated text. The final rule adopts only the single clarifying edit in §1037.621(g), as proposed.

13. Canadian Vehicle Standards

During the Phase 2 rulemaking, Environment and Climate Change Canada (ECCC) emphasized that the highway weight limitations in Canada are much greater than those in the U.S. Where the U.S. federal highways have limits of 80,000 pounds gross combined weight, Canadian provinces have weight limits up to 140,000 pounds. This difference could potentially limit emission reductions that could be achieved if ECCC were to fully harmonize with the U.S.'s HD Phase 2 standards because a significant portion of the tractors sold in Canada have GCWR (Gross Combined Weight Rating) greater than EPA's 120,000-pound weight criterion for "heavy-haul" tractors.

EPA addressed this in Phase 2 by adopting provisions that allow the manufacturers the option for vehicles above 120,000 pounds GCWR to meet the more stringent standards that reflect the ECCC views on appropriate technology improvements, along with the powertrain requirements that go along with higher GCWR (see 81 FR 73582, October 25, 2016). Vehicles in the 120,000 to 140,000 pound GCWR range would normally be treated as simple "heavy haul" tractors in GEM, which eliminates the GEM input for aerodynamics. However, vehicles certified to the optional standards would be classified as "heavy Class 8" tractors in GEM, which then requires an aerodynamic input. Nevertheless, they both use the heavier payload for heavy haul.

ECCC has since adopted final standards for these 120,000 to 140,000 pound GCWR tractors, which differ from the optional standards finalized in Phase 2.[24] Since the purpose of these

[24] Government of Canada. Regulations Amending the Heavy-duty Vehicle and Engine Greenhouse Gas Emission Regulations and Other Regulations Made Under the Canadian Environmental Protection Act, 1999: SOR/2018-98, Canada Gazette, Part II, Volume 152, Number 11, May 16, 2018. Available online: http://gazette.gc.ca/rp-pr/p2/2018/2018-05-30/html/sor-dors98-eng.html

standards was to facilitate certification of vehicles intended for Canada, we proposed optional standards in §1037.670 that would be the same as the final ECCC standards. We did not receive any comments adverse the proposed optional standards and we are finalizing the optional standards as proposed in §1037.670. Note that these standards are not directly comparable to either the normal Class 8 standards or the heavy haul standards of §1037.106 because GEM uses different inputs for them. Manufacturers who choose to opt into meeting the Canadian standards would achieve greater emission reductions compared to EPA's program.

ECCC has also adopted new standards for tractors in the 97,000 to 120,000 pound GCWR category. In general, EPA would classify a tractor in the 97,000 to 120,000 lb GCWR range in one of its Class 8 tractor subcategories. EPA's Class 8 tractor standards, which cover up to 120,000 lb GCWR, have standards that are *more stringent* than ECCC's standards for their 97,000 to 120,000 lb GCWR subcategory. We did not propose special provisions for these tractors, but requested comment on the need for special provisions for these vehicles. Both EMA and Volvo commented that special provisions are necessary to facilitate certification of 97,000 to 120,000-pound GCWR tractors for export to Canada. EMA suggested a similar approach for these 97,000 to 120,000-pound GCWR tractors as the one provided for the optional certification for tractors at or above 120,000 pounds GCWR, proposed in §1037.670. Similarly, Volvo requested that EPA provide subcategories and standards for these tractors that align with the ECCC regulations. We have concerns with the suggestion of providing an option for tractor standards that are less stringent than our current standards. EPA did not propose and is not taking any final action on special provisions for such vehicles at this time.

14. Transmission Calibrations

Manufacturers with advanced transmission calibrations may use the powertrain test option in §1037.550 to demonstrate the performance of their transmissions. We adopted this option to provide an incentive for the development of advanced transmissions with sophisticated calibrations.

Transmission manufacturers have developed some new efficient calibrations, but must also maintain less efficient calibrations to address special types of operation. Due to concerns about resale value, most customers want to retain the ability to select the correct calibration for their operation. For transmissions with such selectable calibrations, §1037.235(a) requires that they test using the worst-case calibration, which can undermine the incentive to continue improving the calibrations. We received comment requesting that we allow averaging of the worst-case and best-case performance, however this request would be a significant departure from how engine families are certified and what 40 CFR part 1037 currently requires for transmissions. We also received comment on weighting the calibration performance based on the actual use of these calibrations in the field. We believe that this option will give the most representative use of these calibrations and their impact on CO_2 emissions. After consideration of these comments, we are finalizing a change to allow manufacturers to measure both the best- and worst-case calibrations and weight them by prior model year based on survey data, prior model year sales volume, or other appropriate means. This weighting will be accomplished by testing both calibrations and weighting the results in Table 2 of §1037.550 as described in amendments made in §1037.235(a). See Chapter 2 of the Response to Comments for further details on comments received and our responses.

15. Other Minor Heavy-Duty Vehicle Amendments

We received no adverse comments to the following proposed amendments. EPA is finalizing the following amendments to part 1037 as proposed:

- Section 1037.103(c) – Adding phrase "throughout the useful life".
- Section 1037.105 Table 5 – Updating footnote format in table.
- Section 1037.106 Table 1 – Updating footnote format in table.
- Section 1037.120(b) – Correcting the text with respect to tires and Heavy Heavy-Duty vehicles.
- Section 1037.150(c) – Adding a sentence pointing to additional interim provisions for small manufacturers.
- Section 1037.150(aa) – Clarifying the production limit for drayage tractors under the custom chassis allowance.
- Section 1037.201(h) – Correcting phrase "except that §1037.245 describes..." to refer to §1037.243.
- Section 1037.205(e) – Correcting parenthetical "(see 40 CFR 1036.510)" to refer to 40 CFR 1036.503.
- Section 1037.225(e) – Reorganizing paragraph with the introduction noting starting data, paragraph (e)(1) with existing text, and a new paragraph (e)(2) regarding the requirement that the amended application be "correct and complete".
- Section 1037.230(a)(2) – Adding two clarifying paragraphs for optional tractor subcategories.
- Section 1037.243(c) – Rephrasing for consistency with other paragraphs in the section.
- Section 1037.255 – Replacing the possessive "your" with articles a/an/the throughout this section and added clarifying statements related to the information submitted in an application for a certificate of conformity.
- Section 1037.301(b) – Removing phrase "matches or exceeds the efficiency improvement".
- Section 1037.635(c)(1)—Editorial, adding a missing "the".
- Section 1037.701(h)—Editorial, fixing reference.
- Section 1037.705(c)(2)—Adding a clarification for exported vehicles.
- Section 1037.801—Correcting punctuation in Compression-ignition and Low rolling resistance tires definitions; adding the word "motor" to definition of Electric vehicle; adding definition of electronic control module; clarifying Heavy-duty vehicle definition with respect to incomplete vehicles; adding definition of High-strength steel; clarifying Light-duty truck definition; adding Tonne definition.
- Section 1037.805(c) and (d) – Editorial; updating to be consistent with format in other parts.

EPA is also finalizing the following additional amendments, that include revisions we are finalizing as proposed but with additional clarifications, editorial improvements, or to fix typographical errors, after consideration of comments, as noted. Chapter 2 of our Response to Comments includes additional details on some of these amendments, as well as other amendments or clarifications requested by commenters and our responses.

- Section 1037.150(c) – Reorganizing the section into subparagraphs; removing "qualifying" throughout; moving reference to NAICS codes into definition of "small manufacturer" in § 1037.801; and combining the statements regarding the MY 2022 implementation date for tractor and vocational vehicles and the additional delays in later years for alternatively-fueled tractors and vocational vehicles into the new paragraph (c)(2) to provide further clarification in response to CARB's seeming misinterpretation of the regulations in a submitted comment related to our proposed §1037.150(y)(4) provision. Also moving the certification-focused portion of the early certification provision proposed as part of §1037.150(y)(4) to a new paragraph (c)(4) as discussed in Section II.C.11.

- Section 1037.231(b)(7) – Adding an additional revision to provide clarification on forward gear availability, noting that available forward gear means the vehicle has the hardware and software to allow operation in those gears, consistent with our final revision to §1037.520(g) as noted in Section II.A.2.
- Section 1037.235(h)—Providing an example of an "untested configuration" in response to EMA's request for clarification.
- Section 1037.601(a)(2)—Removing limit of "up to 50" and added a more general statement that we will limit the number of engines.
- Section 1037.615— Clarifying that fuel cells powered by hydrogen should have a Family Emission Limit of 0 g/ton-mile for calculating CO_2 credits. Vehicles fueled by hydrogen are inherently carbon-free, which supports treating these vehicles the same as electric vehicles. This clarification is responsive to a comment from EMA.
- Section 1037.660(a)(2) – Revising to specify the permissible delay before engaging neutral idle when the vehicle is stopped; updating from proposed value of two seconds to the final value of five seconds after consideration of a request from Ford that suggested "two seconds is too short to account for normal stops and restarts in real on-road driving". This request was posed in an email to EPA following the proposed rule.[25]
- Section 1037.740(b)—Updated naming convention to match vehicle service classes Our revised delay of five seconds for neutral idle accommodates Ford's request and is consistent with the permissible §1037.740(b)—Updating the naming convention to match vehicle service classes.
- Section 1037.801 – Updating the proposed definitions for "hybrid engine or powertrain" and "hybrid vehicle" to be consistent with the proposed and further developed hybrid powertrain test procedure revisions to part 1036 subpart F, and the definitions of "hybrid powertrain" and "mild hybrid" added to 40 CFR part 1036. These revisions add examples of systems that qualify as hybrid engines or powertrains, specifically systems that recover kinetic energy and use it to power an electric heater in the aftertreatment. Updating model year definition as discussed in Section II.C.6 and small manufacturer definition as discussed in II.C.11.
- Section 1037.805(b) – Updating quantity and quantity descriptions including additional revisions to those proposed to ensure that these descriptions were consistent throughout the part.
- Section 1037.805(f) – Adding an additional revision to those proposed to update gravitational constant after consideration of comments received on the proposal.

[25] Memorandum to Docket EPA-HQ-OAR-2019-0307, E-mail from Ken McAlinden (Ford) Requesting Regulatory Change for Neutral Idle Credit, Christopher Laroo, September 23, 2020.

- Appendix III to part 1037 – Updating the definition of the emission control identifier "DWSW" to clarify *high-strength* steel wheel and maintain consistency with the related requirements in Table 6 of §1037.520, after consideration of comment by CARB.

D. Onboard Diagnostics ("OBD")

EPA proposed several updates to the onboard diagnostic (OBD) provisions of 40 CFR part 86, subpart A, related to onboard diagnostic requirements for heavy-duty engines and requested comment on general improvements and efforts to harmonize EPA and CARB OBD requirements (see 85 FR 28152). This section presents the changes we are adopting to OBD requirements after consideration of comments received. Additional details on these and other OBD amendments or clarifications requested by commenters and our responses are available in Chapter 2 of our Response to Comments document.

EPA's OBD regulations for heavy-duty engines are contained in 40 CFR 86.010-18, and were promulgated February 24, 2009 (74 FR 8310). Although these regulations were originally harmonized with CARB's OBD program, CARB has since updated and made changes to their regulations which EPA has not adopted. Most recently, in October 2019, CARB approved revisions to the onboard diagnostics requirements that include implementation of real emissions assessment logging (REAL) for heavy-duty engines and other vehicles.

The proposed rule requested comment on differences between existing EPA and CARB OBD regulations and included specific proposed revisions intended to reduce these differences. EPA proposed six specific revisions to update existing OBD regulations and harmonize with CARB requirements. We received comments supportive of these proposals, as well as comments indicating that EPA should reconsider certain proposals to ensure the regulations are clear and have the desired effect. After further evaluation and consideration of comments, EPA is finalizing four of these six proposed revisions:

(1) Adopting as proposed the CARB 5% threshold for misfire in §86.010-18(g)(2). This would allow manufacturers to not detect misfires under certain conditions, such as during aftertreatment regeneration and some low temperature operation.
(2) Adopting as proposed CARB's misfire flexibilities in 1971.1(e)(2.3.3) which include identifying when it is reasonable for a manufacturer to seek approval for systems that cannot detect all misfire under all required speed and load conditions and where they seek approval to disable misfire detections.
(3) Adopting with a clarification the proposed revision to our in-use compliance standards in §86.010-18(p) to reflect the CARB approach for minimum ratios for representative samples where a system would be considered noncompliant if the representative test sample (or performance group) indicates that the in-use ratio is below 0.088. A clarification was added to specify that the in-use ratio is based on the "average" value for the test sample group.
(4) Adopting as proposed the allowance to use CARB OBD reporting templates for EPA OBD requirements.

EPA received comments on the 5% threshold for misfire indicating concern that the provision as proposed does not reflect CARB's most recent requirements. EPA's proposal in §86.010-18(g)(2)(iii)(C) was to require misfire detection on those engines equipped with sensors that can detect misfire occurrences. Existing CARB requirements state that all diesel engines are required to continuously monitor for misfire, not just those engines equipped to detect for misfire. EPA is finalizing the misfire provision as proposed but may further review this provision and may consider harmonizing with existing CARB requirements that require misfire detection for all diesel engines as a part of a future rulemaking. For example, the Cleaner Trucks Initiative ("CTI") rulemaking intends to consider updating existing EPA OBD regulations and harmonizing further with CARB OBD requirements as noted in the Advance Notice of Proposed Rulemaking (ANPR) (85 FR 3306, January 21, 2020). EPA received comment on the proposal to revise our in-use compliance standards that recommended adding a clarification to the proposed language to indicate that the in-use ratio is based on the average in-use ratio of the engines in the test sample group. The comment pointed out that the regulations as proposed were not clear as to how the in-use ratio would be determined. Existing EPA regulations in §86.010-18(j)(3)(i) - (ii) specify that manufacturers must collect and report in-use monitoring performance data representative of production vehicles, separate production vehicles into monitoring performance groups and submit data that represents each of these groups. The purpose of this requirement is to analyze in-use data from more than one vehicle to ensure that the OBD system is functioning properly. The frequency that some OBD monitors run can vary depending on the duty cycle of a particular vehicle, therefore, using the average in-use ratio from to evaluate performance is most appropriate. Adding this clarification also increases the alignment of EPA and CARB OBD requirements. After consideration of these factors we have added the word "average" to §86.010-18(p)(4)(ii) to provide this clarity. Comments were also received on the in-use requirements stating that an additional provision should be included to §86.010-18(p)(4)(ii) to ensure that compliance with the in-use ratio requirement is not influenced by engines with very high ratios which could lower the average value. We are not finalizing this change at this time but intend to review whether or not revisions to this provision should be considered as a part of the CTI rulemaking effort. EPA received no adverse comments on the proposal to allow the use of CARB's OBD reporting template. Using the CARB template will help streamline certification processes and reduce the time manufacturers may spend entering duplicative information on different forms. EPA is finalizing this provision as proposed to help harmonize requirements and streamline the certification process.

EPA is not taking final action at this time on two proposed revisions: 1) To allow CARB certified configurations to not count as separate engines families for the purposes of determining OEM test requirements, and 2) to allow a simplified carryover OBD certification path intended for special engine families. We received comments indicating concern that these proposals were not clear. For example, CARB noted that the proposed regulatory requirements for both carryover certification and for determining required OBD demonstration testing requirements relied on the term "special engine family" which is not defined in EPA regulations. EPA intends to review these two issues and other comments received on existing OBD requirements as part of a more comprehensive effort to consider updating our existing OBD regulations in the intended CTI rulemaking.

III. Other Amendments

A. Ethanol-Blend Test Fuels for Nonroad Spark-Ignition Engines and Vehicles, Highway Motorcycles, and Portable Fuel Containers

EPA adopted exhaust and evaporative emission standards for gasoline-fueled nonroad engines, vehicles, and equipment before there was a federal gasoline test fuel with 10 percent ethanol (E10). Most of those programs therefore relied on testing with neat gasoline (E0) or with a splash-blended mix of neat gasoline and ethanol to make E10. In the meantime, EPA adopted a federal gasoline test fuel with 10 percent ethanol for testing motor vehicles (79 FR 23414, April 28, 2014).

California ARB adopted its own specification for an E10 test fuel for testing motor vehicles, referred to as “LEV III E10.” California ARB revised its nonroad emission control programs to require manufacturers to start using LEV III E10 test fuel for certification starting in model year 2020, without allowing for carryover of previous data from testing with neat gasoline. California ARB’s move to require use of LEV III E10 test fuel for certification has led manufacturers to express a concern about the test burden associated with separate testing to demonstrate compliance with EPA and California ARB emission standards.

The concern for aligning test requirements related to test fuel applies for marine spark-ignition engines (40 CFR part 1045), nonroad spark-ignition engines above 19 kW (40 CFR part 1048), and recreational vehicles (40 CFR part 1051).[26] We expect a similar situation to apply for highway motorcycles in the 2022-2025 time frame based on California ARB’s plans for further rulemaking activity.

We have issued guidance for marine spark-ignition engines (40 CFR part 1045)[27] and for recreational vehicles (40 CFR part 1051)[28] describing how we may approve certification based on emission measurements with an E10 test fuel. We are revising 40 CFR parts 1045, 1048, and 1051, consistent with the recently issued guidance documents, to allow for certification based on emission measurements with EPA’s E10 test fuel without requiring EPA approval, and without adjusting emission standards to account for fuel effects. For marine spark-ignition engines (40 CFR part 1045), this merely replaces the existing provision allowing for the alternative of using a splash-blended E10 test fuel. For recreational vehicles (40 CFR part 1051) and Large SI engines (40 CFR part 1048), naming EPA’s E10 specification as the alternative test fuel is a new provision. We are not prepared in this rulemaking to justify adopting new emission standards or to otherwise change the stringency of the existing standards. It is therefore necessary for EPA to be able to do confirmatory testing with either the original E0 test fuel, or the manufacturer’s selected alternative fuel.

We are also allowing the same approach for certification based on emission measurements with EPA’s E10 test fuel for highway motorcycles (including EPA confirmatory testing with either E0 or E10).

We expect this approach of allowing E10 as an alternative test fuel to adequately address concerns for the identified sectors. Many of these engines have closed-loop fuel controls that reduce the effect of fuel variables on exhaust emissions. Many also have relatively large compliance margins relative to the standards that apply. These factors help manufacturers confidently test with E10 as an alternative fuel, knowing that they continue to be liable for meeting emission standards on the specified E0 test fuel.

In the proposed rule we described a process for approving the use of California ARB’s LEV III E10 test fuel instead of EPA’s E10 test fuel as the alternative test fuel. That process is detailed in the existing regulations at 40 CFR 1065.701(b). The National Marine Manufacturers Association, the Motorcycle Industry Council, and Polaris requested that we revise the regulation

[26] EPA adopted amendments to address these concerns for nonroad spark-ignition engines at or below 19 kW in an earlier rulemaking (80 FR 9114, February 19, 2015).

[27] “Marine Spark Ignition Engine Certification Testing with California ARB E10 Test Fuel,” EPA guidance document CD-18-15, December 24, 2018.

[28] “Off-Highway Recreational Vehicle Certification Testing with California ARB E10 Test Fuel,” EPA guidance document CD-19-03, April 22, 2019.

to include California ARB's LEV III E10 as an alternative test fuel. The two sets of fuel specifications are nearly identical, with the notable difference being that California ARB's LEV III E10 test fuel has a lower volatility, which corresponds to the fuel regulations that apply in California. For testing hot-stabilized engines, volatility has a very small effect on exhaust emissions.

We are not revising the regulation to specify California ARB's LEV III E10 test fuel as an alternative test fuel. We expect the approval process described in 40 CFR 1065.701(b) to allow for review that will typically result in approval to use the California test fuel. However, we remain concerned that there may be some limited circumstances in which testing with the California fuel may not be appropriate for EPA certification. For example, engine manufacturers might name a Family Emission Limit to earn emission credits with a very narrow compliance margin. In that case, we would want to be able to explore with the manufacturer whether its testing adequately supports the proposed application for certification. As another example, some nonroad sectors include standards and testing requirements for controlling off-cycle emissions. It may be appropriate for the manufacturer to perform some of this off-cycle testing for certification using EPA's E0 or E10 test fuel in addition to testing over specified duty cycles with California ARB's LEV III E10 test fuel. To illustrate this point, we observed from a recent experience exploring potential noncompliance that an engine that has electronic feedback control can have a sensitivity to fuel parameters that is much greater than we would expect based on a simple assessment of combustion chemistry. We also note that the experience of implementing these changes in test fuel requirements will inform our ongoing approach for approving requests. Data supporting the equivalence of EPA and California test fuels would lead us to reduce our concerns for approving requests. In contrast, if we learn that fuel effects are greater than expected, we would review requests more carefully. This more careful review could be limited to a single manufacturer or a single type of engine (or engine technology), or it may apply more broadly.

We specify evaporative emission standards and test procedures for portable fuel containers and nonroad spark-ignition equipment in 40 CFR part 59, subpart F, and 40 CFR part 1060, respectively. The gasoline test fuel is splash-blended E10. California ARB specifies their LEV III gasoline test fuel for the analogous procedures in California, but they allow manufacturers to submit data instead using EPA's specified test fuel. Accordingly, we believe manufacturers do not face the same burden of needing to perform duplicate measurements for the two agencies. We are therefore not changing the EPA test fuel for portable fuel containers.

Commenters largely affirmed the proposed approach for increased flexibility for using E10 test fuels.[29] We understand this approach —allowing testing with E10 testing as an alternative procedure—to be an interim measure. We expect to continue the move toward adopting E10 test fuel specifications, without referencing an E0 test fuel specification, as we consider updating emission standards for each sector over time. When we establish new standards, we would expect to evaluate the stringency of those standards based on testing with E10 test fuel, which will allow for adopting a singular test fuel.

B. Removing Obsolete CFR Content

EPA first adopted emission standards for light-duty motor vehicles and heavy-duty highway engines in the 1970s. Emission standards for the first categories of nonroad engines started to apply in the 1990s. Each of these programs include emission standards that apply by model year.

[29] See the Response to Comments for detailed input from commenters.

For most of these programs over time, engines and vehicles were subject to increasingly stringent standards and improved certification and testing requirements. All these standards and regulatory provisions are codified in the Code of Federal Regulations. As time passes, the regulations for past model years become obsolete, but it remains in print until there is a rulemaking change to remove it from print. We are removing large portions of this regulatory content that no longer applies. The following sections describe these changes for different sectors.

Note that Section III.D describes several amendments to emission control programs for motor vehicles in 40 CFR parts 85 and 86. These amendments include several provisions that also remove obsolete regulatory content.

1. Clean Fuel Fleet Standards (40 CFR part 88)

The Clean Air Act Amendments of 1990 included numerical standards for the Clean Fuel Fleet program that were intended to encourage innovation and reduce emissions for fleets of motor vehicles in certain nonattainment areas as compared to conventionally fueled vehicles available at the time. As originally adopted, those Clean Fuel Fleet standards were substantially more stringent than the standards that applied to vehicles and engines generally.

Now that we have begun implementing Tier 3 standards in 40 CFR part 86, subpart S, the Clean Fuel Fleet standards are either less stringent than or equivalent to the standards that apply to vehicles and engines generally. Because the statute continues to require Clean Fuel Fleet standards for state clean-fuel vehicle programs, we cannot simply remove the Clean Fuel Fleet program from the regulations. Rather, we are implementing the Clean Fuel Fleet standards in 40 CFR part 88 with a compliance option where vehicles and engines certified to current standards under 40 CFR part 86 and part 1036 would be deemed to comply with the Clean Fuel Fleet standards as Ultra Low-Emission Vehicles. Further, the Clean Fuel Fleet program as adopted included labeling requirements for engine and vehicle manufacturers to identify compliant engines and vehicles, and a restriction against including such engines or vehicles when calculating emission credits. Both provisions would also no longer be applicable because of the earlier mentioned increased stringency of standards for engines and vehicles, and under the compliance option we are establishing. Therefore, we are also removing these regulations. This will give clear instructions to vehicle and engine manufacturers as well as states that continue to have Clean Fuel Fleet provisions in their State Implementation Plans or become subject to these requirements in the future under CAA sections 182(c)(4)(A) and 246(a).

For states with areas that become subject to the clean-fuel vehicle program requirements in the future based on a new designation as an ozone nonattainment area, the required state implementation plan submission for the program or for a substitute measure is due within 42 months after the effective date of an area’s nonattainment designation. The clean-fuel vehicle program requirements apply for ozone nonattainment areas with an initial designation as Serious, Severe, or Extreme. For marginal and moderate ozone nonattainment areas that are reclassified as Serious, Severe, or Extreme, the required state implementation plan submission for the program or for a substitute measure is due on the date specified in the EPA rulemaking finalizing the area’s reclassification.

The Clean Fuel Fleet program also depends on vehicle classifications that include Zero Emission Vehicles and Inherently Low-Emission Vehicles. We are therefore preserving these defined terms in 40 CFR part 88. Under the new provisions, we will consider as Zero Emission Vehicles all electric vehicles and any vehicle that does not emit NOx, PM, HC, CO, or formaldehyde (including evaporative emissions). We are simplifying the definition of Inherently

Low-Emission Vehicles to mean any certified vehicle that is designed to not vent fuel vapors to the atmosphere.

2. Legacy Nonroad Standards (40 CFR Parts 89 through 94)

The 1990 amendments to the Clean Air Act authorized EPA to set emission standards for nonroad engines. This led to a series of rulemakings to adopt emission control programs for different nonroad sectors. From 1994 through 1999, EPA adopted these emission control programs in 40 CFR parts 89, 90, 91, 92, and 94 (all part of Subchapter C).

Starting in 2002, EPA adopted emission standards for additional nonroad emission control programs in a new subchapter, which allowed for improved organization and harmonization across sectors. We codified these new standards and related provisions in 40 CFR parts 1048, 1051, 1065, and 1068 (all part of Subchapter U). Since then, we have migrated the "legacy" emission control programs from Subchapter C to Subchapter U. In each case, the migration corresponded to new emission standards and substantially updated compliance and testing provisions. This applies for the following sectors:

Sector	Legacy Regulation	Current Regulation
Land-based nonroad diesel engines	40 CFR part 89	40 CFR part 1039
Nonroad spark-ignition engines at or below 19 kW	40 CFR part 90	40 CFR part 1054
Marine spark-ignition engines	40 CFR part 91	40 CFR part 1045
Locomotives and locomotive engines	40 CFR part 92	40 CFR part 1033
Marine diesel engines	40 CFR part 94	40 CFR part 1042

As a result of this migration, engine manufacturers have not certified engines under the legacy parts for the last 5-10 years. Removing these legacy parts reduces the cost to the Agency and prevents confusion for readers who think that the old provisions still apply.

While EPA's engine certification programs don't rely on these obsolete provisions, the new programs refer to the legacy parts for some specific provisions. For example, the new standard-setting part for each type of engine/equipment allows manufacturers to continue to certify carryover engine families based on test data from procedures specified in the legacy parts. We are not discontinuing further use of carryover data from engines originally certified under the legacy parts. On the other hand, this provision will gradually sunset itself as manufacturers update engine designs and perform new testing for their engine families to meet current standards.

Another example of relying on the legacy parts in the new regulations is emission credits generated under the legacy parts. In most cases, current programs either disallow using those credits for certification, or they allow it without keeping separate accounts for credits generated under the legacy parts. We are making no changes where credits from legacy parts are either unavailable or indistinguishable from currently generated credits. One exception is for land-based nonroad diesel engines certified under 40 CFR parts 89 and 1039. Current provisions in §1039.740 allow for limited use of Tier 2 and Tier 3 credits from part 89 for certifying Tier 4 engines. We are revising §1039.740, as proposed, to continue to allow manufacturers to use credits generated from Tier 2 and Tier 3 engines by simply changing the relevant references 40 CFR part 89 to 40 CFR part 1039, Appendix I.

We are also aware that other federal and state regulations and compliance programs include numerous references to 40 CFR parts 89 through 94. To address this, we are replacing the full text of regulations in the legacy parts with a paragraph describing the historical scope and purpose for each part. The remaining paragraph also directs readers to the new regulations that apply in Subchapter U and clarifies how the regulatory requirements transition to the new content. As an example, the statute and regulations prohibit tampering with certified engines throughout an engine's lifetime, even if the original text describing that prohibition no longer resides in its original location in the Code of Federal Regulations.

We are also including the emission standards from the legacy parts as reference material in an appendix in the appropriate CFR parts. This allows for readily citing the historical standards in our own emission control programs, and in any other federal or state regulations or compliance materials that depend on citing emission standards that are no longer current for purposes of gaining EPA certification as part of our nonroad emission control program.

In addition to removing references to the legacy parts, we are taking the opportunity to remove additional obsolete content from the newer regulations. Most of these changes were adopted to address temporary concerns as part of transitioning to new standards or other new requirements. We adopted these changes in isolated regulatory sections as "interim provisions." Most of these interim provisions have been obsolete for several years.

References to the legacy parts are especially common for stationary engines EPA regulates under 40 CFR part 60, subpart IIII and subpart JJJJ. The emission standards for stationary engines in many cases rely on current or past nonroad emission standards in 40 CFR parts 89, 90, and 94. Including all the iterations of these emission standards as reference material allows us to preserve the existing set of standards and requirements for stationary engines. This rule includes numerous amendments to 40 CFR part 60 to change regulatory cites from the legacy parts to the new regulatory parts in Subchapter U, or to copy referenced text directly into 40 CFR part 60.

Most of the changes for stationary engines in 40 CFR part 60 are intended to update references without changing standards or other provisions. We are making three more substantive changes. First, we are allowing all manufacturers of emergency stationary compression-ignition internal combustion engines and stationary emergency spark-ignition engines to certify using assigned deterioration factors. Since these emergency engines generally serve in standby status in anticipation of emergency situations, they often have lifetime operation that is much less extensive than non-emergency engines. Assigned deterioration factors would allow manufacturers to demonstrate the durability of emission controls without performing testing that might otherwise exceed the operating life of the engines being certified. We are prepared to publish assigned deterioration factors based on currently available information. We may need to revise those values in the future as additional information becomes available, so we are not including specific values for assigned deterioration factors in this rulemaking. We are adopting these provisions as proposed, except that we are referencing the relevant nonroad regulations that apply and we are clarifying that assigned deterioration factors for stationary engines are not limited to small-volume manufacturers.

Second, stationary spark-ignition engines are currently subject to emission standards and certification procedures adopted under 40 CFR part 90 for Phase 1 engines. Revising the requirements for these engines to instead rely on the certification procedures in 40 CFR part 1054 requires that we identify the Phase 1 standards as not including the following provisions that apply for Phase 3 engines (as noted in the amended regulatory text for Appendix I of part 1054):

- The useful life and corresponding deterioration factors.
- Evaporative emission standards.
- Altitude adjustments.
- Warranty assurance provisions in §1054.120(f).
- Emission-related installation instructions.
- Bonding.

Third, in response to a comment from the EMA, we are revising the instruction regarding VOC measurement methods to allow manufacturers to use any method that is specified for highway or nonroad engines in 40 CFR part 1065, subpart C. The current regulation at 40 CFR 60.4241(i) identifies specific measurement procedures. When we revised 40 CFR part 1065 to include fourier transform infrared analyzers as an additional measurement method, it would have been appropriate to modify 40 CFR 60.4241(i) to identify this additional measurement method. We are addressing that in this rule by broadly referencing test methods in 40 CFR part 1065, subpart C, which includes fourier transform infrared analyzers.

In addition, following the proposed rule, we realized that 40 CFR part 89 includes content that is, in fact, not obsolete. Specifically, there is an interpretation of the Clean Air Act regarding the preemption of state regulations related to nonroad engines in 40 part 89, subpart A, Appendix A (62 FR 67736, December 30, 1997). This interpretation describes EPA's belief that states may regulate the use and operation of nonroad engines within certain parameters. This final rule preserves Appendix A by copying it into 40 CFR part 1074, where we more broadly describe a range of issues related to preemption of state regulation of nonroad engines.

C. Certification Fees (40 CFR Part 1027)

EPA is making several minor changes in 40 CFR part 1027 to update the procedures and align the instructions with current practices. None of these changes involve change or reconsideration of fee policies. We are finalizing the following changes:

- Correcting the name of the compliance program.
- Replacing the schedule of fees from 2005 with the fees that apply for applications submitted in 2020.
- Revising the timeline for announcing adjusted fees for the upcoming year from a January 31 deadline to a March 31 deadline. This will allow for a more orderly process of calculating the new fees using the information from the previous year.
- Correcting the equation for non-evaporative certificates to no longer apply the inflation adjustment to operating costs. This corrects a publishing error that mistakenly introduced parentheses in the equation.
- Correcting the Internet address for the consumer price index used for inflation adjustments.
- Removing the sample calculation for determining fees for 2006.
- Revising submission and payment instructions to refer only to electronic forms and transactions through www.Pay.gov.
- Clarifying that deficient filings must be resolved before the end of the model year, and that the time limit for requesting refunds applies equally to deficient filings.

We received no comments on the proposed amendments to 40 CFR part 1027 and are adopting these amendments without modification.

D. Additional Amendments for Motor Vehicles and Motor Vehicle Engines (40 CFR Parts 85 and 86)

Motor vehicles and motor vehicle engines are subject to emission standards and certification requirements under 40 CFR part 86. This applies for light-duty vehicles, light-duty trucks, heavy-duty vehicles and engines, and highway motorcycles. There are additional compliance provisions in 40 CFR part 85. We are adopting the following amendments to these provisions:

- Part 85: We are amending the provisions for importation, exemptions, and model year to clarify that they no longer apply for heavy-duty engines. Those engines are already subject to analogous provisions under 40 CFR part 1068. While the two sets of provisions are largely the same, we want to avoid the ambiguity of having overlapping requirements. One aspect of this migration involves discontinuing the provisions that apply for Independent Commercial Importers for heavy-duty engines. No one has used these provisions for several years, and we have no reason to believe anyone will start to use these provisions. We are revising the regulatory text for the final rule, based on a comment, to clarify that the importation provisions continue to apply for highway motorcycles, and that references to engines in 40 CFR part 85, subpart P, continue to apply for replacement engines intended for installation in motor vehicles subject to the same importation provisions.
- Part 85: We are making several minor corrections to (1) refer to provisions in 40 CFR part 1068 related to confidential business information and hearing procedures, and (2) clarify organization names and addresses for submitting information.
- Part 85, Subpart O: This subpart set emission standards for 1993 and older model year urban buses undergoing engine rebuilding. We have confirmed with the American Public Transportation Association that there are very few such urban buses still operating, and that none of them will have engine rebuilds. We are therefore removing this content from the CFR.
- Section 85.1902(b)(2): We are clarifying that defect-reporting requirements under paragraph (b)(2) apply for defects related to noncompliance with greenhouse gas emission standards, not criteria emission standards. This corrects an earlier amendment that inadvertently described the provisions as applying to noncompliance with any kind of emission standard. Defects related to criteria emission standards are covered by §85.1902(b)(1).
- Sections 86.113-04, 86.213, and 86.513: Adding optional reference procedures for measuring aromatic and olefin content of E0 gasoline test fuel. These changes align with the reference procedures for EPA's Tier 3 E10 gasoline test fuel at 40 CFR 1065.710(b). These changes are needed because material limitations prevent laboratories from using the procedures in ASTM D1319. This change also applies for the E0 gasoline test fuel specified in 40 CFR 1065.710(c),
- Section 86.129-00: Revising the description of test weight basis to be loaded vehicle weight for all light-duty vehicles and light-duty trucks. This is a correction to align the regulation with current practice.
- Section 86.130-96: We are correcting the reference to a testing flowchart that was moved to 40 CFR 1066.801.
- Sections 86.401-97 and 86.413-78: We are removing obsolete sections to prevent confusion.

- Sections 86.419-2006 and 86.427-78: We are revising the table with service accumulation parameters to clarify how to perform testing separately for Class I-A and Class I-B, rather than treating them as a single class.
- Sections 86.435-78 and 86.436-78: We are correcting references to the regulation to clarify that a motorcycle is compliant if measured test results are at or below the standards.
- Section 86.531-78: We are adding instruction to seal exhaust system leaks as needed before testing highway motorcycles. The amendment also applies for testing off-highway motorcycles and all-terrain vehicles under 40 CFR part 1051. This same instruction also applies for light-duty vehicle testing under 40 CFR 1066.110(b)(1)(vi). We made minor wording changes after the proposed rule to clarify that manufacturers need to close all known leaks as part of the effort to prevent exhaust leaks from affecting the compliance demonstration.
- Part 86, Subpart P: The idle test procedures for spark-ignition engine and vehicles are no longer needed for certification or other compliance demonstrations. We are therefore removing this content from the CFR.
- Part 86, Subpart Q: Engine technology has advanced to include internal feedback controls and compensation to allow for operation at a wide range of altitudes. The certification requirements related to altitude adjustments are therefore mostly or completely obsolete. We are finalizing a simplified version of the altitude provisions for highway motorcycles at 40 CFR 86.408-78(c) and (d) in case there are some very small motorcycles that require adjustment for altitude.
- Section 86.1803: We are revising the definition for heavy-duty vehicle, with a conforming revision to the definition for light-duty truck, to clarify that the sole regulatory criterion for whether a complete vehicle is a heavy-duty vehicle for purposes of the regulation is whether its gross vehicle weight rating is above 8,500 pounds. The current approach remains unchanged for incomplete vehicles; that is, heavy-duty vehicles also include incomplete vehicles even if their gross vehicle weight rating is at or below 8,500 pounds, if their curb weight is above 6,000 pounds or if their basic vehicle frontal area is greater than 45 square feet. The revisions are intended to (1) prevent light-duty trucks from becoming heavy-duty vehicles in a configuration involving a hybrid powertrain due to the extra weight related to energy storage and (2) avoid an incentive for manufacturers to add vehicle weight or frontal area simply to avoid the standards that apply for light-duty vehicles. In these cases, under the current definition, the curb weight or frontal area would artificially increase to the point that the vehicle would qualify as a heavy-duty vehicle, even though it otherwise has the characteristics of a light-duty truck. This same change is not necessary for incomplete vehicles because certifying manufacturers have the option to select the appropriate vehicle classification for those vehicles. Note that the change applies only for future certification; any certified heavy-duty vehicle that would no longer fit the description will not be affected by the amended definition.
- Section 86.1811-17: The Federal Register mistakenly published a reference to the Tier 3 p.m. standard. Since we intended for the standard to apply at all times, we are amending the regulation to properly refer to that as the Tier 3 PM standard.
- Section 86.1813-01: We are clarifying that electric vehicles and fuel cell vehicles are not subject to evaporative and refueling emission standards. The preamble to the final

rule adopting the light-duty Tier 3 standards stated that these emission standards apply only for volatile fuels, but we did not include a clear statement excluding electric vehicles and fuel cell vehicles in the regulations (79 FR 23514, April 28, 2014).

- Section 86.1818-12: We are clarifying that manufacturers calculate the in-use CO_2 standard using the appropriate test result for carbon-related exhaust emissions after adjustment with the deterioration factor to account for durability effects. In many cases, the deterioration factor is 0 (additive) or 1 (multiplicative), in which case the deterioration factor does not change the calculated in-use CO_2 standard.
- Section 86.1838-01: We are restoring text that was inadvertently removed in an earlier amendment. The restored text specifies which mileage provisions from §86.1845 do not apply for small-volume manufacturers doing in-use verification testing.
- Section 86.1868: We are adopting detailed provisions describing how reduced air conditioning test requirements apply for electric vehicles and plug-in hybrid electric vehicles. These provisions are consistent with current practice described in EPA guidance. We specify that plug-in hybrid electric vehicles qualify for relief from AC17 testing, like electric vehicles, if they have an adjusted all electric range of 60 miles or more and they do not need engine power for cabin cooling during vehicle operation represented by the AC17 procedure; in response to a comment on the proposed rule, we have revised the amended regulatory text to clarify that the specified driving range applies for combined city/highway driving. Specifying a 60-mile range is intended to include vehicles for which an owner can typically expect to avoid using the engine for daily commuting, including commutes on a hot summer day. Finally, we are clarifying that manufacturers do not need to make a demonstration to qualify for air conditioning efficiency credits for pure electric vehicles or for plug-in hybrid electric vehicles, provided that those vehicles qualify for waived AC17 testing as described above. This is due to the complexity of quantifying credit quantities in grams CO_2 per mile for driving without engine power. We also specify that AC17 testing with plug-in hybrid electric vehicles, if required, always be done in charge-sustaining mode to avoid the confounding effect of intermittent engine operation during the test.

E. Additional Amendments for Locomotives (40 CFR Part 1033)

EPA is updating 40 CFR part 1033 to remove references to specific content in 40 CFR part 92, as described in Section III.B.2. In addition, we are adopting the following minor corrections and changes:

- Section 1033.150: Remove the interim provisions that no longer apply. This leaves paragraphs (e) and (k) as the only remaining paragraphs in this section.
- Section 1033.255: Clarify that doing anything to make information false or incomplete after submitting an application for certification is the same as submitting false or incomplete information. For example, if there is a change to any corporate information or engine parameters described in the manufacturer's previously submitted application for certification, the manufacturer must amend the application to include the new information. Amendments include additional minor changes to align regulatory text across programs.
- Section 1033.601: Correct references to specific provisions in 40 CFR part 1068.
- Section 1033.701: Correct a paragraph reference.

- Section 1033.740: Remove the reference to part 92 because the emission credit provisions of part 92 are being removed from the CFR. We are replacing the reference to emission credits from part 92 with the equivalent statement saying that manufacturers may continue to use emission credits from locomotives certified in 2008 and earlier model years. EPA's recordkeeping will not identify credits as being from either part 92 or part 1033. Any credits generated under part 92 will continue to be available for certifying locomotives under part 1033.
- Section 1033.901: Name the date, January 1, 2000, that marked the start of the original locomotive emission standards, rather than describing the date with reference to publication of the original final rule and its effective date (18978 FR 63, April 16, 1998).
- Section 1033.925: Removing text in paragraph (e) that is already in paragraph (b) of the same section.

F. Additional Amendments for Land-Based Nonroad Diesel Engines (40 CFR Part 1039)

EPA's emission standards and certification requirements for land-based nonroad compression-ignition (CI) engines are identified in 40 CFR part 1039. We refer to these as Nonroad CI engines. Several changes to 40 CFR part 1039 that apply broadly are described above. Specifically, Section III.B.2 describes how we are removing regulatory content related to the Tier 1, Tier 2, and Tier 3 standards originally adopted in 40 CFR part 89. We are accordingly amending 40 CFR part 1039 to remove references to 40 CFR part 89 that no longer apply.

This section describes additional amendments for EPA's Nonroad CI program:

- Section 1039.20: Remove the option to use a branded name instead of the engine manufacturer's corporate name for uncertified stationary engines. Since these engines are not certified, there is no way for EPA to document any relationship between the engine manufacturer and the branded company. We also are not aware of anyone using this provision.
- Section 1039.20: Revise the label statement for stationary engines covered by §1039.20 to avoid references to specific parts of the CFR. This is intended to prevent confusion. We can approve continued use of labels with the older previous statement under the provisions of §1039.135(f). This may be needed, for example, if manufacturers have remaining labels in their inventory.
- Section 1039.101: Add a table entry to clarify how standards apply for engines with maximum engine power above 560 kW. The current rendering in the Code of Federal Regulations can be misleading.
- Section 1039.102: Correct the heading of Table 6 to include engines at or below 560 kW. The table was published in a way that inadvertently excluded 560 kW engines.
- Section 1039.135: Discontinue the equipment labeling requirement to state that engines must be refueled with ultra low-sulfur diesel fuel (ULSD). Since in-use diesel fuel for these engines must universally meet ULSD requirements, there is no longer a benefit to including this label information.
- Section 1039.205: Add text to clarify how engine manufacturers should identify information in the application for certification related to engine diagnostic systems that are required under §1039.110.
- Section 1039.255: Clarify that doing anything to make information false or incomplete after submitting an application for certification is the same as submitting false or

incomplete information. For example, if there is a change to any corporate information or engine parameters described in the manufacturer's previously submitted application for certification, the manufacturer must amend the application to include the new information. Amendments include additional minor changes to align regulatory text across programs.

- Section 1039.740: Remove the reference to emission credits from part 89. There is no need for this since the records related to credit accounting do not identify credits as being from part 89 or part 1039.
- Section 1039.801: Revise the definition of "low-hour" to state that engines with NOx aftertreatment should qualify as "low-hour" up to 300 hours, with other engines qualifying as "low-hour" up to only 125 hours. This is intended to ensure that engines tested to establish the low-hour emission result for an engine family are properly represented as new engines that have not started to experience deterioration of emission controls. In line with the comments from EMA, we understand the longer stabilization period to be appropriate for engines with NOx aftertreatment. In contrast, engines without NOx aftertreatment reach a point of stabilized emission levels much sooner, which supports the shorter duration for low-hour testing before starting service accumulation. This does not preclude continued testing beyond 125 hours for engines without NOx aftertreatment, but it would prevent manufacturers from planning test programs that extend well beyond 125 hours. This is similar to provisions that already apply for marine diesel engines under 40 CFR part 1042; however, we are also adjusting the definition of "low-hour" for marine diesel engines to reference NOx aftertreatment instead of a power cutoff.
- Section 1039.801: Revise the definition of "small-volume engine manufacturer" to remove the requirement to have certified engines in the United States before 2003. This limitation was related to the transition to meeting the Tier 4 standards. Now that those phase-in provisions have expired, the remaining provisions relate to reporting CH_4 and N_2O emissions and using assigned deterioration factors. We believe these provisions can reasonably be applied to start-up small businesses meeting the Tier 4 standards.

G. Additional Amendments for Marine Diesel Engines (40 CFR Parts 1042 and 1043)

EPA's emission standards and certification requirements for marine diesel engines under the Clean Air Act are set out in 40 CFR part 1042. Emission standards and related fuel requirements that apply internationally are set out in 40 CFR part 1043.

Several changes to 40 CFR part 1042 that apply more broadly are described above. Specifically, Section III.B.2 describes how we are removing regulatory content related to the Tier 1 and Tier 2 standards originally adopted in 40 CFR part 94. We are accordingly amending 40 CFR part 1042 to remove references to 40 CFR part 94 that no longer apply.

This section describes additional amendments for our marine diesel engine program.

1. Marine Replacement Engine Exemption

We are adopting several adjustments to the replacement engine exemption in §1042.615.

a. EPA's Advance Determination for Tier 4 Marine Replacement Engines

The proposed rule described that we were intending to clarify the regulatory determination that applies for cases involving new replacement engines that are normally subject to Tier 4 standards (see §1042.615(a)(1)). In the 2008 final rule to adopt the Tier 4 standards, we finalized a determination "that Tier 4 engines equipped with aftertreatment technology to control either NO_x or PM are not required for use as replacement engines for engines from previous tiers in accordance with this regulatory replacement engine provision." The preamble to that final rule made it clear that the determination was limited to "Tier 4 marine diesel replacement engines that comply with the Tier 4 standards through the use of catalytic aftertreatment systems." (73 FR 37157) However, that limitation was not copied into the regulatory text. The development involving Tier 4 engines that rely on EGR instead of aftertreatment led us to revisit the discrepancy from the 2008 rule. The 2008 rule also stated that "[s]hould an engine manufacturer develop a Tier 4 compliant engine solution that does not require the use of such technology, then this automatic determination will not apply."

EMA and the California Air Resources Board (CARB) both commented on the proposed change to the replacement engine exemption in §1042.615(a)(1). EMA's comment suggested that we should leave the regulatory text in §1042.615(a)(1) unchanged from what we adopted in 2008. CARB suggested that we entirely abandon the advance determination that Tier 4 engines are not suitable as replacements for earlier engines, regardless of aftertreatment, which would require a case-by-case engineering analysis in all cases to demonstrate that an exemption is appropriate.

As we explained in the 2008 rulemaking, an engine manufacturer is generally prohibited from selling a marine engine that does not meet the standards that are in effect when that engine is produced. However, we recognized that there may be situations in which a vessel owner may require an engine certified to an earlier tier of standards, including (1) when a vessel has been designed to use a particular engine such that it cannot physically accommodate a different engine due to size or weight constraints (e.g., a new engine model will not fit into the existing engine compartment); or (2) when the engine is matched to key vessel components such as the propeller, or when a vessel has a pair of engines that must be matched for the vessel to function properly. Our 2008 rule allows the engine manufacturer to make the relevant determinations, but we adopted a provision that requires the engine manufacturer to consider all previous tiers and use any of their own engine models from the most recent tier that meets the vessel's physical and performance requirements. If an engine manufacturer produces an engine that meets a previous tier of standards representing better control of emissions than that of the engine being replaced, the manufacturer would need to supply the engine meeting the tier of standards with the lowest emission levels.

At that time, we made an advance determination that Tier 4 engines would not be required as replacement engines for previous tier engines. As we explained in Section IV.C.2 of the final rule preamble, we expected that installing such a Tier 4 engine in a vessel that was originally designed and built with a previous tier engine could require extensive vessel modifications (e.g., addition of a urea tank and associated plumbing; extra room for a SCR or PM filter; additional control equipment) that may affect important vessel characteristics such as vessel stability. We stated that we were not implying Tier 4 engines would never be appropriate as replacements for engines from previous tiers; rather, the determination was intended to simplify the search across engines and was based on the presumption that Tier 4 engines would not fit in most cases. We also stated that the advance determination was made solely for Tier 4 marine diesel replacement engines that comply with the Tier 4 standards through the use of catalytic aftertreatment systems. We stated: "Should an engine manufacturer develop a Tier 4 compliant engine solution that does not require the use of such technology, then this automatic determination will not apply. Instead our existing provision will apply and it would be necessary to show that a non-catalytic Tier 4 engine would not meet the required physical or performance needs of the vessel."

We were also not intending to prevent states or local entities from including Tier 4 engines in incentive programs that encourage vessel owners to replace existing previous tier engines with new Tier 4 engines or to retrofit control technologies on existing engines, since those incentive programs often are designed to offset some of the costs of installing or using advanced emission control technology solutions. However, on a national basis, we continue to believe our original approach described in the 2008 final rule is appropriate. The characteristics of the national fleet are likely different from the fleet of vessels affected in California; taking away the Tier 4 determination should not be made lightly or without a thorough understanding of the impact on existing boats. It would therefore be appropriate for us to include the advance determination that Tier 4 engines with aftertreatment are not suitable as replacement for earlier engines. In particular, we stand by our 2008 assessment that it is appropriate to automatically consider SCR-equipped engines to not have "the appropriate physical or performance characteristics to repower" pre-Tier 4 vessels, which in turn qualifies the repower for an exempt replacement engine.

EMA objected to the proposed clarification to apply the advance determination only for engines that meet Tier 4 standards with aftertreatment. The EMA comment suggests that the same presumption and regulatory burden should apply for EGR-equipped engines because compliant engines with EGR instead of aftertreatment also necessarily involve significant costs and vessel redesigns. EGR-equipped engines use exhaust gas recirculation (EGR) instead of SCR to control NOx emissions. Engines with EGR include additional hardware to manage airflow in and through the engine, and to manage wastewater.

Revising the regulation to make clear that the advance determination was not intended to include EGR-equipped engines from the advance determination is in fact a very minor change in policy. Engine manufacturers may still qualify for the replacement engine exemption based on a showing that an EGR-equipped engine does not have "the appropriate physical or performance characteristics to repower the vessel." However, there are two reasons to believe that EGR-equipped engines may be suitable for repower. First, all EGR-equipped Tier 4 engines are locomotive-sized Category 2 engines. Vessels with Category 2 engines generally have engine compartments that have room for additional hardware and other componentry. Second, the additional hardware for EGR-equipped engines would generally involve a greater design effort than upgrading to a Tier 3 engine, but this kind of change would often fit within the scope of vessel repower projects. Vessel owners would also need to follow new protocols for maintaining the engines and dealing with wastewater and other technical issues. None of these challenges create any inherent conflict with installing the Tier 4 engines to replace earlier engines.

These factors together support a policy in which an EGR-equipped engine can be considered unsuitable for repower based on its physical or performance characteristics, but this conclusion should not be presumed. We would accomplish that policy objective by revising §1042.615(a)(1) as proposed.

b. Other Amendments Related to Marine Replacement Engines

We are modifying the requirement that engine manufacturers notify EPA after shipping exempt replacement engines. As originally adopted, §1042.615(a) requires an engine manufacturer to send EPA notification 30 days after shipping an exempt engine to demonstrate that the selected engine was the cleanest available for the given installation. We indicated that "[t]hese records will be used by EPA to evaluate whether engine manufacturers are properly making the feasibility determination and applying the replacement engine provisions." We also indicated that we expected engine manufacturers to examine "not just engine dimensions and weight but other pertinent vessel characteristics such as drive shafts, reduction gears, cooling systems, exhaust and ventilation systems, and propeller shafts; electrical systems; … and such other ancillary systems and vessel equipment that would affect the choice of an engine." While engine manufacturers have submitted these reports, the information provided has not supported our original objective. Specifically, the reports vary widely in information provided but in many instances are too case-specific. Therefore, we are requiring manufacturers to submit a single annual report that is due at the same time as the general requirement for reporting on replacement engines under 40 CFR 1068.240. The annual report would include the information described in our 2008 rule for all the affected engines and vessels. This change would provide a predictable schedule for EPA to review the submitted information. This would also allow EPA to standardize the format and substance of the reported information. Manufacturers would benefit from submitting a consistent set of information in an annual submission for all their replacement engine information.

We are revising the regulatory instructions for submitting replacement engine reports under §1042.615. The replacement engine exemption applies only for engines that are shipped to boat owners or are otherwise designated for a specific vessel. Engine manufacturers may produce and ship exempt replacement engines (with per-cylinder displacement up to 7 liters) without making the specified demonstrations, as allowed under 40 CFR 1068.240(c), but manufacturers may produce only a limited number of those "untracked" engines in a given year. Those untracked replacement engines are covered by the reporting requirements that apply under §1068.240 since the tracked exemption under §1042.615 and §1068.240(b) does not allow for shipping engines to distributors without identifying a specific installation and making the necessary demonstrations for that installation. We are taking a streamlined approach for reporting related to Tier 3 engines since the demonstration for those engines consists of affirming EPA's regulatory determination that no suitable Tier 4 engines (without aftertreatment) are available for replacement. We do not expect engines with per-cylinder engine displacement below 7 liters to be able to meet Tier 4 standards without aftertreatment devices. As a result, Tier 3 replacement engines are limited only in that they may not be used to replace engines that were certified to Tier 4 standards.

Finally, we are clarifying that the determination related to Tier 4 replacement engines applies differently for engines that become new based on vessel modifications. Under the definition of "new vessel" in §1042.901, modification of an existing vessel may cause the vessel to become "new" if the vessel modifications cause the vessel's assessed value to at least double. In this case, all engines installed on the vessel are subject to standards for the model year based on the date of vessel modifications. Since the effective dates of the Tier 4 standards, we have learned that there may be circumstances in which vessel modifications may be substantial enough to qualify a vessel as "new," but the installation of new Tier 4 engines may not be practical or feasible without cost-prohibitive additional vessel modifications. For example, a commercial vessel owner may want to substantially upgrade an older vessel, including engine replacement with a much lower-emitting engine. If the upgrade doubles the assessed value of the vessel, this would trigger a need for all installed or replacement engines above 600 kW to be certified to Tier 4 standards. We have learned that such a project may become cost-prohibitive based on the additional vessel modifications needed to accommodate the Tier 4 engine, which could cause the vessel to continue operating in the higher-emitting configuration. To address this scenario, we are allowing the replacement engine exemption for certain vessels that become new because of modifications, subject to a set of conditions. Specifically, the exemption would apply only with EPA's advance approval based on a demonstration that the installation of a Tier 4 engine would require significant vessel redesign that is infeasible or impractical. EPA's assessment may account for the extent of the modifications already planned for the project. EPA may approve installation of Tier 3 engines instead of Tier 4 engines for qualifying vessels. Recreational engines and commercial engines below 600 kW are not subject to Tier 4 standards. As a result, if a vessel becomes new through modification, it should be reasonable to expect such new engines to be certified to Tier 3 standards rather than being eligible for the replacement engine exemption.

2. Provisions Related to On-Off Controls for Marine Engines

EPA adopted the current set of emissions standards for Category 3 marine diesel engines in 2010 (75 FR 22932; April 30, 2010). The Tier 3 standards include provisions allowing engine manufacturers to design their engines with control systems that allow an engine to meet the Tier 3 standards while operating in U.S. waters, including the North American Emission Control Area and the U.S. Caribbean Sea Emission Control Area (ECAs), and the less stringent Tier 2 standards while operating outside of U.S. waters. We refer to this design strategy as "on-off control." These provisions reflect the geographic nature of the NOx engine standards contained in Regulation 13, MARPOL Annex VI.

Engine manufacturers have raised questions about the meaning of the regulatory provision at §1042.101 that requires Category 3 engines to "comply fully with the Tier 2 standards when the Tier 3 emission controls are disabled." This was intended to incorporate the "on-off controls" allowed under MARPOL Annex VI for the IMO Tier III NOx limits. The HC and CO standards for Category 3 engines apply equally for EPA's Tier 2 and Tier 3 standards adopted under the Clean Air Act, so there should be no question that those standards apply even if NOx controls are disabled. While 40 CFR 1042.104 includes a PM requirement, it is a reporting requirement only. The only other "standard" for Category 3 engines in 40 CFR part 1042 is the requirement related to mode caps in §1042.104(c). The mode caps serve as separate emission standards for each test point in the duty cycle used for certifying the engines. The 2010 final rule describes how the mode caps are necessary for proper implementation of the Tier 3 standards for SCR-equipped engines (75 FR 22932). Since Category 3 engines with SCR systems would generally comply with the Tier 2 NOx standard in the "disabled" configuration without SCR, we believe there would be no benefit to applying the mode caps as a part of the Tier 2 configuration for these Tier 3 engines with on-off controls. We are therefore clarifying that the mode caps are associated only with the Tier 3 NOx standards. This approach is consistent with the on-off control provisions adopted under MARPOL Annex VI.

The regulation also allows for on-off controls for NOx for auxiliary engines used on vessels powered by Category 3 engines. More broadly, §1402.650(d) allows those auxiliary engines to be certified to MARPOL Annex VI standards instead of being certified to EPA's emission standards under 40 CFR part 1042. The regulation as originally written describes how these engines must comply with EPA's Tier 3 and Tier 4 standards in the same way that Category 3 engines must comply with EPA's Tier 2 and Tier 3 standards. However, since auxiliary engines installed on Category 3 vessels are certified to MARPOL Annex VI standards instead of EPA's emission standards, the regulation should describe how these auxiliary engines must meet the IMO Tier II and IMO Tier III NOx standards to comply with the on-off control provisions under §1042.115(g). These requirements related to the EIAPP certificates for engines with on-off controls are addressed under MARPOL Annex VI and 40 CFR part 1043.

3. Miscellaneous Marine Diesel Amendments

EPA is making several additional changes across 40 CFR part 1042 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions. Specifically, the final rule includes the following amendments:

- Section 1042.101: Revise the instruction for specifying a longer useful life. The regulation as originally adopted states that engine design, advertising, and marketing may equally serve as the basis for establishing a longer useful life. We would not expect manufacturers to specify a longer useful life based only on advertising and marketing claims. The amendment emphasizes that design life is the basis for specifying a longer useful life, with the further explanation that the recommended overhaul interval can be understood, together with advertising and marketing materials and other relevant factors, to properly represent an engine's design life.
- Section 1042.101: The Federal Register mistakenly published references to Tier 3 p.m. standards and Tier 4 p.m. standards. Since we intended for those standards to apply at all times, we are amending the regulation to properly refer to those as Tier 3 PM standards and Tier 4 PM standards.
- Section 1042.115: Revise the provision related to on-off controls to clarify that we have designated NOx Emission Control Areas (ECAs) for U.S. waters. We no longer need to reference a possible future ECA. We will rely on the U.S. ECA boundaries to establish the area in which engines with on-off controls for aftertreatment-based standards need to be fully operational.
- Section 1042.125: Add maintenance requirements for fuel-water separator cartridges or elements as an additional example of maintenance that is not emission-related. This aligns with the maintenance specifications for land-based nonroad diesel engines in 40 CFR part 1039.
- Section 1042.135: Revise the labeling instruction for engines installed in domestic-only vessels to clarify that it applies only for engines above 130 kW, and that it applies equally for commercial and recreational vessels. These changes both align the EPA regulations to more closely align with the international standards under MARPOL Annex VI.
- Section 1042.145: Remove obsolete paragraphs. We proposed to revise §1042.145(j) to adjust the provision related to using certified land-based engines in marine vessels; however, we are reconsidering those changes and may again pursue such further amendments to those provisions.
- Section 1042.255: Clarify that doing anything to make information false or incomplete after submitting an application for certification is the same as submitting false or incomplete information. For example, if there is a change to any corporate information or engine parameters described in the manufacturer's previously submitted application for certification, the manufacturer must amend the application to include the new information. Amendments include additional minor changes to align regulatory text across programs.
- Section 1042.302: For emission testing during sea trials for Category 3 engines with on-off controls, allow manufacturers the flexibility to omit testing in Tier 2 mode if they do not need aftertreatment to meet the Tier 2 standards. We are most interested in compliance with the Tier 3 standards, since those controls are active anytime vessels are operating within ECA boundaries. System design and calibration with

aftertreatment involves greater uncertainty than engines that comply using only in-cylinder controls. As a result, we believe the compliance demonstration for Tier 2 mode adds value only if it involves aftertreatment.

- Section 1042.650: Revise the introductory text to clarify that paragraphs (a) through (c) continue to apply only for Category 1 and Category 2 engines, and that the provisions related to auxiliary engines on Category 3 vessels in paragraph (d) apply equally for Category 3 auxiliary engines. By adding paragraph (d) with limitation described in the section's introductory text, we inadvertently excluded Category 3 auxiliary engines.
- Section 1042.655: Clarify that measuring engine-out emissions for engines that use exhaust aftertreatment must account for the backpressure and other effects associated with the aftertreatment devices. While improving the alignment between measured results and modeled results, this change also has the effect of removing the expectation that engine-out (pre-catalyst) emissions must meet Tier 2 standards; this is intended to address the case in which an engine may meet the Tier 2 standards with a different SCR dosing strategy rather than by completely disabling the SCR system.
- Section 1042.701: Remove the reference to emission credits from part 94. This reference is not needed since the records related to credit accounting do not identify credits as being from part 94 or part 1042.
- Section 1042.801: Remove the requirement to register fuels used to certify remanufacturing systems. EPA does not register fuels such as natural gas or liquefied petroleum gas, so it is not appropriate to impose such a registration requirement. The requirement continues to apply for remanufacturing systems that are based on diesel fuel additives.
- Section 1042.901: Revise the definition of "low-hour" to state that engines with NOx aftertreatment should qualify as "low-hour" up to 300 hours, with other engines qualifying as "low-hour" up to only 125 hours. This change shortens the low-hour testing period for recreational engines above 560 kW, and for commercial engines with maximum engine power between 560 and 600 kW. This change is intended to ensure that low-hour engine testing are properly represented as new engines that have not started to experience deterioration of emission controls. Engines with NOx aftertreatment need extra time to achieve stabilized emission rates. In contrast, engines without NOx aftertreatment reach a point of stabilized emission levels much sooner, which supports the shorter duration for low-hour testing before starting service accumulation. This does not preclude continued testing beyond 125 hours for engines without NOx aftertreatment, but it would prevent manufacturers from planning test programs that extend well beyond 125 hours. We requested comment on this approach in the proposed rule, and EMA submitted comments supporting this adjustment.
- Section 1043.41: Clarify that engine manufacturers may continue to produce new engines under an established EIAPP certificate after a change in emission standards for purposes other than installation in a new vessel. For example, manufacturers may need to produce engines certified to IMO Tier II NOx standards after 2016 for installation as replacement engines in vessels built before 2016.
- Section 1042.910 and §1043.100: Incorporate by reference the 2017 edition of MARPOL Annex VI and the NOx Technical Code, dated 2017, which contains all amendments through 2016.

H. Portable Fuel Containers (40 CFR Part 59)

EPA's emission standards and certification requirements for portable fuel containers are described in 40 CFR part 59. Section III.A describes an amendment related to test fuel specifications. In addition, we are adopting the following amendments:

- Section 59.626: Correct the reference to additional testing to recognize that the manufacturer may need to test multiple containers.
- Section 59.628: Align recordkeeping specifications with the provisions that apply for nonroad engines and equipment. This removes the ambiguity from applying specifications differently for different types of testing information. As noted in Section III.J, now that test records are stored electronically, there is no reason to differentiate testing information into routine and non-routine records.
- Section 59.650: Revise the blending instruction to specify a lower level of precision; specifying a range of 10.0±1.0 percent, which is consistent with the approach we take in 40 CFR 1060.515 and 1060.520.
- Section 59.653: Correct the pressure specification for durability testing. The amendment adjusts the kPa value to match the psi value in the regulation. This aligns with the pressure testing specified for nonroad fuel tanks.
- Section 59.653: Clarify that the fuel fill level needs to stay at 40 percent full throughout slosh testing. The container should be closed for the duration of the test, so this clarification is mainly intended to ensure that the fuel tank does not leak during the test.
- Section 59.660: Revise the test exemption to clarify that anyone subject to regulatory prohibitions may ask for a testing exemption.
- Section 59.664: Correct the web address for U.S. Department of Treasury Circular 570.
- Section 59.680: Clarify how the definition of "portable fuel container" applies for different colors. The regulatory text states that red, yellow, and blue utility jugs qualify as portable fuel containers regardless of any contrary labeling or marketing. This is intended to prevent circumvention of emission standards with containers that would be commonly recognized as portable fuel containers. Containers that are not red, yellow, or blue qualify as fuel containers if they meet the criteria described in the definition. The amendment to clarify this point does not represent a change in policy. For example, anyone who sold uncertified purple portable fuel containers that were subject to standards may be in violation of the prohibitions in 40 CFR 59.602.

We received no adverse comments on the proposed amendments to 40 CFR part 59 and are adopting these amendments without modification.

I. Evaporative Emission Standards for Nonroad Spark-Ignition Engines and Equipment (40 CFR Part 1060)

EPA adopted evaporative emission standards and test procedures in 40 CFR part 1060. Section III.A describes amendments related to test fuel specifications. EPA is also adopting numerous changes across 40 CFR part 1060 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions. This includes the following changes:

- Sections 1060.1 and 1060.801: Clarify how standards apply for portable nonroad fuel tanks.
- Sections 1060.30 and 1060.825: Consolidate information-collection provisions into a single section.
- Section 1060.104: Clarify that any approval from California ARB is sufficient for demonstrating compliance with running loss standards, rather than limiting this to approved Executive Orders.
- Section 1060.105: Clarify the requirement for tanks to be sealed to recognize the exception allowed under the regulation.
- Sections 1060.105 and 1060.240: Allow manufacturers more generally to exercise the alternative of using procedures adopted by California ARB. This is necessary to allow testing with the E10 test fuel adopted by California ARB after the 2004 version of its regulation that is currently referenced in the Code of Federal Regulations.
- Section 1060.120: Update the terminology to refer to "the date the equipment is sold to the ultimate purchaser" instead of the "point of first retail sale." We also don't want to prohibit manufacturers from including components in the warranty if they fail without increasing evaporative emissions. These changes align with similar amendments in our other programs.
- Section 1060.130: Clarify how manufacturers must identify limitations on the types of equipment covered by the application for certification, especially for fuel caps. We allow equipment manufacturers to certify their equipment using widely varying approaches for fuel caps. The equipment manufacturer's certification and testing method needs to be reflected in their instructions for anyone completing assembly of equipment from that equipment manufacturer.
- Section 1060.135: Clarify how the equipment labeling provisions apply for engine manufacturers, and clarify that manufacturers need to apply labels at the time of manufacture. In many cases, the labeling is integral to the production process, such as for molded fuel tanks.
- Section 1060.135: Allow for permanently identifying the date of manufacture somewhere other than the emission control information label using any method (not only stamping or engraving) and require that the manufacturer describe in the application for certification where the equipment identifies the date of manufacture.
- Section 1060.135: We proposed to revise paragraph (b)(5) to simplify the equipment labeling options; however, we decided to defer action on this change in this rulemaking. This leaves the regulatory text unchanged, which allows all the existing labeling options available for manufacturers. We may consider amending these labeling provisions in a future rulemaking.
- Section 1060.137: Clarify when and how to label fuel caps. This depends only on whether the fuel cap is certified, not on whether the fuel cap is mounted directly on the fuel tank. It is also important to include the part number on the fuel cap if the equipment is designed with a pressurized fuel tank.
- Section 1060.205: Clarify that the application for certification needs to identify the EPA-issued emission family name if the certified configuration relies on one or more certified components.

- Section 1060.205: Replace the requirement to submit data from invalid tests with a requirement to simply notify EPA in the application for certification if a test was invalidated.
- Section 1060.225: Clarify how manufacturers may amend the application for certification during and after the model year, consistent with the current policy regarding field fixes.
- Section 1060.235: Clarify that we can direct manufacturers to send test products to EPA for confirmatory testing, or to a different lab that we specify.
- Section 1060.235: Add an explicit allowance for carryover engine families to include the same kind of within-family running changes that are currently allowed over the course of a model year. The original text may have been understood to require that such running changes be made separate from certifying the engine family for the new model year.
- Section 1060.250: Remove references to routine and standard tests and remove the shorter recordkeeping requirement for routine data (or data from routine tests). We are adopting an amendment to require that all test records must be kept for eight years. With electronic recording of test data, there should be no advantage to keeping the shorter recordkeeping requirement for a subset of test data. EPA also notes that the eight-year period restarts with certification for a new model year if the manufacturer uses carryover data.
- Section 1060.255: Clarify that doing anything to make information false or incomplete after submitting an application for certification is the same as submitting false or incomplete information. For example, if there is a change to any corporate information or parameters described in the manufacturer's previously submitted application for certification, the manufacturer must amend the application to include the new information. Amendments include additional minor changes to align regulatory text across programs.
- Section 1060.505: Revise the provision describing alternative test procedures to align with parallel text in 40 CFR 1065.10(c). It is important to note that approved alternative procedures increase flexibility for certifying manufacturers without limiting available methods for EPA testing.
- Section 1060.520: For slosh testing and for the preconditioning fuel soak, specify that the fuel fill level should not decrease during testing, other than what would occur from permeation and from any appropriate testing steps to perform durability tests during the preconditioning fuel soak. We also specify that leaking fuel tanks are never suitable for testing, even if there is a potential to repair the leak.
- Section 1060.601: Remove the reference to fuel caps since there is no need for a separate description about how the regulatory prohibitions apply for fuel caps. As noted in §1061.1(c), fuel cap manufacturers that choose to certify their fuel caps under 40 CFR part 1060 become subject to all the requirements associated with certification.
- Section 1060.610: Adopt provisions clarifying how manufacturers can ship products that are not yet certified if that is needed for completing assembly at multiple locations, including shipment between companies and shipment between two facilities from a single company. These provisions are analogous to the provisions that apply for engines in 40 CFR 1068.260.
- Section 1060.640: Migrate engine branding to 40 CFR 1068.45.

- Section 1060.801: Update the contact information for the Designated Compliance Officer.
- Section 1060.801: Revise the definition of "model year" to clarify that the calendar year relates to the time that engines are produced under a certificate of conformity.
- Section 1060.801: Revise the definition of "placed into service" to prevent circumvention that may result from a manufacturer or dealer using a piece of equipment in a way that could otherwise cause it to no longer be new and subject to the prohibitions of 40 CFR 1068.101.
- Section 1060.81: Correct the web address for the American Boat and Yacht Council.
- Section 1060.815: Migrate provisions related to confidential business information to 40 CFR part 1068.

J. Additional Amendments for Nonroad Spark-Ignition Engines at or Below 19 kW (40 CFR Part 1054)

EPA's emission standards and certification requirements for nonroad spark-ignition engines at or below 19 kW are described in 40 CFR part 1054. EPA is adopting numerous changes across 40 CFR part 1054 to correct errors, to add clarification, and to make adjustments based on lessons learned from implementing these regulatory provisions. This includes the following changes:

- Section 1054.1: Clarify that the provision allowing for voluntary certification under 40 CFR part 1054 for larger engines applies only for engines up to 30 kW and up to 1,000 cubic centimeters.
- Section 1054.2: Add a clarifying note to say that a person or other entity other than a conventional "manufacturer" may need to certify engines that become new after being placed into service (such as engines converted from highway or stationary use). This is intended to address an assumption that only conventional manufacturers can certify engines.
- Sections 1054.30, 1054.730, and 1054.825: Consolidate information-collection provisions into a single section.
- Section 1054.120: Clarify that extended-warranty requirements apply for the emission-related warranty only to the extent that warranties are actually provided to the consumer, rather than to any published warranties that are offered. The principles are that the emission-related warranty should not be less effective for emission-related items than for items that are not emission-related, and that the emission-related warranty for a given component should not be less effective than the basic mechanical warranty for that same component.
- Section 1054.125: Allow for special maintenance procedures that address low-use engines. For example, operators in certain circumstances may perform engine maintenance after a smaller number of hours than would otherwise apply.
- Section 1054.130: Remove references to "nonroad" equipment to accommodate regulations for stationary engines in 40 CFR part 60, subpart JJJJ, that rely on these same provisions.
- Section 1054.135: Allow for including optional label content only if this does not cause the manufacturer to omit other information based on limited availability of space on the label.

- Section 1054.145: Remove obsolete content. Most of the provisions in this section were needed only for the transition to the Phase 3 standards. We are also clarifying that the provision that allows for testing with California Phase 2 test fuel applies only through model year 2019. California ARB requires testing with its Phase 3 test fuel starting in model year 2020.
- Section 1054.205: Replace the requirement to submit data from invalid tests with a requirement to simply notify EPA in the application for certification if a test was invalidated.
- Section 1054.205: Specify that the application for certification needs to include estimated initial and final dates for producing engines for the model year, and an estimated date for the initial introduction into U.S. commerce. This information helps with managing information in the application and overseeing testing and other compliance requirements. This amendment aligns with current practice.
- Section 1054.225: Simplify the instruction on changing the Family Emission Limit during the model year to specify that the manufacturer must identify the date of the change based only on the month and year. This change aligns with current practice for amending applications for certification.
- Section 1054.225: Clarify how manufacturers may amend the application for certification during and after the model year, consistent with the current policy regarding field fixes.
- Section 1054.235: Clarify that air-fuel ratio and other adjustable parameters are part of the selection of a worst-case test configuration for emission-data engines. If an engine has rich and lean settings, the manufacturer should determine which is the worst-case setting for emission measurements to determine deterioration factors. In particular, it is not appropriate to combine results from different settings to calculate any kind of average or composite value. Service accumulation between emission measurements may include any representative combination of those settings.
- Section 1054.235: Add an explicit allowance for carryover engine families to include the same kind of within-family running changes that are currently allowed over the course of a model year. The original text may have been understood to require that such running changes be made separate from certifying the engine family for the new model year.
- Section 1054.235: Clarify how EPA will calibrate engines within normal production tolerances for things that are not adjustable parameters.
- Sections 1054.235, 1054.240, 1054.245, 1054.601, and 1054.801: Describe how to demonstrate compliance with dual-fuel and flexible-fuel engines. This generally involves testing with each separate fuel, or with a worst-case fuel blend.
- Section 1054.240: Clarify that each measurement from emission-data vehicles must meet emission standards.
- Section 1054.245: Clarify the basis for EPA approval for using deterioration factors from other engines. EPA approval depends on the manufacturer demonstrating that emission measurements reasonably represent in-use deterioration for the engine family being certified. This copies in regulatory text that already applies under other EPA programs.
- Section 1054.245: Copy in the values and formulas used for assigned deterioration factors for handheld and nonhandheld engines. This includes a minor correction to the

equation from 40 CFR 90.104(g) and a new description about combining deterioration factors for HC and NOx, but otherwise maintains the current policy and practice for these deterioration factors.

- Section 1054.250: Remove references to routine and standard tests and remove the shorter recordkeeping requirement for routine data (or data from routine tests). We are adopting a requirement to keep all test records for eight years. With electronic recording of test data, there should be no advantage to keeping the shorter recordkeeping requirement for a subset of test data. EPA also notes that the eight-year period restarts with certification for a new model year if the manufacturer uses carryover data.
- Section 1054.255: Clarify that doing anything to make information false or incomplete after submitting an application for certification is the same as submitting false or incomplete information. For example, if there is a change to any corporate information or engine parameters described in the manufacturer's previously submitted application for certification, the manufacturer must amend the application to include the new information.
- Section 1054.255: Clarify that voiding certificates for a failure to comply with recordkeeping or reporting requirements will be limited to the certificates that relate to the particular recordkeeping or reporting failure.
- Section 1054.301: Clarify the process for requesting a small-volume exemption from production-line testing. This is better handled as preliminary approval under §1054.210 rather than including it as part of the application for certification.
- Section 1054.310: Provide an example to illustrate how manufacturers may need to divide the annual production period into four quarters if it is longer (or shorter) than 52 weeks.
- Section 1054.315: Clarify that results from repeat tests can be averaged together, provided that the engine is not modified during the test program. This applies for engine modifications to switch to a different engine configuration or to improve emission control for a given engine configuration.
- Sections 1054.315 and 1054.320: Clarify how to manage test results for engines that fail an emission standard. Manufacturers must use the PLT test result from a failing engine regardless of the disposition of the failing engine. Manufacturers report test results after modifying a failing engine to show that it can be covered by the certificate of conformity, but manufacturers may factor these test results into PLT calculations only if the manufacturer changes production processes for all further engines to match the adjustments made to the failing engine. In that case, the test results from the modified engine count as a new test engine for the PLT calculations, rather than replacing the results from the engine before modifications. These regulatory changes codify the practice we have already established by guidance.[30]
- Section 1054.505: Clarify the instructions for controlling torque at non-idle test modes, and for demonstrating compliance with cycle-validation criteria. The revised language more carefully describes the current practice for testing engines.
- Section 1054.620: Clarify that provisions apply for any kind of competition, not just racing.

[30] "Production Line Testing (PLT) Report Clarification", EPA guidance document CD-15-21, August 31, 2015.

- Sections 1054.625 and 1054.626: Remove obsolete text.
- Section 1054.640: Migrate engine branding provisions to §1068.45.
- Section 1054.690: Correct the web address for U.S. Department of Treasury Circular 570 and clarify how an automatic suspension of a certificate of conformity applies for certain numbers of engines, and how U.S. Customs incorporates the bonding requirements into its entry procedures.
- Section 1054.701: Change terminology for counting engines from "intended for sale in the United States" to "U.S.-direction production volume." This conforms to the usual approach for calculating emission credits for nonroad engines.
- Section 1054.710: Clarify that it is not permissible to show a proper balance of credits for a given model by using emission credits from a future model year.
- Section 1054.730: Clarify terminology for ABT reports.
- Section 1054.740: Remove obsolete content.
- Section 1054.801: Update the contact information for the Designated Compliance Officer.
- Section 1054.801: Remove the note from the definition of "handheld" describing which standards apply for various types of equipment. The note does not cover all the provisions that apply, which has led to more confusion than clarity.
- Section 1054.801: Revise the definition of "model year" to clarify that the calendar year relates to the time that engines are produced under a certificate of conformity.
- Section 1054.801: Revise the definition of "new nonroad engine" to clarify that imported engines become new based on the original date of manufacture, rather than the original model year. This clarification is necessary because 40 CFR 1068.360 requires redesignation of an imported engine's model year in certain circumstances.
- Section 1054.801: Revise the definition of "placed into service" to prevent circumvention that may result from a manufacturer or dealer using a piece of equipment in a way that could otherwise cause it to no longer be new and subject to the prohibitions of 40 CFR 1068.101.
- Section 1054.801: Revise the definition of "small-volume equipment manufacturer" to state that the volume limits apply for all calendar years, not just 2007 through 2009. We no longer use this definition for limiting the scope of transition or phase-in provisions. The provisions for reduced production-line testing, assigned deterioration factors, and reduced bonding burdens should apply without regard to the specific years identified in the original regulation adopting the Phase 3 standards.
- Section 1054.815: Migrate provisions related to confidential business information to 40 CFR part 1068.

K. Amendments for General Compliance Provisions (40 CFR Part 1068)

We are amending the replacement engine exemption in §1068.240 to adjust the criteria by which manufacturers qualify exempted engines under the tracked option in §1068.240(b). Engine manufacturers may produce any number of exempt replacement engines if they meet all the specified requirements and conditions. To account for the timing of making the necessary demonstrations, the regulation specifies that engines must be designated as either tracked or untracked by September 30 following each production year, which coincides with the reporting requirement to document the number of exempt replacement engines each manufacturer produces. The regulation as adopted specifies that manufacturers must meet "all the requirements and conditions that apply under paragraph (b)...."

We proposed to amend the regulation to clarify that the requirement for the engine manufacturer to retrieve the replaced engine (or confirm that it had been destroyed) was not subject to the reporting deadline of September 30 following the production year. The Truck and EMA commented to suggest that it would be better to apply a later deadline rather than removing the deadline entirely. The specific suggestion was to require converting a replacement engine from tracked to untracked if the replaced engine was not recovered within five years. We agree that the suggested approach would be beneficial for ensuring that replaced engines are accounted for and believe that the reported information would fit within the scope of current compliance responsibilities for both manufacturers and EPA. We are therefore including this adjustment in the final rule.

We also requested comment on several possible adjustments to the replacement engine exemption to address manufacturers' concerns about complying with the limit of producing only 0.5 percent of their production volume for specified sizes and types of engines under the untracked option. This is most challenging for large engines with very low production volumes. California ARB commented to recommend keeping the 0.5 percent limit because it should be rare to need more exempt replacement engines, and the regulation already allows for a greater number of exempt replacement engines where manufacturers are able to meet the tracking requirements.

EMA commented with a suggestion that the manufacturers should be allowed to produce up to five exempt replacement engines under the untracked option, in addition to the 0.5 percent. This was intended to account for the fact that 0.5 percent of a couple hundred engines does not allow for any substantial flexibility to supply distributors with these exempt replacement engines. We recognize the limit of the percentage-based approach and agree that allowing five engines per year to meet demand for these engines is appropriate. We are leaving the 0.5 percent limit in place in this rulemaking, but we are including an adjustment to address the engine manufacturers' concerns about low-volume production. Rather than adding an allowance for these five engines for all companies and all sectors/categories, we are amending the regulation to allow for the greater of five engines or 0.5 percent of production. This focuses the amendment on the companies and product line where the percentage-based approach provides no substantial ability to participate in the untracked option for replacement engines. Allowing five engines makes a difference for engine models with annual production volumes below 900 for a given type and displacement category.

EMA had additional comments related to the limits and oversight provisions for the untracked option of the replacement engine exemption. As noted in the Response to Comments, we are deferring action on those broader comments until a future rulemaking.

L. Other Requests for Comment

The proposed rule described several areas where we were interested in comments to gather information, perspectives, and feedback on possible future rulemaking amendments. These comments are included in Chapter 4 of the Response to Comments. The other chapters of the Response to Comments also include several issues with similar input regarding potential future rulemaking amendments.

IV. Statutory Authority and Executive Order Reviews

Additional information about these statutes and Executive Orders can be found at http://www2.epa.gov/laws-regulations/laws-and-executive-orders.

A. Executive Order 12866: Regulatory Planning and Review and Executive Order 13563: Improving Regulation and Regulatory Review

This action is not a significant regulatory action and was therefore not submitted to the Office of Management and Budget (OMB) for review.

B. Executive Order 13771: Reducing Regulations and Controlling Regulatory Costs

This action is considered an Executive Order 13771 deregulatory action. This final rule provides meaningful burden reduction by adjusting testing and certification requirements in a way that reduces burden for manufacturers. We are also eliminating over 600 pages of obsolete regulatory provisions from the Code of Federal Regulations, which reduces the administrative burden of compliance.

C. Paperwork Reduction Act (PRA)

This action does not impose any new information collection burden under the PRA. OMB has previously approved the information collection activities contained in the existing regulations and has assigned OMB control numbers 2060-0104, 2060-0287, 2060-0338, 2060-0545, 2060-0641. This rule clarifies and simplifies procedures without affecting information collection requirements.

D. Regulatory Flexibility Act (RFA)

I certify that this action will not have a significant economic impact on a substantial number of small entities under the RFA. In making this determination, the impact of concern is any significant adverse economic impact on small entities. An agency may certify that a rule will not have a significant economic impact on a substantial number of small entities if the rule relieves regulatory burden, has no net burden or otherwise has a positive economic effect on the small entities subject to the rule. This action is designed to reduce testing burdens, increase compliance flexibility, and make various corrections and adjustments to compliance provisions; as a result, we anticipate no costs associated with this rule. We have therefore concluded that this action will have no net regulatory burden for directly regulated small entities.

E. Unfunded Mandates Reform Act (UMRA)

This action does not contain any unfunded mandate as described in UMRA, 2 U.S.C. 1531–1538, and does not significantly or uniquely affect small governments. This action imposes no enforceable duty on any state, local or tribal governments. Requirements for the private sector do not exceed $100 million in any one year.

F. Executive Order 13132: Federalism

This action does not have federalism implications. It will not have substantial direct effects on the states, on the relationship between the national government and the states, or on the distribution of power and responsibilities among the various levels of government.

G. Executive Order 13175: Consultation and Coordination with Indian Tribal Governments

This action does not have tribal implications as specified in Executive Order 13175. This rule will be implemented at the Federal level and affects engine and vehicle manufacturers. Thus, Executive Order 13175 does not apply to this action.

H. Executive Order 13045: Protection of Children from Environmental Health Risks and Safety Risks

This action is not subject to Executive Order 13045 because it is not economically significant as defined in Executive Order 12866, and because the EPA does not believe the environmental health or safety risks addressed by this action present a disproportionate risk to children.

I. Executive Order 13211: Actions Concerning Regulations That Significantly Affect Energy Supply, Distribution or Use

J. This action is not subject to Executive Order 13211, because it is not a significant regulatory action under Executive Order 12866.National Technology Transfer and Advancement Act (NTTAA) and 1 CFR part 51

Section 12(d) of the National Technology Transfer and Advancement Act of 1995 (''NTTAA''), Public Law 104–113, 12(d) (15 U.S.C. 272 note) directs EPA to use voluntary consensus standards in its regulatory activities unless to do so would be inconsistent with applicable law or otherwise impractical. Voluntary consensus standards are technical standards (e.g., materials specifications, test methods, sampling procedures, and business practices) that are developed or adopted by voluntary consensus standards bodies. NTTAA directs agencies to provide Congress, through OMB, explanations when the Agency decides not to use available and applicable voluntary consensus standards. This action involves technical standards.

Except for the standards discussed below, the standards included in the regulatory text as incorporated by reference (in parts 60, 86, 1036, 1037, 1060, and 1065) were all previously approved for IBR and no change is included in this action.

In accordance with the requirements of 1 CFR 51.5, we are incorporating by reference the use of test methods and standards from ASTM International. This includes the following standards and test methods:

Standard or Test Method	Regulation	Summary
ASTM D3588-98 (Reapproved 2017)e1, Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels.	40 CFR 1036.530 and 1036.810	Test method describes how to determine the lower heating value and other parameters for gaseous fuels.
ASTM D5769-20, Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry.	40 CFR 86.1, 86.113-04, 86.213, and 86.513	Test method describes how to measure aromatic content of gasoline. This would be an alternative to the currently specified method in ASTM D1319, as described in Section II.A.3 for 40 CFR 1065.710.

ASTM D6550-20, Standard Test Method for Determination of Olefin Content of Gasolines by Supercritical-Fluid Chromatography.	40 CFR 86.1, 86.113-04, 86.213, and 86.513	Test method describes how to measure olefin content of gasoline. This would be an alternative to the currently specified method in ASTM D1319, as described in Section II.A.3 for 40 CFR 1065.710.
ASTM D6667-14 (Reapproved 2019), Standard Test Method for Determination of Total Volatile Sulfur in Gaseous Hydrocarbons and Liquefied Petroleum Gases by Ultraviolet Fluorescence.	40 CFR 1065.720 and 1065.1010	Test method describes how to measure sulfur in liquefied petroleum gas.

The referenced standards and test methods may be obtained through the ASTM International website (www.astm.org) or by calling ASTM at (610) 832–9585.

As described in Section II.A.5, EPA is publishing a new version of the Greenhouse Gas emissions Model (GEM), which manufacturers will use for certifying heavy-duty highway vehicles to the Phase 2 GHG emission standards in 40 CFR part 1037. The model calculates GHG emission rates for heavy-duty highway vehicles based on input values defined by the manufacturer. GEM Version 3.5.1 applies for all Phase 2 vehicles. GEM also includes a Hardware-in-Loop submodel to simulate vehicle engines, transmissions, and other powertrain components. These models are referenced in §§1037.520, 1037.550, and 1037.801. The models are available as noted in the amended regulations at 40 CFR 1037.810.

We are removing numerous referenced documents as part of the effort to remove obsolete provisions in 40 CFR parts 85 through 94 and elsewhere.

K. Executive Order 12898: Federal Actions to Address Environmental Justice in Minority Populations and Low-Income Populations

The EPA believes this action does not have disproportionately high and adverse human health or environmental effects on minority populations, low-income populations or indigenous peoples, as specified in Executive Order 12898 (59 FR 7629, February 16, 1994). Due to the small environmental impact, this regulatory action will not have a disproportionate adverse effect on minority populations, low-income populations, or indigenous peoples.

L. Congressional Review Act (CRA)

This action is subject to the CRA, and EPA will submit a rule report to each House of the Congress and to the Comptroller General of the United States. This action is not a “major rule” as defined by 5 U.S.C. 804(2).

M. Judicial Review

Under CAA section 307(b)(1), judicial review of this final rule is available only by filing a petition for review in the U.S. Court of Appeals for the District of Columbia Circuit by [INSERT DATE 60 DAYS AFTER PUBLICATION IN THE FEDERAL REGISTER]. Under CAA section 307(d)(7)(B), only an objection to this final rule that was raised with reasonable specificity during the period for public comment can be raised during judicial review. Section

307(d)(7)(B) of the Clean Air Act also provides a mechanism for EPA to convene a proceeding for reconsideration, “[i]f the person raising an objection can demonstrate to EPA that it was impracticable to raise such objection within [the period for public comment] or if the grounds for such objection arose after the period for public comment (but within the time specified for judicial review) and if such objection is of central relevance to the outcome of the rule.” Any person seeking to make such a demonstration should submit a Petition for Reconsideration to the Office of the Administrator, Environmental Protection Agency, Room 3000, William Jefferson Clinton Building, 1200 Pennsylvania Ave. N.W., Washington, DC 20460, with an electronic copy to the person listed in FOR FURTHER INFORMATION CONTACT, and the Associate General Counsel for the Air and Radiation Law Office, Office of General Counsel (Mail Code 2344A), Environmental Protection Agency, 1200 Pennsylvania Ave. N.W., Washington, DC 20004. Note that under CAA section 307(b)(2), the requirements established by this final rule may not be challenged separately in any civil or criminal proceedings brought by EPA to enforce these requirements.

List of Subjects

40 CFR Part 9

Reporting and recordkeeping requirements.

40 CFR Part 59

Air pollution control, Confidential business information, Labeling, Ozone, Reporting and recordkeeping requirements, Volatile organic compounds.

40 CFR Part 60

Administrative practice and procedure, Air pollution control, Aluminum, Beverages, Carbon monoxide, Chemicals, Coal, Electric power plants, Fluoride, Gasoline, Glass and glass products, Grains, Greenhouse gases, Household appliances, Incorporation by reference, Industrial facilities, Insulation, Intergovernmental relations, Iron, Labeling, Lead, Lime, Metals, Motor vehicles, Natural gas, Nitrogen dioxide, Petroleum, Phosphate, Plastics materials and synthetics, Polymers, Reporting and recordkeeping requirements, Rubber and rubber products, Sewage disposal, Steel, Sulfur oxides, Vinyl, Volatile organic compounds, Waste treatment and disposal, Zinc.

40 CFR Part 85

Confidential business information, Greenhouse gases, Imports, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Warranties.

40 CFR Part 86

Administrative practice and procedure, Confidential business information, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 88

Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements.

40 CFR Part 89

Administrative practice and procedure, Confidential business information, Imports, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Research, Vessels, Warranties.

40 CFR Part 90

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Reporting and recordkeeping requirements, Research, Warranties.

40 CFR Part 91

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 92

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Railroads, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 94

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Penalties, Reporting and recordkeeping requirements, Vessels, Warranties.

40 CFR Part 1027

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Reporting and recordkeeping requirements.

40 CFR Part 1033

Administrative practice and procedure, Confidential business information, Environmental protection, Labeling, Penalties, Railroads, Reporting and recordkeeping requirements.

40 CFR Part 1036

Administrative practice and procedure, Air pollution control, Confidential business information, Environmental protection, Greenhouse gases, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1037

Administrative practice and procedure, Air pollution control, Confidential business information, Environmental protection, Incorporation by reference, Labeling, Motor vehicle pollution, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1039

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1042

Administrative practice and procedure, Air pollution control, Confidential business information, Environmental protection, Imports, Incorporation by reference, Labeling, Penalties, Reporting and recordkeeping requirements, Vessels, Warranties.

40 CFR Part 1043

Administrative practice and procedure, Air pollution control, Imports, Incorporation by reference, Reporting and recordkeeping requirements, Vessels.

40 CFR Part 1045

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1048

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Research, Warranties.

40 CFR Part 1051

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1054

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1060

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Incorporation by reference, Labeling, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1065

Administrative practice and procedure, Air pollution control, Incorporation by reference, Reporting and recordkeeping requirements, Research.

40 CFR Part 1066

Air pollution control, Incorporation by reference, Reporting and recordkeeping requirements.

40 CFR Part 1068

Administrative practice and procedure, Air pollution control, Confidential business information, Imports, Motor vehicle pollution, Penalties, Reporting and recordkeeping requirements, Warranties.

40 CFR Part 1074

Administrative practice and procedure, Air pollution control.

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Andrew Wheeler,
Administrator.

For the reasons set out in the preamble, we are amending title 40, chapter I of the Code of Federal Regulations as set forth below.

PART 9—OMB APPROVALS UNDER THE PAPERWORK REDUCTION ACT

1. The authority citation for part 9 continues to read as follows:

Authority: 7 U.S.C. 135 et seq., 136-136y; 15 U.S.C. 2001, 2003, 2005, 2006, 2601-2671; 21 U.S.C. 331j, 346a, 31 U.S.C. 9701; 33 U.S.C. 1251 et seq., 1311, 1313d, 1314, 1318, 1321, 1326, 1330, 1342, 1344, 1345 (d) and (e), 1361; E.O. 11735, 38 FR 21243, 3 CFR, 1971-1975 Comp. p. 973; 42 U.S.C. 241, 242b, 243, 246, 300f, 300g, 300g-1, 300g-2, 300g-3, 300g-4, 300g-5, 300g-6, 300j-1, 300j-2, 300j-3, 300j-4, 300j-9, 1857 et seq., 6901-6992k, 7401-7671q, 7542, 9601-9657, 11023, 11048.

2. Amend §9.1 by:

a. Removing entries for 85.1403 through 85.1415, 85.1514, 85.1712, 85.1808, 85.2208, and 85.2401 through 85.2409;

b. Revising the entries under the heading “Control of Emissions From New and In-Use Highway Vehicles and Engine”;

c. Removing the heading “Clean-Fuel Vehicles” and the items under that heading;

d. Removing the heading “Control of Emissions From New and In-Use Nonroad Compression-Ignition Engines” and the items under that heading;

e. Removing the heading “Control of Emissions From New and In-use Nonroad Engines” and the items under that heading;

f. Removing the heading “Control of Emissions From New and In-Use Marine Compression-Ignition Engines” and the items under that heading;

g. Revising the entries under the heading “Fuel Economy of Motor Vehicles”;

h. Revising the entry for “1033.825” to read as “1033.925” and

i. Revising the entry for “1042.825” to read as “1042.925”.

The revisions read as follows:

§9.1 OMB approvals under the Paperwork Reduction Act.

* * * * *

* * * * * *	
Control of Air Pollution From Motor Vehicles and Motor Vehicle Engines	
85.503	2060-0104
85.505	2060-0104
85.1504	2060-0095
85.1505	2060-0095
85.1507	2060-0095
85.1508	2060-0095
85.1509	2060-0095
85.1511	2060-0095
85.1512	2060-0095
85.1705	2060-0104
85.1706	2060-0104
85.1708	2060-0104
85.1710	2060-0104
85.1802	2060-0104

85.1803	2060-0104
85.1806	2060-0104
85.1903	2060-0104
85.1904	2060-0104
85.1905	2060-0104
85.1906	2060-0104
85.1908	2060-0104
85.1909	2060-0104
85.2110	2060-0104
85.2114	2060-0060
85.2115	2060-0060
85.2116	2060-0060
85.2117	2060-0060
85.2118	2060-0060
85.2119	2060-0060
85.2120	2060-0060
Control of Emissions From New and In-Use Highway Vehicles and Engines	
86.000-7	2060-0104
86.000-24	2060-0104
86.001-21	2060-0104
86.001-23	2060-0104
86.001-24	2060-0104
86.004-28	2060-0104
86.004-38	2060-0104
86.004-40	2060-0104
86.079-31—86.079-33	2060-0104
86.079-39	2060-0104
86.080-12	2060-0104
86.082-34	2060-0104
86.085-37	2060-0104
86.090-27	2060-0104
86.091-7	2060-0104
86.094-21	2060-0104
86.094-25	2060-0104
86.094-30	2060-0104
86.095-14	2060-0104
86.095-35	2060-0104
86.096-24	2060-0104
86.098-23	2060-0104
86.099-10	2060-0104
86.107-98	2060-0104
86.108-00	2060-0104
86.111-94	2060-0104
86.113-15	2060-0104
86.113-94	2060-0104
86.129-00	2060-0104
86.142-90	2060-0104
86.144-94	2060-0104

86.150-98	2060-0104
86.155-98	2060-0104
86.159-08	2060-0104
86.160-00	2060-0104
86.161-00	2060-0104
86.162-03	2060-0104
86.163-00	2060-0104
86.412-78	2060-0104
86.414-78	2060-0104
86.415-78	2060-0104
86.416-80	2060-0104
86.421-78	2060-0104
86.423-78	2060-0104
86.427-78	2060-0104
86.428-80	2060-0104
86.429-78	2060-0104
86.431-78	2060-0104
86.432-78	2060-0104
86.434-78	2060-0104
86.435-78	2060-0104
86.436-78	2060-0104
86.437-78	2060-0104
86.438-78	2060-0104
86.439-78	2060-0104
86.440-78	2060-0104
86.445-2006	2060-0104
86.446-2006	2060-0104
86.447-2006	2060-0104
86.448-2006	2060-0104
86.449	2060-0104
86.513	2060-0104
86.537-90	2060-0104
86.542-90	2060-0104
86.603-98	2060-0104
86.604-84	2060-0104
86.605-98	2060-0104
86.606-84	2060-0104
86.607-84	2060-0104
86.609-98	2060-0104
86.612-97	2060-0104
86.614-84	2060-0104
86.615-84	2060-0104
86.884-5	2060-0104
86.884-7	2060-0104
86.884-9	2060-0104
86.884-10	2060-0104
86.884-12	2060-0104
86.884-13	2060-0104
86.1106-87	2060-0104

86.1107-87	2060-0104
86.1108-87	2060-0104
86.1110-87	2060-0104
86.1111-87	2060-0104
86.1113-87	2060-0104
86.1114-87	2060-0104
86.1805-17	2060-0104
86.1806-17	2060-0104
86.1809-12	2060-0104
86.1811-17	2060-0104
86.1823-08	2060-0104
86.1826-01	2060-0104
86.1829-15	2060-0104
86.1839-01	2060-0104
86.1840-01	2060-0104
86.1842-01	2060-0104
86.1843-01	2060-0104
86.1844-01	2060-0104
86.1845-04	2060-0104
86.1847-01	2060-0104
86.1862-04	2060-0104
86.1920-86.1925	2060-0287
* * * * * * *	
Fuel Economy of Motor Vehicles	
600.005	2060-0104
600.006	2060-0104
600.007	2060-0104
600.010	2060-0104
600.113-12	2060-0104
600.206-12	2060-0104
600.207-12	2060-0104
600.209-12	2060-0104
600.301 – 600.314-08	2060-0104
600.507-12	2060-0104
600.509-12	2060-0104
600.510-12	2060-0104
600.512-12	2060-0104
* * * * * *	

PART 59—NATIONAL VOLATILE ORGANIC COMPOUND EMISSION STANDARDS FOR CONSUMER AND COMMERCIAL PRODUCTS

3. The authority citation for part 59 continues to read as follows:

Authority: 42 U.S.C. 7414 and 7511b(e).

Subpart F—[Amended]

4. Amend §59.626 by revising paragraph (e) to read as follows:

§59.626 What emission testing must I perform for my application for a certificate of conformity?

* * * * *

(e) We may require you to test units of the same or different configuration in addition to the units tested under paragraph (b) of this section.

* * * * *

5. Amend §59.628 by revising paragraph (b) to read as follows:

§59.628 What records must I keep and what reports must I send to EPA?

* * * * *

(b) Keep required data from emission tests and all other information specified in this subpart for five years after we issue the associated certificate of conformity. If you use the same emission data or other information for a later production period, the five-year period restarts with each new production period if you continue to rely on the information.

* * * * *

6. Amend §59.650 by revising paragraph (c) to read as follows:

§59.650 General testing provisions.

* * * * *

(c) The specification for gasoline to be used for testing is given in 40 CFR 1065.710(c). Use the grade of gasoline specified for general testing. Blend this grade of gasoline with reagent grade ethanol in a volumetric ratio of 90.0 percent gasoline to 10.0 percent ethanol to achieve a blended fuel that has 10.0 ±1.0 percent ethanol by volume. You may use ethanol that is less pure if you can demonstrate that it will not affect your ability to demonstrate compliance with the applicable emission standards.

* * * * *

7. Amend §59.653 by revising paragraphs (a)(1), (a)(3), and (a)(4)(ii)(C) to read as follows:

§59.653 How do I test portable fuel containers?

* * * * *

(a) * * *

(1) *Pressure cycling*. Perform a pressure test by sealing the container and cycling it between + 13.8 and −3.4 kPa (+2.0 and −0.5 psig) for 10,000 cycles at a rate of 60 seconds per cycle. For this test, the spout may be removed, and the pressure applied through the opening where the spout attaches. The purpose of this test is to represent environmental wall stresses caused by pressure changes and other factors (such as vibration or thermal expansion). If your container cannot be tested using the pressure cycles specified by this paragraph (a)(1), you may ask to use special test procedures under §59.652(c).

* * * * *

(3) *Slosh testing*. Perform a slosh test by filling the portable fuel container to 40 percent of its capacity with the fuel specified in paragraph (e) of this section and rocking it at a rate of 15 cycles per minute until you reach one million total cycles. Use an angle deviation of + 15° to −15° from level. Take steps to ensure that the fuel remains at 40 percent of its capacity throughout the test run.

(4) * * *

(ii) * * *

(C) Actuate the spout by fully opening and closing without dispensing fuel. The spout must return to the closed position without the aid of the operator (e.g., pushing or pulling the spout closed). Repeat for a total of 10 actuations. If at any point the spout fails to return to the closed position, the container fails the diurnal test.

* * * * *

8. Amend §59.660 by revising paragraph (b) to read as follows:

§59.660 Exemption from the standards.

* * * * *

(b) Manufacturers and other persons subject to the prohibitions in §59.602 may ask us to exempt portable fuel containers to purchase, sell, or distribute them for the sole purpose of testing them.

* * * * *

9. Amend §59.664 by revising paragraph (c) to read as follows:

§59.664 What are the requirements for importing portable fuel containers into the United States?

* * * * *

(c) You may meet the bond requirements of this section by obtaining a bond from a third-party surety that is cited in the U.S. Department of Treasury Circular 570, “Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies” (*https://www.fiscal.treasury.gov/surety-bonds/circular-570.html*).

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10. Amend §59.680 by revising the definition of “Portable fuel container” to read as follows:

§59.680 What definitions apply to this subpart?

* * * * *

Portable fuel container means a reusable container of any color that is designed and marketed or otherwise intended for use by consumers for receiving, transporting, storing, and dispensing gasoline, diesel fuel, or kerosene. For the purposes of this subpart, all utility jugs that are red, yellow or blue in color are deemed to be portable fuel containers, regardless of how they are labeled or marketed.

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PART 60—STANDARDS OF PERFORMANCE FOR NEW STATIONARY SOURCES

11. The authority statement for part 60 continues to read as follows:

Authority: 42 U.S.C. 7401 et seq.

12. Amend §60.4200 by revising paragraph (d) to read as follows:

§60.4200 Am I subject to this subpart?

* * * * *

(d) Stationary CI ICE may be eligible for exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C, except that owners and operators, as well as manufacturers, may be eligible to request an exemption for national security.

13. Amend §60.4201 by revising paragraph (a), paragraph (d) introductory text, paragraph (f) introductory text, and paragraph (h) to read as follows:

§60.4201 What emission standards must I meet for non-emergency engines if I am a stationary CI internal combustion engine manufacturer?

(a) Stationary CI internal combustion engine manufacturers must certify their 2007 model year and later non-emergency stationary CI ICE with a maximum engine power less than or equal to 2,237 kilowatt (KW) (3,000 horsepower (HP)) and a displacement of less than 10 liters per cylinder to the certification emission standards for new nonroad CI engines in 40 CFR 1039.101, 40 CFR 1039.102, 40 CFR 1039.104, 40 CFR 1039.105, 40 CFR 1039.107, and 40 CFR 1039.115 and 40 CFR part 1039, Appendix I, as applicable, for all pollutants, for the same model year and maximum engine power.

* * * * *

(d) Stationary CI internal combustion engine manufacturers must certify the following non-emergency stationary CI ICE to the appropriate Tier 2 emission standards for new marine CI engines as described in 40 CFR part 1042, Appendix I, for all pollutants, for the same displacement and rated power:

* * * * *

(f) Notwithstanding the requirements in paragraphs (a) through (c) of this section, stationary non-emergency CI ICE identified in paragraphs (a) and (c) of this section may be certified to the provisions of 40 CFR part 1042 for commercial engines that are applicable for the engine's model year, displacement, power density, and maximum engine power if the engines will be used solely in either or both of the following locations:

* * * * *

(h) Stationary CI ICE certified to the standards in 40 CFR part 1039 and equipped with auxiliary emission control devices (AECDs) as specified in 40 CFR 1039.665 must meet the Tier 1 certification emission standards for new nonroad CI engines in 40 CFR part 1039, Appendix I while the AECD is activated during a qualified emergency situation. A qualified emergency situation is defined in 40 CFR 1039.665. When the qualified emergency situation has ended and the AECD is deactivated, the engine must resume meeting the otherwise applicable emission standard specified in this section.

14. Amend §60.4202 by revising paragraphs (a)(1)(i), (a)(2), (b)(2), paragraph (e) introductory text, and paragraph (g) introductory text to read as follows:

§60.4202 What emission standards must I meet for emergency engines if I am a stationary CI internal combustion engine manufacturer?

(a) * * *

(1) * * *

(i) The Tier 2 emission standards for new nonroad CI engines for the appropriate rated power as described in 40 CFR part 1039, Appendix I, for all pollutants and the smoke standards as specified in 40 CFR 1039.105 for model year 2007 engines, and

* * * * *

(2) For engines with a rated power greater than or equal to 37 KW (50 HP), the Tier 2 or Tier 3 emission standards for new nonroad CI engines for the same rated power as described in 40 CFR part 1039, Appendix I for all pollutants and the smoke standards as specified in 40 CFR 1039.105 beginning in model year 2007.

(b) * * *

(2) For 2011 model year and later, the Tier 2 emission standards as described in 40 CFR part 1039, Appendix I for all pollutants and the smoke standards as specified in 40 CFR 1039.105.

* * * * *

(e) Stationary CI internal combustion engine manufacturers must certify the following emergency stationary CI ICE that are not fire pump engines to the appropriate Tier 2 emission standards for new marine CI engines as described in 40 CFR part 1042, Appendix I, , for all pollutants, for the same displacement and rated power:

* * * * *

(g) Notwithstanding the requirements in paragraphs (a) through (d) of this section, stationary emergency CI ICE identified in paragraphs (a) and (c) of this section may be certified to the provisions of 40 CFR part 1042 for commercial engines that are applicable for the engine's model year, displacement, power density, and maximum engine power if the engines will be

used solely in either or both of the locations identified in paragraphs (g)(1) and (2) of this section. Engines that would be subject to the Tier 4 standards in 40 CFR part 1042 that are used solely in either or both of the locations identified in paragraphs (g)(1) and (2) of this section may instead continue to be certified to the appropriate Tier 3 standards in 40 CFR part 1042.
* * * * *

15. Amend §60.4204 by revising paragraphs (a) and (f) to read as follows:

§60.4204 What emission standards must I meet for non-emergency engines if I am an owner or operator of a stationary CI internal combustion engine?

(a) Owners and operators of pre-2007 model year non-emergency stationary CI ICE with a displacement of less than 10 liters per cylinder must comply with the emission standards in table 1 to this subpart. Owners and operators of pre-2007 model year non-emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder must comply with the Tier 1 emission standards in 40 CFR part 1042, Appendix I.
* * * * *

(f) Owners and operators of stationary CI ICE certified to the standards in 40 CFR part 1039 and equipped with AECDs as specified in 40 CFR 1039.665 must meet the Tier 1 certification emission standards for new nonroad CI engines in 40 CFR part 1039, Appendix I while the AECD is activated during a qualified emergency situation. A qualified emergency situation is defined in 40 CFR 1039.665. When the qualified emergency situation has ended and the AECD is deactivated, the engine must resume meeting the otherwise applicable emission standard specified in this section.

16. Amend §60.4205 by revising paragraph (a) to read as follows:

§60.4205 What emission standards must I meet for emergency engines if I am an owner or operator of a stationary CI internal combustion engine?

(a) Owners and operators of pre-2007 model year emergency stationary CI ICE with a displacement of less than 10 liters per cylinder that are not fire pump engines must comply with the emission standards in Table 1 to subpart IIII. Owners and operators of pre-2007 model year emergency stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder that are not fire pump engines must comply with the Tier 1 emission standards in 40 CFR part 1042, Appendix I.
* * * * *

17. Amend §60.4210 by revising paragraphs (a) and (b), paragraph (c) introductory text, paragraphs (c)(3), (d), (i), and (j) and adding paragraph (k) to read as follows:

§60.4210 What are my compliance requirements if I am a stationary CI internal combustion engine manufacturer?

(a) Stationary CI internal combustion engine manufacturers must certify their stationary CI ICE with a displacement of less than 10 liters per cylinder to the emission standards specified in §60.4201(a) through (c) and §60.4202(a), (b) and (d) using the certification procedures required in 40 CFR part 1039, subpart C, and must test their engines as specified in 40 CFR part 1039. For the purposes of this subpart, engines certified to the standards in table 1 to this subpart shall be subject to the same certification procedures required for engines certified to the Tier 1 standards in 40 CFR part 1039, Appendix I. For the purposes of this subpart, engines certified to the standards in table 4 to this subpart shall be subject to the same certification procedures

required for engines certified to the Tier 1 standards in 40 CFR part 1039, Appendix I, except that engines with NFPA nameplate power of less than 37 KW (50 HP) certified to model year 2011 or later standards shall be subject to the same requirements as engines certified to the standards in 40 CFR part 1039.
(b) Stationary CI internal combustion engine manufacturers must certify their stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder to the emission standards specified in §60.4201(d) and (e) and §60.4202(e) and (f) using the certification procedures required in 40 CFR part 1042, subpart C, and must test their engines as specified in 40 CFR part 1042.
(c) Stationary CI internal combustion engine manufacturers must meet the requirements of 40 CFR 1039.120, 1039.125, 1039.130, and 1039.135, and 40 CFR part 1068 for engines that are certified to the emission standards in 40 CFR part 1039. Stationary CI internal combustion engine manufacturers must meet the corresponding provisions of 40 CFR part 1042 for engines that would be covered by that part if they were nonroad (including marine) engines. Labels on such engines must refer to stationary engines, rather than or in addition to nonroad or marine engines, as appropriate. Stationary CI internal combustion engine manufacturers must label their engines according to paragraphs (c)(1) through (3) of this section.
* * * * *
(3) Stationary CI internal combustion engines manufactured after January 1, 2007 (for fire pump engines, after January 1 of the year listed in table 3 to this subpart, as applicable) must be labeled according to paragraphs (c)(3)(i) through (iii) of this section.
(i) Stationary CI internal combustion engines that meet the requirements of this subpart and the corresponding requirements for nonroad (including marine) engines of the same model year and HP must be labeled according to the provisions in 40 CFR part 1039 or 1042, as appropriate.
(ii) Stationary CI internal combustion engines that meet the requirements of this subpart, but are not certified to the standards applicable to nonroad (including marine) engines of the same model year and HP must be labeled according to the provisions in 40 CFR part 1039 or 1042, as appropriate, but the words “stationary” must be included instead of “nonroad” or “marine” on the label. In addition, such engines must be labeled according to 40 CFR 1039.20.
(iii) Stationary CI internal combustion engines that do not meet the requirements of this subpart must be labeled according to 40 CFR 1068.230 and must be exported under the provisions of 40 CFR 1068.230.
(d) An engine manufacturer certifying an engine family or families to standards under this subpart that are identical to standards applicable under 40 CFR part 1039 or 1042 for that model year may certify any such family that contains both nonroad (including marine) and stationary engines as a single engine family and/or may include any such family containing stationary engines in the averaging, banking and trading provisions applicable for such engines under those parts.
* * * * *
(i) The replacement engine provisions of 40 CFR 1068.240 are applicable to stationary CI engines replacing existing equipment that is less than 15 years old.
(j) Stationary CI ICE manufacturers may equip their stationary CI internal combustion engines certified to the emission standards in 40 CFR part 1039 with AECDs for qualified emergency situations according to the requirements of 40 CFR 1039.665. Manufacturers of stationary CI ICE equipped with AECDs as allowed by 40 CFR 1039.665 must meet all the requirements in 40 CFR 1039.665 that apply to manufacturers. Manufacturers must document that the engine

complies with the Tier 1 standard in 40 CFR part 1039, Appendix I, when the AECD is activated. Manufacturers must provide any relevant testing, engineering analysis, or other information in sufficient detail to support such statement when applying for certification (including amending an existing certificate) of an engine equipped with an AECD as allowed by 40 CFR 1039.665.

(k) Manufacturers of any size may certify their emergency stationary CI internal combustion engines under this section using assigned deterioration factors established by EPA, consistent with 40 CFR 1039.240 and 1042.240.

18. Amend §60.4211 by revising paragraphs (a)(3) and (b)(1) to read as follows:

§60.4211 What are my compliance requirements if I am an owner or operator of a stationary CI internal combustion engine?

(a) * * *

(3) Meet the requirements of 40 CFR part 1068, as they apply to you.

(b) * * *

(1) Purchasing an engine certified to emission standards for the same model year and maximum engine power as described in 40 CFR part 1039 and part 1042, as applicable. The engine must be installed and configured according to the manufacturer's specifications.

* * * * *

19. Amend §60.4212 by revising paragraphs (a) and (c) to read as follows:

§60.4212 What test methods and other procedures must I use if I am an owner or operator of a stationary CI internal combustion engine with a displacement of less than 30 liters per cylinder?

* * * * *

(a) The performance test must be conducted according to the in-use testing procedures in 40 CFR part 1039, subpart F, for stationary CI ICE with a displacement of less than 10 liters per cylinder, and according to 40 CFR part 1042, subpart F, for stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder. Alternatively, stationary CI ICE that are complying with Tier 2 or Tier 3 emission standards as described in 40 CFR part 1039, Appendix I, or with Tier 2 emission standards as described in 40 CFR part 1042, Appendix I, may follow the testing procedures specified in §60.4213, as appropriate.

* * * * *

(c) Exhaust emissions from stationary CI ICE subject to Tier 2 or Tier 3 emission standards as described in 40 CFR part 1039, Appendix I, or Tier 2 emission standards as described in 40 CFR part 1042, Appendix I, must not exceed the NTE numerical requirements, rounded to the same number of decimal places as the applicable standard, determined from the following equation:

NTE requirement for each pollutant = $(1.25) \times (STD)$ (Eq. 1)

Where:

STD = The standard specified for that pollutant in 40 CFR part 1039 or part 1042, as applicable.

* * * * *

20. Amend §60.4216 by revising paragraphs (b) and (c) to read as follows:

§60.4216 What requirements must I meet for engines used in Alaska?

* * * * *

(b) Except as indicated in paragraph (c) of this section, manufacturers, owners and operators of stationary CI ICE with a displacement of less than 10 liters per cylinder located in remote areas of Alaska may meet the requirements of this subpart by manufacturing and installing engines meeting the Tier 2 or Tier 3 emission standards described in 40 CFR part 1042 for the same model year, displacement, and maximum engine power, as appropriate, rather than the otherwise applicable requirements of 40 CFR part 1039, as indicated in §§60.4201(f) and 60.4202(g).
(c) Manufacturers, owners, and operators of stationary CI ICE that are located in remote areas of Alaska may choose to meet the applicable emission standards for emergency engines in §§60.4202 and 60.4205, and not those for non-emergency engines in §§60.4201 and 60.4204, except that for 2014 model year and later nonemergency CI ICE, the owner or operator of any such engine must have that engine certified as meeting at least the Tier 3 PM standards identified in Appendix I of 40 CFR part 1039 or in 40 CFR 1042.101.
* * * * *

21. Amend §60.4219 by revising the definition for "Certified emissions life" to read as follows:

§60.4219 What definitions apply to this subpart?

* * * * *

Certified emissions life means the period during which the engine is designed to properly function in terms of reliability and fuel consumption, without being remanufactured, specified as a number of hours of operation or calendar years, whichever comes first. The values for certified emissions life for stationary CI ICE with a displacement of less than 10 liters per cylinder are given in 40 CFR 1039.101(g). The values for certified emissions life for stationary CI ICE with a displacement of greater than or equal to 10 liters per cylinder and less than 30 liters per cylinder are given in 40 CFR 1042.101(e).

* * * * *

22. Amend §60.4230 by revising paragraph (e) to read as follows:

§60.4230 Am I subject to this subpart?

* * * * *

(e) Stationary SI ICE may be eligible for exemption from the requirements of this subpart as described in 40 CFR part 1068, subpart C (or the exemptions described in 40 CFR parts 1048 and 1054, for engines that would need to be certified to standards in those parts), except that owners and operators, as well as manufacturers, may be eligible to request an exemption for national security.

* * * * *

23. Amend §60.4231 by revising paragraphs (a) through (d) to read as follows:

§60.4231 What emission standards must I meet if I am a manufacturer of stationary SI internal combustion engines or equipment containing such engines?

(a) Stationary SI internal combustion engine manufacturers must certify their stationary SI ICE with a maximum engine power less than or equal to 19 KW (25 HP) manufactured on or after July 1, 2008 to the certification emission standards and other requirements for new nonroad SI engines in 40 CFR part 1054, as follows:

If engine displacement is * * *	and manufacturing dates are * * *	the engine must meet the following non-handheld emission standards identified in 40 CFR part 1054 and related requirements:
(1) below 225 cc	July 1, 2008 to December 31, 2011	Phase 2.
(2) below 225 cc	January 1, 2012 or later	Phase 3.
(3) at or above 225 cc	July 1, 2008 to December 31, 2010	Phase 2.
(4) at or above 225 cc	January 1, 2011 or later	Phase 3.

(b) Stationary SI internal combustion engine manufacturers must certify their stationary SI ICE with a maximum engine power greater than 19 KW (25 HP) (except emergency stationary ICE with a maximum engine power greater than 25 HP and less than 130 HP) that use gasoline and that are manufactured on or after the applicable date in §60.4230(a)(2), or manufactured on or after the applicable date in §60.4230(a)(4) for emergency stationary ICE with a maximum engine power greater than or equal to 130 HP, to the certification emission standards and other requirements for new nonroad SI engines in 40 CFR part 1048. Stationary SI internal combustion engine manufacturers must certify their emergency stationary SI ICE with a maximum engine power greater than 25 HP and less than 130 HP that use gasoline and that are manufactured on or after the applicable date in §60.4230(a)(4) to the Phase 1 emission standards in 40 CFR part 1054, Appendix I, applicable to class II engines, and other requirements for new nonroad SI engines in 40 CFR part 1054. Stationary SI internal combustion engine manufacturers may certify their stationary SI ICE with a maximum engine power less than or equal to 30 KW (40 HP) with a total displacement less than or equal to 1,000 cubic centimeters (cc) that use gasoline to the certification emission standards and other requirements as appropriate for new nonroad SI engines in 40 CFR part 1054.
(c) Stationary SI internal combustion engine manufacturers must certify their stationary SI ICE with a maximum engine power greater than 19 KW (25 HP) (except emergency stationary ICE with a maximum engine power greater than 25 HP and less than 130 HP) that are rich burn engines that use LPG and that are manufactured on or after the applicable date in §60.4230(a)(2), or manufactured on or after the applicable date in §60.4230(a)(4) for emergency stationary ICE with a maximum engine power greater than or equal to 130 HP, to the certification emission standards and other requirements for new nonroad SI engines in 40 CFR part 1048. Stationary SI internal combustion engine manufacturers must certify their emergency stationary SI ICE greater than 25 HP and less than 130 HP that are rich burn engines that use LPG and that are manufactured on or after the applicable date in §60.4230(a)(4) to the Phase 1 emission standards in 40 CFR part 1054, Appendix I, applicable to class II engines, and other requirements for new nonroad SI engines in 40 CFR part 1054. Stationary SI internal combustion engine manufacturers may certify their stationary SI ICE with a maximum engine power less than or equal to 30 KW (40 HP) with a total displacement less than or equal to 1,000 cc that are rich burn engines that use LPG to the certification emission standards and other requirements as appropriate for new nonroad SI engines in 40 CFR part 1054.
(d) Stationary SI internal combustion engine manufacturers who choose to certify their stationary SI ICE with a maximum engine power greater than 19 KW (25 HP) and less than 75 KW (100

HP) (except gasoline and rich burn engines that use LPG and emergency stationary ICE with a maximum engine power greater than 25 HP and less than 130 HP) under the voluntary manufacturer certification program described in this subpart must certify those engines to the certification emission standards for new nonroad SI engines in 40 CFR part 1048. Stationary SI internal combustion engine manufacturers who choose to certify their emergency stationary SI ICE greater than 25 HP and less than 130 HP (except gasoline and rich burn engines that use LPG), must certify those engines to the Phase 1 emission standards in 40 CFR part 1054, Appendix I, applicable to class II engines, for new nonroad SI engines in 40 CFR part 1054. Stationary SI internal combustion engine manufacturers may certify their stationary SI ICE with a maximum engine power less than or equal to 30 KW (40 HP) with a total displacement less than or equal to 1,000 cc (except gasoline and rich burn engines that use LPG) to the certification emission standards and other requirements as appropriate for new nonroad SI engines in 40 CFR part 1054. For stationary SI ICE with a maximum engine power greater than 19 KW (25 HP) and less than 75 KW (100 HP) (except gasoline and rich burn engines that use LPG and emergency stationary ICE with a maximum engine power greater than 25 HP and less than 130 HP) manufactured prior to January 1, 2011, manufacturers may choose to certify these engines to the standards in Table 1 to this subpart applicable to engines with a maximum engine power greater than or equal to 100 HP and less than 500 HP.

*   *   *   *   *

24. Revise §60.4238 to read as follows:

§60.4238 What are my compliance requirements if I am a manufacturer of stationary SI internal combustion engines ≤19 KW (25 HP) or a manufacturer of equipment containing such engines?

Stationary SI internal combustion engine manufacturers who are subject to the emission standards specified in §60.4231(a) must certify their stationary SI ICE using the certification and testing procedures required in 40 CFR part 1054, subparts C and F. Manufacturers of equipment containing stationary SI internal combustion engines meeting the provisions of 40 CFR part 1054 must meet the provisions of 40 CFR part 1060, subpart C, to the extent they apply to equipment manufacturers.

25. Revise §60.4239 to read as follows:

§60.4239 What are my compliance requirements if I am a manufacturer of stationary SI internal combustion engines >19 KW (25 HP) that use gasoline or a manufacturer of equipment containing such engines?

Stationary SI internal combustion engine manufacturers who are subject to the emission standards specified in §60.4231(b) must certify their stationary SI ICE using the certification procedures required in 40 CFR part 1048, subpart C, and must test their engines as specified in that part. Stationary SI internal combustion engine manufacturers who certify their stationary SI ICE with a maximum engine power less than or equal to 30 KW (40 HP) with a total displacement less than or equal to 1,000 cc to the certification emission standards and other requirements for new nonroad SI engines in 40 CFR part 1054, and manufacturers of stationary SI emergency engines that are greater than 25 HP and less than 130 HP who meet the Phase 1 emission standards in 40 CFR part 1054, Appendix I, applicable to class II engines, must certify their stationary SI ICE using the certification and testing procedures required in 40 CFR part 1054, subparts C and F. Manufacturers of equipment containing stationary SI internal combustion engines meeting the provisions of 40 CFR part 1054 must meet the provisions of 40 CFR part 1060, subpart C, to the extent they apply to equipment manufacturers.

26. Revise §60.4240 to read as follows:

§60.4240 What are my compliance requirements if I am a manufacturer of stationary SI internal combustion engines >19 KW (25 HP) that are rich burn engines that use LPG or a manufacturer of equipment containing such engines?

Stationary SI internal combustion engine manufacturers who are subject to the emission standards specified in §60.4231(c) must certify their stationary SI ICE using the certification procedures required in 40 CFR part 1048, subpart C, and must test their engines as specified in that part. Stationary SI internal combustion engine manufacturers who certify their stationary SI ICE with a maximum engine power less than or equal to 30 KW (40 HP) with a total displacement less than or equal to 1,000 cc to the certification emission standards and other requirements for new nonroad SI engines in 40 CFR part 1054, and manufacturers of stationary SI emergency engines that are greater than 25 HP and less than 130 HP who meet the Phase 1 emission standards in 40 CFR part 1054, Appendix I, applicable to class II engines, must certify their stationary SI ICE using the certification and testing procedures required in 40 CFR part 1054, subparts C and F. Manufacturers of equipment containing stationary SI internal combustion engines meeting the provisions of 40 CFR part 1054 must meet the provisions of 40 CFR part 1060, subpart C, to the extent they apply to equipment manufacturers.

27. Amend §60.4241 by revising paragraphs (a), (b), and (i) to read as follows:

§60.4241 What are my compliance requirements if I am a manufacturer of stationary SI internal combustion engines participating in the voluntary certification program or a manufacturer of equipment containing such engines?

(a) Manufacturers of stationary SI internal combustion engines with a maximum engine power greater than 19 KW (25 HP) that do not use gasoline and are not rich burn engines that use LPG can choose to certify their engines to the emission standards in §60.4231(d) or (e), as applicable, under the voluntary certification program described in this subpart. Manufacturers who certify their engines under the voluntary certification program must meet the requirements as specified in paragraphs (b) through (g) of this section. In addition, manufacturers of stationary SI internal combustion engines who choose to certify their engines under the voluntary certification program, must also meet the requirements as specified in §60.4247. Manufacturers of stationary SI internal combustion engines who choose not to certify their engines under this section must notify the ultimate purchaser that testing requirements apply as described in §60.4243(b)(2); manufacturers must keep a copy of this notification for five years after shipping each engine and make those documents available to EPA upon request.

(b) Manufacturers of engines other than those certified to standards in 40 CFR part 1054 must certify their stationary SI ICE using the certification procedures required in 40 CFR part 1048, subpart C, and must follow the same test procedures that apply to large SI nonroad engines under 40 CFR part 1048, but must use the D-1 cycle of International Organization of Standardization 8178-4: 1996(E) (incorporated by reference, see 40 CFR 60.17) or the test cycle requirements specified in Table 3 to 40 CFR 1048.505, except that Table 3 of 40 CFR 1048.505 applies to high load engines only. Manufacturers of any size may certify their stationary emergency engines at or above 130 hp using assigned deterioration factors established by EPA, consistent with 40 CFR 1048.240. Stationary SI internal combustion engine manufacturers who certify their stationary SI ICE with a maximum engine power less than or equal to 30 KW (40 HP) with a total displacement less than or equal to 1,000 cc to the certification emission standards and other requirements for new nonroad SI engines in 40 CFR part 1054, and manufacturers of emergency engines that are greater than 25 HP and less than 130 HP who meet the Phase 1 standards in 40 CFR part 1054, Appendix I, applicable to class II engines, must certify their stationary SI ICE using the certification and testing procedures required in 40 CFR part 1054, subparts C and F. Manufacturers of equipment containing stationary SI internal combustion engines meeting the provisions of 40 CFR part 1054 must meet the provisions of 40 CFR part 1060, subpart C, to the extent they apply to equipment manufacturers.

* * * * *

(i) For engines being certified to the voluntary certification standards in Table 1 of this subpart, the VOC measurement shall be made by following the procedures in 40 CFR part 1065, subpart C, to determine the total NMHC emissions. As an alternative, manufacturers may measure ethane, as well as methane, for excluding such levels from the total VOC measurement.

28. Revise §60.4242 to read as follows:

§60.4242 What other requirements must I meet if I am a manufacturer of stationary SI internal combustion engines or equipment containing stationary SI internal combustion engines or a manufacturer of equipment containing such engines?

(a) Stationary SI internal combustion engine manufacturers must meet the provisions of 40 CFR parts 1048, 1054, and 1068, as applicable, except that engines certified pursuant to the voluntary certification procedures in §60.4241 are subject only to the provisions indicated in §60.4247 and are permitted to provide instructions to owners and operators allowing for deviations from certified configurations, if such deviations are consistent with the provisions of paragraphs §60.4241(c) through (f). Manufacturers of equipment containing stationary SI internal combustion engines meeting the provisions of 40 CFR part 1054 must meet the provisions of 40 CFR part 1060, as applicable. Labels on engines certified to 40 CFR part 1048 must refer to stationary engines, rather than or in addition to nonroad engines, as appropriate.

(b) An engine manufacturer certifying an engine family or families to standards under this subpart that are identical to standards identified in 40 CFR part 1048 or 1054 for that model year may certify any such family that contains both nonroad and stationary engines as a single engine family and/or may include any such family containing stationary engines in the averaging, banking and trading provisions applicable for such engines under those parts. This provision also applies to equipment or component manufacturers certifying to standards under 40 CFR part 1060.

(c) Manufacturers of engine families certified to 40 CFR part 1048 may meet the labeling requirements referred to in paragraph (a) of this section for stationary SI ICE by either adding a separate label containing the information required in paragraph (a) of this section or by adding the words “and stationary” after the word “nonroad” to the label.

(d) For all engines manufactured on or after January 1, 2011, and for all engines with a maximum engine power greater than 25 HP and less than 130 HP manufactured on or after July 1, 2008, a stationary SI engine manufacturer that certifies an engine family solely to the standards applicable to emergency engines must add a permanent label stating that the engines in that family are for emergency use only. The label must be added according to the labeling requirements specified in 40 CFR 1048.135(b).

(e) All stationary SI engines subject to mandatory certification that do not meet the requirements of this subpart must be labeled and exported according to 40 CFR 1068.230. Manufacturers of stationary engines with a maximum engine power greater than 25 HP that are not certified to standards and other requirements under 40 CFR part 1048 are subject to the labeling provisions of 40 CFR 1048.20 pertaining to excluded stationary engines.
(f) For manufacturers of gaseous-fueled stationary engines required to meet the warranty provisions in 1054.120, we may establish an hour-based warranty period equal to at least the certified emissions life of the engines (in engine operating hours) if we determine that these engines are likely to operate for a number of hours greater than the applicable useful life within 24 months. We will not approve an alternate warranty under this paragraph (f) for nonroad engines. An alternate warranty period approved under this paragraph (f) will be the specified number of engine operating hours or two years, whichever comes first. The engine manufacturer shall request this alternate warranty period in its application for certification or in an earlier submission. We may approve an alternate warranty period for an engine family subject to the following conditions:
(1) The engines must be equipped with non-resettable hour meters.
(2) The engines must be designed to operate for a number of hours substantially greater than the applicable certified emissions life.
(3) The emission-related warranty for the engines may not be shorter than any published warranty offered by the manufacturer without charge for the engines. Similarly, the emission-related warranty for any component shall not be shorter than any published warranty offered by the manufacturer without charge for that component.

29. Amend §60.4243 by revising paragraph (f) to read as follows:

§60.4243 What are my compliance requirements if I am an owner or operator of a stationary SI internal combustion engine?

* * * * *

(f) If you are an owner or operator of a stationary SI internal combustion engine that is less than or equal to 500 HP and you purchase a non-certified engine or you do not operate and maintain your certified stationary SI internal combustion engine and control device according to the manufacturer's written emission-related instructions, you are required to perform initial performance testing as indicated in this section, but you are not required to conduct subsequent performance testing unless the stationary engine undergoes rebuild, major repair or maintenance. Engine rebuilding means to overhaul an engine or to otherwise perform extensive service on the engine (or on a portion of the engine or engine system). For the purpose of this definition, perform extensive service means to disassemble the engine (or portion of the engine or engine system), inspect and/or replace many of the parts, and reassemble the engine (or portion of the engine or engine system) in such a manner that significantly increases the service life of the resultant engine.

* * * * *

30. Amend §60.4245 by revising paragraph (a)(3) to read as follows:

§60.4245 What are my notification, reporting, and recordkeeping requirements if I am an owner or operator of a stationary SI internal combustion engine?

* * * * *

(a) * * *

(3) If the stationary SI internal combustion engine is a certified engine, documentation from the manufacturer that the engine is certified to meet the emission standards and information as required in 40 CFR parts 1048, 1054, and 1060, as applicable.

* * * * *

31. Amend §60.4247 by revising paragraph (a) to read as follows:

§60.4247 What parts of the mobile source provisions apply to me if I am a manufacturer of stationary SI internal combustion engines or a manufacturer of equipment containing such engines?

(a) Manufacturers certifying to emission standards in 40 CFR part 1054 must meet the provisions of 40 CFR part 1054. Note that 40 CFR part 1054, Appendix I, describes various provisions that do not apply for engines meeting Phase 1 standards. Manufacturers of equipment containing stationary SI internal combustion engines meeting the provisions of 40 CFR part 1054 must meet the provisions of 40 CFR part 1060 to the extent they apply to equipment manufacturers.

* * * * *

32. Amend §60.4248 by revising the definition for "Certified emissions life" and "Certified stationary internal combustion engine" to read as follows:

§60.4248 What definitions apply to this subpart?

* * * * *

Certified emissions life means the period during which the engine is designed to properly function in terms of reliability and fuel consumption, without being remanufactured, specified as a number of hours of operation or calendar years, whichever comes first. The values for certified emissions life for stationary SI ICE with a maximum engine power less than or equal to 19 KW (25 HP) are given in 40 CFR 1054.107 and 40 CFR 1060.101, as appropriate. The values for certified emissions life for stationary SI ICE with a maximum engine power greater than 19 KW (25 HP) certified to 40 CFR part 1048 are given in 40 CFR 1048.101(g). The certified emissions life for stationary SI ICE with a maximum engine power greater than 75 KW (100 HP) certified under the voluntary manufacturer certification program of this subpart is 5,000 hours or 7 years, whichever comes first. You may request in your application for certification that we approve a shorter certified emissions life for an engine family. We may approve a shorter certified emissions life, in hours of engine operation but not in years, if we determine that these engines will rarely operate longer than the shorter certified emissions life. If engines identical to those in the engine family have already been produced and are in use, your demonstration must include documentation from such in-use engines. In other cases, your demonstration must include an engineering analysis of information equivalent to such in-use data, such as data from research engines or similar engine models that are already in production. Your demonstration must also include any overhaul interval that you recommend, any mechanical warranty that you offer for the engine or its components, and any relevant customer design specifications. Your demonstration may include any other relevant information. The certified emissions life value may not be shorter than any of the following:

(1) 1,000 hours of operation.

(2) Your recommended overhaul interval.

(3) Your mechanical warranty for the engine.

Certified stationary internal combustion engine means an engine that belongs to an engine family that has a certificate of conformity that complies with the emission standards and requirements in this part, or of 40 CFR part 1048 or 40 CFR part 1054, as appropriate.

* * * * *

PART 85— CONTROL OF AIR POLLUTION FROM MOBILE SOURCES

33. The authority citation for part 85 continues to read as follows:

Authority: 42 U.S.C. 7401-7671q.

Subpart O—[Removed and Reserved]

34. Remove and reserve Subpart O, consisting of §§85.1401 through 85.1415

35. Amend §85.1501 by revising paragraph (a) to read as follows:

§85.1501 Applicability.

(a) Except where otherwise indicated, this subpart is applicable to motor vehicles offered for importation or imported into the United States for which the Administrator has promulgated regulations under 40 CFR part 86, subpart D or subpart S, prescribing emission standards, but which are not covered by certificates of conformity issued under section 206(a) of the Clean Air Act (i.e., which are nonconforming vehicles as defined below), as amended, and part 86 at the time of conditional importation. Compliance with regulations under this subpart shall not relieve any person or entity from compliance with other applicable provisions of the Clean Air Act. This subpart no longer applies for heavy-duty engines certified under 40 CFR part 86, subpart A; references in this subpart to "engines" therefore apply only for replacement engines intended for installation in motor vehicles that are subject to this subpart.

* * * * *

36. Amend §85.1511 by adding introductory text and paragraph (b)(5) to read as follows:

§85.1511 Exemptions and exclusions.

The exemption provisions of 40 CFR part 1068, subpart D, apply instead of the provisions of this section for heavy-duty motor vehicles and heavy-duty motor vehicle engines regulated under 40 CFR part 86, subpart A, 40 CFR part 1036, and 40 CFR part 1037. The following provisions apply for other motor vehicles and motor vehicle engines:

* * * * *

(b) * * *

(5) *Export exemption*. Vehicles may qualify for a temporary exemption under the provisions of 40 CFR 1068.325(d).

* * * * *

37. Revise §85.1514 to read as follows:

§85.1514 Treatment of confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

38. Amend §85.1701 by revising paragraph (a)(1) to read as follows:

§85.1701 General applicability.

(a) * * *

(1) Beginning January 1, 2014, the exemption provisions of 40 CFR part 1068, subpart C, apply instead of the provisions of this subpart for heavy-duty motor vehicle engines regulated under 40 CFR part 86, subpart A, except that the nonroad competition exemption of 40 CFR 1068.235 and the nonroad hardship exemption provisions of 40 CFR 1068.245, 1068.250, and 1068.255 do not apply for motor vehicle engines. Note that the provisions for emergency vehicle field modifications in §85.1716 continue to apply for heavy-duty engines.

*   *   *   *   *

39. Revise §85.1712 to read as follows:

§85.1712   Treatment of confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

40. Revise §85.1801 to read as follows:

§85.1801   Applicability and definitions.

(a) The recall provisions of 40 CFR part 1068, subpart E, apply instead of the provisions of this subpart for heavy-duty motor vehicles and heavy-duty motor vehicle engines regulated under 40 CFR part 86, subpart A, 40 CFR part 1036, and 40 CFR part 1037. The provisions of this subpart S apply for other motor vehicles and motor vehicle engines.

(b) For the purposes of this subpart, except as otherwise provided, words shall be defined as provided for by sections 214 and 302 of the Clean Air Act, 42 U.S.C. 1857, as amended.

(1) *Act* shall mean the Clean Air Act, 42 U.S.C. 1857, as amended.

(2) *Days* shall mean calendar days.

41. Revise §85.1807 to read as follows:

§85.1807 Public hearings.

Manufacturers may request a hearing as described in 40 CFR part 1068, subpart G.

42. Revise §85.1808 to read as follows:

§85.1808 Treatment of confidential information.

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

43. Amend §85.1902 by revising paragraph (b)(2) to read as follows:

§85.1902   Definitions.

*   *   *   *   *

(b) *   *   *

(2) A defect in the design, materials, or workmanship in one or more emission-related parts, components, systems, software or elements of design which must function properly to ensure continued compliance with greenhouse gas emission standards.

*   *   *   *   *

44. Amend §85.2102 revising paragraph (a)(18) and by adding and reserving paragraph (b) to read as follows:

§85.2102   Definitions.

(a) *   *   *

(18) *MOD Director* has the meaning given for “Designated Compliance Officer” in 40 CFR 1068.30.

(b) [Reserved].

45. Amend §85.2115 by revising paragraph (a)(4) to read as follows:

§85.2115 Notification of intent to certify.

(a) *   *   *

(4) Two complete and identical copies of the notification and any subsequent industry comments on any such notification shall be submitted by the aftermarket manufacturer to: MOD Director.

*   *   *   *   *

46. Revise §85.2301 to read as follows:

§85.2301   Applicability.

The definitions provided by this subpart are effective February 23, 1995 and apply to all motor vehicles regulated under 40 CFR part 86, subpart S, and to highway motorcycles regulated under 40 CFR part 86, subparts E and F. The definitions and related provisions in 40 CFR part 1036, 40 CFR part 1037, and 40 CFR part 1068 apply instead of the provisions in this subpart for heavy-duty motor vehicles and heavy-duty motor vehicle engines regulated under 40 CFR part 86, subpart A, 40 CFR part 1036, and 40 CFR part 1037.

PART 86— CONTROL OF EMISSIONS FROM NEW AND IN-USE HIGHWAY VEHICLES AND ENGINES

47. The authority statement for part 86 continues to read as follows:

Authority: 42 U.S.C. 7401-7671q.

48. Section 86.1 is amended by:

a. Revising the last sentence of paragraph (a);

b. Redesignating paragraphs (b)(19) through (21) as paragraphs (b)(21) through (23); and

c. Adding new paragraphs (b)(19) and (20).

The revision and additions read as follows:

§86.1   Incorporation by reference.

(a) * * * For information on the availability of this material at NARA, email fedreg.legal@nara.gov, or go to www.archives.gov/federal-register/cfr/ibr-locations.html.

* * * * *

(b) * * *

(19) ASTM D5769-20, Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry, approved June 1, 2020 (“ASTM5769”), IBR approved for §§86.113-04(a), 86.213(a), and 86.513(a)

(20) ASTM D6550-20, Standard Test Method for Determination of Olefin Content of Gasolines by Supercritical-Fluid Chromatography, approved July 1, 2020 (“ASTM D6550”), IBR approved for §§86.113-04(a), 86.213(a), and 86.513(a).

*   *   *   *   *

49. Section 86.004-15 is amended by revising paragraph (a)(1) to read as follows:

§86.004-15   NOx plus NMHC and particulate averaging, trading, and banking for heavy-duty engines.

(a)(1) Heavy-duty engines eligible for NOx plus NMHC and particulate averaging, trading and banking programs are described in the applicable emission standards sections in this subpart. For manufacturers not selecting Options 1 or 2 contained in §86.005-10(f), the ABT program requirements contained in §86.000-15 apply for 2004 model year Otto-cycle engines, rather than the provisions contained in this §86.004-15. Participation in these programs is voluntary.

*   *   *   *   *

50. Section 86.010-18 is amended by–

a. Revising paragraphs (g)(2)(ii)(B), and (g)(2)(iii)(C).

b. Adding paragraph (g)(2)(iii)(D).

c. Removing and reserving paragraph (l)(2)(ii).

d. Revising paragraphs (p)(3) and (p)(4).

The revisions and additions read as follows:

§86.010-18 On-board Diagnostics for engines used in applications greater than 14,000 pounds GVWR.

* * * * *

(g) * * *

(2) * * *

(ii) * * *

(B) For model years 2013 and later, on engines equipped with sensors that can detect combustion or combustion quality (e.g., for use in engines with homogeneous charge compression ignition (HCCI) control systems), the OBD system must detect a misfire malfunction when the percentage of misfire is 5 percent or greater.

(iii) * * *

(C) For model years 2013 through 2018, on engines equipped with sensors that can detect combustion or combustion quality, the OBD system must monitor continuously for engine misfire when positive torque is between 20 and 75 percent of peak torque, and engine speed is less than 75 percent of maximum engine speed. If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions, the manufacturer may request that the Administrator approve the monitoring system nonetheless. In evaluating the manufacturer's request, the Administrator will consider the following factors: the magnitude of the region(s) in which misfire detection is limited; the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events); the frequency with which said region(s) are expected to be encountered in-use; the type of misfire patterns for which misfire detection is troublesome; and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation will be based on the following misfire patterns: equally spaced misfire occurring on randomly selected cylinders; single cylinder continuous misfire; and, paired cylinder (cylinders firing at the same crank angle) continuous misfire.

(D) For 20 percent of 2019 model year, 50 percent of 2020 model, and 100 percent of 2021 and later model year diesel engines (percentage based on the manufacturer’s projected sales volume of all diesel engines subject to this regulation) equipped with sensors that can detect combustion or combustion quality, the OBD system must monitor continuously for engine misfire under all positive torque engine speed conditions except within the following range: the engine operating region bound by the positive torque line (i.e., engine torque with transmission in neutral) and the two following points: engine speed of 50 percent of maximum engine speed with the engine torque at the positive torque line, and 100 percent of the maximum engine speed with the engine torque at 10 percent of peak torque above the positive torque line. If a monitoring system cannot detect all misfire patterns under all required engine speed and load conditions, the manufacturer may request that the Administrator approve the monitoring system nonetheless. In evaluating the manufacturer’s request, the Administrator will consider the following factors: the magnitude of the region(s) in which misfire detection is limited; the degree to which misfire detection is limited in the region(s) (i.e., the probability of detection of misfire events); the frequency with which said region(s) are expected to be encountered in-use; the type of misfire patterns for which misfire detection is troublesome; and demonstration that the monitoring technology employed is not inherently incapable of detecting misfire under required conditions (i.e., compliance can be achieved on other engines). The evaluation will be based on the following misfire patterns:

equally spaced misfire occurring on randomly selected cylinders; single cylinder continuous misfire; and, paired cylinder (cylinders firing at the same crank angle) continuous misfire.

* * * * *

(p) * * *

(3) *For model years 2016 through 2018*. (i) On the engine ratings tested according to paragraph (l)(2)(iii) of this section, the certification emissions thresholds shall apply in-use.

(ii) On the manufacturer's remaining engine ratings, separate in-use emissions thresholds shall apply. These thresholds are determined by doubling the applicable thresholds as shown in Table 1 of paragraph (g) of this section and Table 2 of paragraph (h) of this section. The resultant thresholds apply only in-use and do not apply for certification or selective enforcement auditing.

(iii) For monitors subject to meeting the minimum in-use monitor performance ratio of 0.100 in paragraph (d)(1)(ii) of this section, the OBD system shall not be considered noncompliant unless a representative sample indicates the in-use ratio is below 0.088 except for filtering performance monitors for PM filters (paragraph (g)(8)(ii)(A) of this section) and missing substrate monitors (paragraph (g)(8)(ii)(D) of this section) for which the OBD system shall not be considered noncompliant unless a representative sample indicates the in-use ratio is below 0.050.

(iv) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that could not have been reasonably foreseen to occur by the manufacturer.

(4) *For model years 2019 and later*. (i) On all engine ratings, the certification emissions thresholds shall apply in-use.

(ii) For monitors subject to meeting the minimum in-use monitor performance ratio of 0.100 in paragraph (d)(1)(ii) of this section, the OBD system shall not be considered noncompliant unless a representative sample indicates the in-use ratio is below 0.088.

(iii) An OBD system shall not be considered noncompliant solely due to a failure or deterioration mode of a monitored component or system that the manufacturer could not have reasonably foreseen.

* * * * *

51. Section 86.113-04 is amended by revising paragraph (a)(1) to read as follows:

§86.113-04 Fuel specifications.

* * * * *

(a) * * *

(1) Gasoline meeting the following specifications, or substantially equivalent specifications approved by the Administrator, must be used for exhaust and evaporative testing:

Table 1 to §86.113-04(a)(1)–Test fuel specifications for gasoline without ethanol

Item	Regular	Reference Procedure[1]
Research octane, Minimum[2]	93	ASTM D2699
Octane sensitivity[2]	7.5	ASTM D2700
Distillation Range (°F): Evaporated initial boiling point[3] 10% evaporated 50% evaporated 90% evaporated Evaporated final boiling point	75 – 95 120 - 135 200 - 230 300 - 325 415 Maximum	ASTM D86
Total Aromatic Hydrocarbon (vol %)	35% Maximum	ASTM D1319 or ASTM D5769
Olefins (vol %)[4]	10% Maximum	ASTM D1319 or ASTM D6550
Lead, g/gallon (g/liter), Maximum	0.050 (0.013)	ASTM D3237
Phosphorous, g/gallon (g/liter), Maximum	0.005 (0.0013)	ASTM D3231
Total sulfur, wt. %[5]	0.0015 – 0.008	ASTM D2622
Dry Vapor Pressure Equivalent (*DVPE*), kPa (psi)[6]	60.0-63.4 (8.7-9.2)	ASTM D5191

[1]Incorporated by reference, see §86.1.
[2]Octane specifications are optional for manufacturer testing.
[3]For testing at altitudes above 1,219 m (4000 feet), the specified range is 75-105° F.
[4]ASTM D6550 prescribes measurement of olefin concentration in mass %. Multiply this result by 0.857 and round to the first decimal place to determine the olefin concentration in volume %.
[5]Sulfur concentration will not exceed 0.0045 weight percent for EPA testing.
[6]For testing unrelated to evaporative emission control, the specified range is 54.8-63.7 kPa (8.0-9.2 psi). For testing at altitudes above 1,219 m (4000 feet), the specified range is 52.0-55.4 kPa (7.6-8.0 psi). Calculate dry vapor pressure equivalent, *DVPE*, based on the measured total vapor pressure, p_T, using the following equation: $DVPE$ (kPa) = $0.956 \cdot p_T - 2.39$ (or $DVPE$ (psi) = $0.956 \cdot p_T - 0.347$). *DVPE* is intended to be equivalent to Reid Vapor Pressure using a different test method.

* * * * *

52. Section 86.129-00 is amended by revising paragraph (f)(1)(ii)(C) to read as follows:

§86.129-00 Road load power, test weight, and inertia weight class determination.

* * * * *

(f)(1) * * *

(ii) * * *

(C) Regardless of other requirements in this section relating to the testing of HLDTs, for Tier 2 and Tier 3 HLDTs, the test weight basis for FTP and SFTP testing (both US06 and SC03), if applicable, is the vehicle curb weight plus 300 pounds. For MDPVs certified to standards in bin 11 in Tables S04-1 and 2 in §86.1811-04, the test weight basis must be adjusted loaded vehicle weight (ALVW) as defined in this part.

* * * * *

53. Section 86.130-96 is amended by revising paragraph (a) to read as follows:

§86.130-96 Test sequence; general requirements.

* * * * *

(a)(1) *Gasoline- and methanol-fueled vehicles*. The test sequence shown in Figure 1 of 40 CFR 1066.801 shows the steps encountered as the test vehicle undergoes the procedures subsequently described to determine conformity with the standards set forth. The full three- diurnal sequence depicted in Figure 1 of 40 CFR 1066.801 tests vehicles for all sources of evaporative emissions. The supplemental two-diurnal test sequence is designed to verify that vehicles sufficiently purge

their evaporative canisters during the exhaust emission test. Sections 86.132-96, 86.133-96 and 86.138-96 describe the separate specifications of the supplemental two-diurnal test sequence.
(2) *Gaseous-fueled vehicles*. The test sequence shown in Figure 1 of 40 CFR 1066.801 shows the steps encountered as the test vehicle undergoes the procedures subsequently described to determine conformity with the standards set forth, with the exception that the fuel drain and fill and precondition canister steps are not required for gaseous-fueled vehicles. In addition, the supplemental two-diurnal test and the running loss test are not required.
* * * * *

54. Section 86.213 is amended by revising paragraph (a)(2) to read as follows:
§86.213 Fuel specifications.
(a) * * *
(2) You may use the test fuel specified in this paragraph (a)(2) for vehicles that are not yet subject to exhaust testing with an ethanol-blend test fuel under §86.113. Manufacturers may certify based on this fuel using carryover data until testing with the ethanol-blend test fuel is required. The following specifications apply for gasoline test fuel without ethanol:

Table 1 of §86.213(a)(2)–Cold temperature test fuel specifications for gasoline without ethanol

Item	Regular	Premium	Reference Procedure[1]
(RON+MON)/2[2]	87.8±0.3	92.3±0.5	ASTM D2699 ASTM D2700
Sensitivity[3]	7.5	7.5	ASTM D2699 ASTM D2700
Distillation Range (°F): Evaporated initial boiling point 10% evaporated 50% evaporated 90% evaporated Evaporated final boiling point	 76 – 96 98 - 118 179 - 214 316 - 346 413 Maximum	 76 – 96 105 - 125 195 - 225 316 - 346 413 Maximum	ASTM D86
Total Aromatic Hydrocarbon (vol %)	26.4±4.0	32.0±4.0	ASTM D1319 or ASTM D5769
Olefins (vol %)[4]	12.5±5.0	10.5±5.0	ASTM D1319 or ASTM D6550
Lead, g/gallon	0.01, Maximum	0.01, Maximum	ASTM D3237
Phosphorous, g/gallon	0.005 Maximum	0.005 Maximum	ASTM D3231
Total sulfur, wt. %[3]	0.0015 – 0.008	0.0015 – 0.008	ASTM D2622
RVP, psi	11.5±0.3	11.5±0.3	ASTM D5191

[1]Incorporated by reference, see §86.1.
[2]Octane specifications are optional for manufacturer testing. The premium fuel specifications apply for vehicles designed to use high-octane premium fuel.
[3]Sulfur concentration will not exceed 0.0045 weight percent for EPA testing.
[4]ASTM D6550 prescribes measurement of olefin concentration in mass %. Multiply this result by 0.857 and round to the first decimal place to determine the olefin concentration in volume %.
* * * * *

§86.401-97—[Removed]
55. Remove §86.401-97.

56. Amend §86.408-78 by adding paragraphs (c) and (d) to read as follows:
§86.408-78 General standards; increase in emissions; unsafe conditions.
* * * * *

(c) If a new motorcycle is designed to require manual adjustment to compensate for changing altitude, the manufacturer must include the appropriate instructions in the application for certification. EPA will review the instructions to ensure that properly adjusted motorcycles will meet emission standards at both low altitude and high altitude.
(d) An action to install parts, modify engines, or perform other adjustments to compensate for changing altitude is not prohibited under 42 U.S.C. 7522 as long as it is done consistent with the manufacturer's instructions.

§86.413-78—[Removed]
57. Remove §86.413-78.

58. Amend §86.419-2006 by revising paragraph (b) introductory text to read as follows:
§86.419-2006 Engine displacement, motorcycle classes.
* * * * *
(b) Motorcycles will be divided into classes and subclasses based on engine displacement.
* * * * *

59. Amend §86.427-78 by revising paragraph (a)(1) to read as follows:
§86.427-78 Emission tests.
(a)(1) Each test vehicle shall be driven with all emission control systems installed and operating for the following total test distances, or for such lesser distances as the Administrator may agree to as meeting the objectives of this procedure. (See §86.419 for class explanation.)

Displacement class	Total test distance (kilometers)	Minimum test distance (kilometers)	Minimum number of tests
I-A	6,000	2,500	4
I-B	6,000	2,500	4
II	9,000	2,500	4
III	15,000	3,500	4

* * * * *

60. Amend §86.435-78 by revising paragraph (b)(1) to read as follows:
§86.435-78 Extrapolated emission values.
* * * * *
(b) * * *
(1) If the useful life emissions are at or below the standards, certification will be granted.
* * * * *

61. Amend §86.436-78 by revising paragraph (d) to read as follows:
§86.436-78 Additional service accumulation.
* * * * *
(d) To qualify for certification:
(1) The full life emission test results must be at or below the standards, and
(2) The deterioration line must be below the standard at the minimum test distance and the useful life, or all points used to generate the line, must be at or below the standard.
* * * * *

62. Amend §86.513 by revising paragraphs (a)(1) and (a)(3) to read as follows:

§86.513 Fuel and engine lubricant specifications.

(a) *Gasoline*. (1) Use gasoline meeting the following specifications for exhaust and evaporative emission testing:

Table 1 of §86.513(a)(1)—Gasoline Test Fuel Specifications

Item	Value	Procedure[1]
Distillation Range: 1. Initial boiling point, °C 2. 10% point, °C 3. 50% point, °C 4. 90% point, °C 5. End point, °C	23.9—35.0 [2] 48.9—57.2 93.3—110.0 148.9—162.8 212.8 maximum	ASTM D86
Total aromatic hydrocarbon, volume %	35 maximum	ASTM D1319 or ASTM D5769
Olefins, volume %[3]	10 maximum	ASTM D1319 or ASTM D6550
Lead (organic), g/liter	0.013 maximum	ASTM D3237
Phosphorous, g/liter	0.0013 maximum	ASTM D3231
Sulfur, weight %	0.008 maximum	ASTM D2622
Dry Vapor Pressure Equivalent (*DVPE*), kPa	55.2 to 63.4 [4]	ASTM D5191

[1]Incorporated by reference, see §86.1.

[2]For testing at altitudes above 1,219 m, the specified initial boiling point range is (23.9 to 40.6) °C.

[3]ASTM D6550 prescribes measurement of olefin concentration in mass %. Multiply this result by 0.857 and round to the first decimal place to determine the olefin concentration in volume %.

[4]For testing at altitudes above 1,219 m, the specified volatility range is 52 to 55 kPa. Calculate dry vapor pressure equivalent, *DVPE*, based on the measured total vapor pressure, p_T, using the following equation: $DVPE$ (kPa) = $0.956 \cdot p_T - 2.39$ (or $DVPE$ (psi) = $0.956 \cdot p_T - 0.347$). *DVPE* is intended to be equivalent to Reid Vapor Pressure using a different test method.

* * * * *

(3) Manufacturers may alternatively use ethanol-blended gasoline meeting the specifications described in 40 CFR 1065.710(b) for general testing without our advance approval. Manufacturers using the ethanol-blended fuel for certifying a given engine family may also use it for any testing for that engine family under this part. If manufacturers use the ethanol-blended fuel for certifying a given engine family, EPA may use the ethanol-blended fuel or the neat gasoline test fuel specified in this section for that engine family. Manufacturers may also request to use fuels meeting alternate specifications as described in 40 CFR 1065.701(b).

* * * * *

63. Revise §86.531-78 to read as follows:

§86.531-78 Vehicle preparation.

(a) The manufacturer shall provide additional fittings and adapters, as required by the Administrator, to accommodate a fuel drain at the lowest point possible in the tank(s) as installed on the vehicle, and to provide for exhaust sample collection.

(b) Connect the motorcycle's exhaust system to the analyzer for all exhaust emission measurements. Seal all known leaks in the exhaust system. Make sure any remaining leaks do not affect the demonstration that the motorcycle complies with standards.

64. Revise §86.1362 to read as follows:

§86.1362 Steady-state testing with a ramped-modal cycle.

(a) This section describes how to test engines under steady-state conditions. Perform ramped-modal testing as described in 40 CFR 1036.505 and 40 CFR part 1065, except as specified in this section.

(b) Measure emissions by testing the engine on a dynamometer with the following ramped-modal duty cycle to determine whether it meets the applicable steady-state emission standards:

RMC Mode	Engine testing			Powertrain testing				CO_2 weighting (percent)[5]
	Time in mode (sec)	Engine Speed[1,2]	Torque (percent)[2,3]	Vehicle speed (mi/hr)[4]	Road-grade coefficients[4]			
					a	*b*	*c*	
1a Steady-state	170	Warm Idle	0	Warm Idle	0	0	0	6
1b Transition	20	Linear Transition	Linear Transition	Linear Transition	5.6E-6	-4.6E-3	-9.1E+0	
2a Steady-state	173	A	100	53.38	-1.6E-6	691.3E-6	2.1E+0	9
2b Transition	20	Linear Transition	Linear Transition	Linear Transition	0	0	0	
3a Steady-state	219	B	50	65.00	-12.8E-6	10.2E-3	-1.6E+0	10
3b Transition	20	B	Linear Transition	65.00	0	0	0	
4a Steady-state	217	B	75	65.00	-10.2E-6	7.8E-3	-268.9E-3	10
4b Transition	20	Linear Transition	Linear Transition	Linear Transition	-8.8E-6	6.7E-3	2.2E+0	
5a Steady-state	103	A	50	53.38	-8.0E-6	6.2E-3	-623.0E-3	12
5b Transition	20	A	Linear Transition	53.38	-5.6E-6	4.4E-3	92.1E-3	
6a Steady-state	100	A	75	53.38	-5.0E-6	3.5E-3	712.4E-3	12
6b Transition	20	A	Linear Transition	53.38	-6.9E-6	5.4E-3	-473.1E-3	
7a Steady-state	103	A	25	53.38	-11.1E-6	8.8E-3	-2.0E+0	12
7b Transition	20	Linear Transition	Linear Transition	Linear Transition	-8.6E-6	6.9E-3	-3.1E+0	
8a Steady-state	194	B	100	65.00	-7.4E-6	5.5E-3	798.2E-3	9
8b Transition	20	B	Linear Transition	65.00	-13.2E-6	10.1E-3	-1.2E+0	
9a Steady-state	218	B	25	65.00	-16.9E-6	13.6E-3	-3.2E+0	9
9b Transition	20	Linear Transition	Linear Transition	Linear Transition	-16.7E-6	13.6E-3	-5.2E+0	
10a Steady-state	171	C	100	77.80	-16.5E-6	13.1E-3	-1.3E+0	2
10b Transition	20	C	Linear Transition	77.80	-18.5E-6	15.4E-3	-2.9E+0	
11a Steady-state	102	C	25	77.80	-24.7E-6	20.2E-3	-5.0E+0	1
11b Transition	20	C	Linear Transition	77.80	-22.1E-6	17.9E-3	-3.8E+0	
12a Steady-state	100	C	75	77.80	-19.2E-6	15.5E-3	-2.5E+0	1
12b Transition	20	C	Linear Transition	77.80	-20.4E-6	16.5E-3	-3.1E+0	
13a Steady-state	102	C	50	77.80	-21.8E-6	17.7E-3	-3.7E+0	1
13b Transition	20	Linear Transition	Linear Transition	Linear Transition	-11.8E-6	7.6E-3	17.6E+0	
14 Steady-state	168	Warm Idle	0	Warm Idle	0	0	0	6

[1]Engine speed terms are defined in 40 CFR part 1065.
[2]Advance from one mode to the next within a 20 second transition phase. During the transition phase, command a linear progression from the settings of the current mode to the settings of the next mode.
[3]The percent torque is relative to maximum torque at the commanded engine speed.
[4]See 40 CFR 1036.505(c) for a description of powertrain testing with the ramped-modal cycle, including the equation that uses the road-grade coefficients.
[5]Use the specified weighting factors to calculate composite emission results for CO_2 as specified in 40 CFR 1036.501.

Subpart P —[Removed and Reserved]

65. Remove and reserve Subpart P.

Subpart Q —[Removed and Reserved]

66. Remove and reserve Subpart Q.

67. Amend §86.1803-01 by revising the definitions for “Heavy-duty vehicle” and “Light-duty truck” to read as follows:

§86.1803-01 Definitions.

* * * * *

Heavy-duty vehicle means any complete or incomplete motor vehicle rated at more than 8,500 pounds GVWR. Heavy-duty vehicle also includes incomplete vehicles that have a curb weight above 6,000 pounds or a basic vehicle frontal area greater than 45 square feet. Note that MDPVs are heavy-duty vehicles that are in many cases subject to requirements that apply for light-duty trucks.

* * * * *

Light-duty truck means any motor vehicle that is not a heavy-duty vehicle, but is:

(1) Designed primarily for purposes of transportation of property or is a derivation of such a vehicle; or

(2) Designed primarily for transportation of persons and has a capacity of more than 12 persons; or

(3) Available with special features enabling off-street or off-highway operation and use.

* * * * *

68. Amend §86.1811-17 by revising paragraph (b)(8)(iii)(C) to read as follows:

§86.1811-17 Exhaust emission standards for light-duty vehicles, light-duty trucks and medium-duty passenger vehicles.

* * * * *

(b) * * *

(8) * * *

(iii) * * *

(C) Vehicles must comply with the Tier 2 SFTP emission standards for NMHC + NOx and CO for 4,000-mile testing that are specified in §86.1811-04(f)(1) if they are certified to transitional Bin 85 or Bin 110 standards, or if they are certified based on a fuel without ethanol, or if they are not certified to the Tier 3 PM standard. Note that these standards apply under this section for alternative fueled vehicles, for flexible fueled vehicles when operated on a fuel other than gasoline or diesel fuel, and for MDPVs, even though these vehicles were not subject to the SFTP standards in the Tier 2 program.

* * * * *

69. Amend §86.1813-17 by revising the introductory text and paragraph (a)(2)(i) to read as follows:

§86.1813-17 Evaporative and refueling emission standards.

Vehicles must meet evaporative and refueling emission standards as specified in this section. These emission standards apply for heavy duty vehicles above 14,000 pounds GVWR as specified in §86.1801. These emission standards apply for total hydrocarbon equivalent (THCE) measurements using the test procedures specified in subpart B of this part, as appropriate. Note that §86.1829 allows you to certify without testing in certain circumstances. These evaporative and refueling emission standards do not apply for electric vehicles, fuel cell vehicles, or diesel-fueled vehicles, except as specified in paragraph (b) of this section. Unless otherwise specified, MDPVs are subject to all the same provisions of this section that apply to LDT4.

(a) * * *

(2) * * *

(i) The emission standard for the sum of diurnal and hot soak measurements from the two-diurnal test sequence and the three-diurnal test sequence is based on a fleet average in a given model year. You must specify a family emission limit (FEL) for each evaporative family. The FEL serves as the emission standard for the evaporative family with respect to all required diurnal and hot soak testing. Calculate your fleet-average emission level as described in §86.1860 based on the FEL that applies for low-altitude testing to show that you meet the specified standard. For multi-fueled vehicles, calculate fleet-average emission levels based only on emission levels for testing with gasoline. You may generate emission credits for banking and trading and you may use banked or traded credits for demonstrating compliance with the diurnal plus hot soak emission standard for vehicles required to meet the Tier 3 standards, other than gaseous-fueled vehicles, as described in §86.1861 starting in model year 2017. You comply with the emission standard for a given model year if you have enough credits to show that your fleet-average emission level is at or below the applicable standard. You may exchange credits between or among evaporative families within an averaging set as described in §86.1861. Separate diurnal plus hot soak emission standards apply for each evaporative/refueling emission family as shown for high-altitude conditions. The sum of diurnal and hot soak measurements may not exceed the following Tier 3 standards:

* * * * *

70. Amend §86.1817-05 by revising paragraph (a)(1) to read as follows:

§86.1817-05 Complete heavy-duty vehicle averaging, trading, and banking program.

(a) * * *

(1) Complete heavy-duty vehicles eligible for the NOx averaging, trading and banking program are described in the applicable emission standards section of this subpart. Participation in this averaging, trading, and banking program is voluntary.

* * * * *

71. Amend §86.1818-12 by revising paragraph (d) to read as follows:

§86.1818-12 Greenhouse gas emission standards for light-duty vehicles, light-duty trucks, and medium-duty passenger vehicles.

* * * * *

(d) *In-use CO_2 exhaust emission standards*. The in-use CO_2 exhaust emission standard shall be the combined city/highway carbon-related exhaust emission value calculated for the appropriate vehicle carline/subconfiguration according to the provisions of §600.113-12(g)(4) of this chapter adjusted by the deterioration factor from §86.1823-08(m). Multiply the result by 1.1 and round to the nearest whole gram per mile. For in-use vehicle carlines/subconfigurations for which a combined city/highway carbon-related exhaust emission value was not determined under §600.113-12(g)(4) of this chapter, the in-use CO_2 exhaust emission standard shall be the combined city/highway carbon-related exhaust emission value calculated according to the

provisions of §600.208 of this chapter for the vehicle model type (except that total model year production data shall be used instead of sales projections) adjusted by the deterioration factor from §86.1823-08(m). Multiply the result by 1.1 and round to the nearest whole gram per mile. For vehicles that are capable of operating on multiple fuels, except plug-in hybrid electric vehicles, a separate in-use standard shall be determined for each fuel that the vehicle is capable of operating on. These standards apply to in-use testing performed by the manufacturer pursuant to regulations at §§86.1845 and 86.1846 and to in-use testing performed by EPA.
* * * * *

72. Amend §86.1838-01 by revising paragraph (c)(2)(iii) to read as follows:
§86.1838-01 Small-volume manufacturer certification procedures.
* * * * *
(c) * * *
(2) * * *
(iii) The provisions of §86.1845-04(c)(2) that require one vehicle of each test group during high mileage in-use verification testing to have a minimum odometer mileage of 75 percent of the full useful life mileage do not apply.
* * * * *

73. Amend §86.1868-12 by revising paragraph (g) introductory text and adding paragraph (g)(5) to read as follows:
§86.1868-12 CO_2 credits for improving the efficiency of air conditioning systems.
* * * * *
(g) *AC17 validation testing and reporting requirements*. For 2020 and later model years, manufacturers must validate air conditioning credits by using the AC17 Test Procedure as follows:
* * * * *
(5) AC17 testing requirements apply as follows for electric vehicles and plug-in hybrid electric vehicles:
(i) Manufacturers may omit AC17 testing for electric vehicles. Electric vehicles may qualify for air conditioning efficiency credits based on identified technologies, without testing. The application for certification must include a detailed description of the vehicle's air conditioning system and identify any technology items eligible for air conditioning efficiency credits. Include additional supporting information to justify the air conditioning credit for each technology.
(ii) The provisions of paragraph (g)(5)(i) of this section also apply for plug-in hybrid electric vehicles if they have an all electric range of at least 60 miles (combined city and highway) after adjustment to reflect actual in-use driving conditions (see 40 CFR 600.311(j)), and they do not rely on the engine to cool the vehicle's cabin for the ambient and driving conditions represented by the AC17 test.
(iii) If AC17 testing is required for plug-in hybrid electric vehicles, perform this testing in charge-sustaining mode.
* * * * *

74. Part 88 is revised to read as follows:
PART 88—CLEAN-FUEL VEHICLES
Sec.

88.1 General applicability.
88.2 through 88.3 [Reserved]
Authority: 42 U.S.C. 7410, 7418, 7581, 7582, 7583, 7584, 7586, 7588, 7589, 7601(a).

§88.1 General applicability.

(a) The Clean Air Act includes provisions intended to promote the development and sale of clean-fuel vehicles (see 42 U.S.C. 7581-7589). This takes the form of credit incentives for State Implementation Plans. The specified clean-fuel vehicle standards to qualify for these credits are now uniformly less stringent than the emission standards that apply for new vehicles and new engines under 40 CFR part 86 and part 1036.

(b) The following provisions apply for purposes of State Implementation Plans that continue to reference the Clean Fuel Fleet Program:

(1) Vehicles and engines certified to current emission standards under 40 CFR part 86 or part 1036 are deemed to also meet the Clean Fuel Fleet standards as Ultra Low-Emission Vehicles.

(2) Vehicles and engines meeting requirements as specified in paragraph (a)(1) of this section with a fuel system designed to not vent fuel vapors to the atmosphere are also deemed to meet the Clean Fuel Fleet standards as Inherently Low-Emission Vehicles. The applies for vehicles using diesel fuel, liquefied petroleum gas, or compressed natural gas. It does not apply for vehicles using gasoline, ethanol, methanol, or liquefied natural gas.

(3) The following types of vehicles qualify as Zero Emission Vehicles:

(i) Electric vehicles (see 40 CFR 86.1803).

(ii) Any other vehicle with a fuel that contains no carbon or nitrogen compounds, that has no evaporative emissions, and that burns without forming oxides of nitrogen, carbon monoxide, formaldehyde, particulate matter, or hydrocarbon compounds. This applies equally for all engines installed on the vehicle.

§§88.2 through 88.3 [Reserved]

75. Part 89 is revised to read as follows:

PART 89—CONTROL OF EMISSIONS FROM NEW AND IN-USE NONROAD COMPRESSION-IGNITION ENGINES

Sec.
89.1 Applicability.
89.2 through 89.3 [Reserved]
Authority: 42 U.S.C. 7401-7671q.

§89.1 Applicability.

The Environmental Protection Agency adopted emission standards for model year 1996 and later nonroad compression-ignition engines under this part 89. EPA has migrated regulatory requirements for these engines to 40 CFR part 1039, with additional testing and compliance provisions in 40 CFR part 1065 and part 1068. The Tier 1, Tier 2, and Tier 3 standards originally adopted in this part 89 are identified in 40 CFR part 1039, Appendix I. See 40 CFR 1039.1 for information regarding the timing of the transition to 40 CFR part 1039, and for information regarding regulations that continue to apply for engines that manufacturers originally certified or otherwise produced under this part 89.

§§89.2 through 89.3 [Reserved]

76. Part 90 is revised to read as follows:

PART 90—CONTROL OF EMISSIONS FROM NONROAD SPARK-IGNITION ENGINES AT OR BELOW 19 KILOWATTS

Sec.
90.1 Applicability.
90.2 through 90.3 [Reserved]
Authority: 42 U.S.C. 7401-7671q.

§90.1 Applicability.

The Environmental Protection Agency adopted emission standards for model year 1997 and later nonroad spark-ignition engines below 19 kW under this part 90. EPA has migrated regulatory requirements for these engines to 40 CFR part 1054, with additional testing and compliance provisions in 40 CFR part 1065 and part 1068. The Phase 1 and Phase 2 standards originally adopted in this part 90 are identified in 40 CFR part 1054, Appendix I. See 40 CFR 1054.1 for information regarding the timing of the transition to 40 CFR part 1054, and for information regarding regulations that continue to apply for engines that manufacturers originally certified or otherwise produced under this part 90.1

§§90.2 through 90.3 [Reserved]

77. Part 91 is revised to read as follows:

PART 91—CONTROL OF EMISSIONS FROM MARINE SPARK-IGNITION ENGINES

Sec.
91.1 Applicability.
91.2 through 91.3 [Reserved]
Authority: 42 U.S.C. 7401-7671q.

§91.1 Applicability.

The Environmental Protection Agency adopted emission standards for model year 1998 and later marine spark-ignition engines under this part 91, except that the standards of this part did not apply to sterndrive/inboard engines. EPA has migrated regulatory requirements for these engines to 40 CFR part 1045, with additional testing and compliance provisions in 40 CFR part 1065 and part 1068. The standards originally adopted in this part 91 are identified in 40 CFR part 1045, Appendix I. See 40 CFR 1045.1 for information regarding the timing of the transition to 40 CFR part 1045, and for information regarding regulations that continue to apply for engines that manufacturers originally certified or otherwise produced under this part 91.

§§91.2 through 91.3 [Reserved]

78. Part 92 is revised to read as follows:

PART 92—CONTROL OF AIR POLLUTION FROM LOCOMOTIVES AND LOCOMOTIVE ENGINES

Sec.
92.1 Applicability.
92.2 through 92.3 [Reserved]
Authority: 42 U.S.C. 7401-7671q.

§92.1 Applicability.

The Environmental Protection Agency first adopted emission standards for freshly manufactured and remanufactured locomotives under this part 92 in 1998. EPA has migrated regulatory requirements for these engines to 40 CFR part 1033, with additional testing and compliance provisions in 40 CFR part 1065 and part 1068. The Tier 0, Tier 1, and Tier 2 standards originally adopted in this part 92 are identified in 40 CFR part 1033, Appendix I. See 40 CFR 1033.1 for information regarding the timing of the transition to 40 CFR part 1033, and for information regarding regulations that continue to apply for engines that manufacturers originally certified or otherwise produced or remanufactured under this part 92. Emission standards started to apply for locomotive and locomotive engines if they were–

(a) Manufactured on or after January 1, 2000;

(b) Manufactured on or after January 1, 1973 and remanufactured on or after January 1, 2000; or

(c) Manufactured before January 1, 1973 and upgraded on or after January 1, 2000.

§§92.2 through 92.3 [Reserved]

79. Part 94 is revised to read as follows:

PART 94—CONTROL OF EMISSIONS FROM MARINE COMPRESSION-IGNITION ENGINES

Sec.

Authority: 42 U.S.C. 7401-7671q.

§94.1 Applicability.

The Environmental Protection Agency adopted emission standards for model year 2004 and later marine compression-ignition engines under this part 94. EPA has migrated regulatory requirements for these engines to 40 CFR part 1042, with additional testing and compliance provisions in 40 CFR part 1065 and part 1068. The Tier 1 and Tier 2 standards originally adopted in this part 94 are identified in 40 CFR part 1042, Appendix I. See 40 CFR 1042.1 for information regarding the timing of the transition to 40 CFR part 1042, and for information regarding regulations that continue to apply for engines that manufacturers originally certified or otherwise produced under this part 94.

§§94.2 through 94.3 [Reserved]

PART 1027 — FEES FOR VEHICLE AND ENGINE COMPLIANCE PROGRAMS

80. The authority statement for part 1027 continues to read as follows:

Authority: 42 U.S.C. 7401-7671q.

81. The heading for part 1027 is revised to read as set forth above.

82. Amend §1027.101 by:

a. Revising paragraph (a); and

b. Removing and reserving paragraph (b).

The revision reads as follows:

§1027.101 To whom do these requirements apply?

(a) This part prescribes fees manufacturers must pay for activities related to EPA's motor vehicle and engine compliance program (MVECP). This includes activities related to approving certificates of conformity and performing tests and taking other steps to verify compliance with emission standards. You must pay fees as described in this part if you are a manufacturer of any of the following products:

(1) Motor vehicles and motor vehicle engines we regulate under 40 CFR part 86. This includes light-duty vehicles, light-duty trucks, medium-duty passenger vehicles, highway motorcycles, and heavy-duty highway engines and vehicles.

(2) The following nonroad engines and equipment:

(i) Locomotives and locomotive engines we regulate under 40 CFR part 1033.

(ii) Nonroad compression-ignition engines we regulate under 40 CFR part 1039.

(iii) Marine compression-ignition engines we regulate under 40 CFR part 1042 or 1043.

(iv) Marine spark-ignition engines and vessels we regulate under 40 CFR part 1045 or 1060. We refer to these as Marine SI engines.

(v) Nonroad spark-ignition engines above 19 kW we regulate under 40 CFR part 1048. We refer to these as Large SI engines.

(vi) Recreational vehicles we regulate under 40 CFR part 1051.

(vii) Nonroad spark-ignition engines and equipment at or below 19 kW we regulate under 40 CFR part 1054 or 1060. We refer to these as Small SI engines.

(3) The following stationary internal combustion engines:

(i) Stationary compression-ignition engines we certify under 40 CFR part 60, subpart IIII.

(ii) Stationary spark-ignition engines we certify under 40 CFR part 60, subpart JJJJ.

(4) Portable fuel containers we regulate under 40 CFR part 59, subpart F.

* * * * *

83. Revise §1027.105 to read as follows:

§1027.105 How much are the fees?

(a) Fees are determined based on the date we receive a complete application for certification. Each reference to a year in this subpart refers to the calendar year, unless otherwise specified. Paragraph (b) of this section specifies baseline fees that apply for certificates received in 2020 See paragraph (c) of this section for provisions describing how we calculate fees for 2021 and later years.

(b) The following baseline fees apply for each application for certification:

(1) Except as specified in paragraph (b)(2) of this section for Independent Commercial Importers, the following fees apply in 2020 for motor vehicles and motor vehicle engines:

Category[a]	Certificate type	Fee
(i) Light-duty vehicles, light-duty trucks, medium-duty passenger vehicle, and complete heavy-duty highway vehicles	Federal	$27,347
(ii) Light-duty vehicles, light-duty trucks, medium-duty passenger vehicle, and complete heavy-duty highway vehicles	California-only	$14,700
(iii) Heavy-duty highway engine	Federal	$56,299
(iv) Heavy-duty highway engine	California-only	$563
(v) Heavy-duty vehicle	Evap	$563
(vi) Highway motorcycle, including Independent Commercial Importers	All	$1,852

[a]The specified categories include engines and vehicles that use all applicable fuels.

(2) A fee of $87,860 applies in 2020 for Independent Commercial Importers with respect to the following motor vehicles:

(i) Light-duty vehicles and light-duty trucks.

(ii) Medium-duty passenger vehicles.

(iii) Complete heavy-duty highway vehicles.

(3) The following fees apply in 2020 for nonroad and stationary engines, vehicles, equipment, and components:

Category	Certificate type	Fee
(i) Locomotives and locomotive engines	All	$563
(ii) Marine compression-ignition engines and stationary compression-ignition engines with per-cylinder displacement at or above 10 liters	All, including EIAPP	$563
(iii) Other nonroad compression-ignition engines and stationary compression-ignition engines with per-cylinder displacement below 10 liters	All	$2,940
(iv) Large SI engines and stationary spark-ignition engines above 19 kW	All	$563
(v) Marine SI engines. Small SI engines, and stationary spark-ignition engines at or below 19 kW	Exhaust only	$563
(vi) Recreational vehicles	Exhaust (or combined exhaust and evap)	$563
(vii) Equipment and fuel-system components associated with nonroad and stationary spark-ignition engines, including portable fuel containers.	Evap (where separate certification is required)	$397

(c) We will calculate adjusted fees for 2021 and later years based on changes in the Consumer Price Index and the number of certificates. We will announce adjusted fees for a given year by March 31 of the preceding year.

(1) We will adjust the values specified in paragraph (b) of this section for years after 2020 as follows:

(i) Use the following equation for certification related to evaporative emissions from nonroad and stationary engines when a separate fee applies for certification to evaporative emission standards:

$$\text{Certificate Fee}_{CY} = \left[\left(Op + L \cdot \frac{CPI_{CY\text{-}2}}{CPI_{2006}}\right)\right] \cdot \frac{OH}{\left[\left(cert\#_{MY\text{-}2} + cert\#_{MY\text{-}3}\right) \cdot 0.5\right]}$$

Where:

Certificate FeeCY = Fee per certificate for a given year.

Op = operating costs are all of EPA's nonlabor costs for each category's compliance program, including any fixed costs associated with EPA's testing laboratory, as described in paragraph (d)(1) of this section.

L = the labor costs, to be adjusted by the Consumer Price Index, as described in paragraph (d)(1) of this section.

CPICY-2 = the Consumer Price Index for the month of November two years before the applicable calendar year, as described in paragraph (d)(2) of this section.

CPI2006 = 201.8. This is based on the October 2006 value of the Consumer Price Index. as described in paragraph (d)(2) of this section

OH = 1.169. This is based on EPA overhead, which is applied to all costs.

cert#MY-2 = the total number of certificates issued for a fee category in the model year two years before the calendar year for the applicable fees as described in paragraph (d)(3) of this section.

cert#MY-3 = the total number of certificates issued for a fee category in the model year three years before the calendar year for the applicable fees as described in paragraph (d)(3) of this section.
(ii) Use the following equation for all other certificates:

$$\text{Certificate Fee}_{CY} = \left[\left(Op + L \cdot \frac{CPI_{CY-2}}{CPI_{2002}}\right)\right] \cdot \frac{OH}{\left[\left(cert\#_{MY-2} + cert\#_{MY-3}\right) \cdot 0.5\right]}$$

Where:
CPI2002 = 180.9. This is based on the December 2002 value of the Consumer Price Index as described in paragraph (d)(2) of this section.

(2) The fee for any year will remain at the previous year's amount until the value calculated in paragraph (c)(1) of this section differs by at least $50 from the amount specified for the previous year.

(d) Except as specified in §1027.110(a) for motor vehicles and motor vehicle engines, we will use the following values to determine adjusted fees using the equation in paragraph (c) of this section:

(1) The following values apply for operating costs and labor costs:

Engine or Vehicle Category	Op	L
(i) Light-duty, medium-duty passenger, and complete heavy-duty highway vehicle certification	$3,322,039	$2,548,110
(ii) Light-duty, medium-duty passenger, and complete heavy-duty highway vehicle in-use testing	$2,858,223	$2,184,331
(iii) Independent Commercial Importers identified in §1027.105(b)(2)	$344,824	$264,980
(iv) Highway motorcycles	$225,726	$172,829
(v) Heavy-duty highway engines	$1,106,224	$1,625,680
(vi) Nonroad compression-ignition engines that are not locomotive or marine engines, and stationary compression-ignition engines with per-cylinder displacement below 10 liters	$486,401	$545,160
(vii) Evaporative certificates related to nonroad and stationary engines	$5,039	$236,670
(viii) All other	$177,425	$548,081

(2) The applicable Consumer Price Index is based on the values published by the Bureau of Labor Statistics for All Urban Consumers at https://www.usinflationcalculator.com/ under "Inflation and Prices" and "Consumer Price Index Data from 1913 to....". For example, we calculated the 2006 fees using the Consumer Price Index for November 2004, which is 191.0.
(3) Fee categories for counting the number of certificates issued are based on the grouping shown in paragraph (d)(1) of this section.

84. Amend §1027.110 by revising paragraph (a) introductory text to read as follows:

§1027.110 What special provisions apply for certification related to motor vehicles?

(a) We will adjust fees for light-duty, medium-duty passenger, and complete heavy-duty highway vehicles as follows:

* * * * *

85. Amend §1027.125 by revising paragraph (e) to read as follows:

§1027.125 Can I get a refund?

*   *   *   *   *

(e) Send refund and correction requests online at www.Pay.gov, or as specified in our guidance.

*   *   *   *   *

86. Amend §1027.130 by revising paragraphs (a) and (b) to read as follows:

§1027.130 How do I make a fee payment?

(a) Pay fees to the order of the Environmental Protection Agency in U.S. dollars using electronic funds transfer or any method available for payment online at www.Pay.gov, or as specified in EPA guidance.

(b) Submit a completed fee filing form at www.Pay.gov.

*   *   *   *   *

87. Amend §1027.135 by revising paragraph (b) to read as follows:

§1027.135 What provisions apply to a deficient filing?

*   *   *   *   *

(b) We will hold a deficient filing along with any payment until we receive a completed form and full payment. If the filing remains deficient at the end of the model year, we will continue to hold any funds associated with the filing so you can make a timely request for a refund. We will not process an application for certification if the associated filing is deficient.

88. Revise §1027.155 to read as follows:

§1027.155 What abbreviations apply to this subpart?

The following symbols, acronyms, and abbreviations apply to this part:

CFR	Code of Federal Regulations.
CPI	Consumer Price Index.
EPA	U.S. Environmental Protection Agency.
Evap	Evaporative emissions.
EIAPP	Engine International Air Pollution Prevention (from MARPOL Annex VI).
ICI	Independent Commercial Importer.
MVECP	Motor vehicle and engine compliance program.
MY	Model year.
U.S.	United States.

PART 1033—CONTROL OF EMISSIONS FROM LOCOMOTIVES

89. The authority citation for part 1033 continues to read as follows:

Authority: 42 U.S.C. 7401-7671q.

90. Amend §1033.150 by—

a. Removing and reserving paragraphs (a) and (d).

b. Revising paragraph (e) introductory text.

c. Removing and reserving paragraphs (h) through (j).

d. Removing paragraphs (l) and (m).
The revision reads as follows:

§1033.150 Interim provisions.

* * * * *

(e) *Producing switch locomotives using certified nonroad engines*. You may use the provisions of this paragraph (e) to produce any number of freshly manufactured or refurbished switch locomotives in model years 2008 through 2017. Locomotives produced under this paragraph (e) are exempt from the standards and requirements of this part subject to the following provisions:

* * * * *

91. Revise §1033.255 to read as follows:

§1033.255 EPA decisions.

(a) If we determine an application is complete and shows that the engine family meets all the requirements of this part and the Clean Air Act, we will issue a certificate of conformity for the engine family for that model year. We may make the approval subject to additional conditions.
(b) We may deny an application for certification if we determine that an engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.
(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.
(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.
(3) Cause any test data to become inaccurate.
(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.
(5) Produce locomotives for importation into the United States at a location where local law prohibits us from carrying out authorized activities.
(6) Fail to supply requested information or amend an application to include all locomotives being produced.
(7) Take any action that otherwise circumvents the intent of the Clean Air Act or this part.

(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).
(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.
(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1033.920).

92. Amend §1033.601 by revising paragraphs (c)(4) and (5) to read as follows:

§1033.601 General compliance provisions.

* * * * *

(c) * * *

(4) The provisions for importing engines and equipment under the identical configuration exemption of 40 CFR 1068.315(h) do not apply for locomotives.
(5) The provisions for importing engines and equipment under the ancient engine exemption of 40 CFR 1068.315(i) do not apply for locomotives.
* * * * *

93. Amend §1033.701 by revising paragraph (k)(1) to read as follows:
§1033.701 General provisions.
* * * * *
(k) * * *
(1) You may retire emission credits generated from any number of your locomotives. This may be considered donating emission credits to the environment. Identify any such credits in the reports described in §1033.730. Locomotives must comply with the applicable FELs even if you donate or sell the corresponding emission credits under this paragraph (k). Those credits may no longer be used by anyone to demonstrate compliance with any EPA emission standards.
* * * * *

94. Amend §1033.740 by revising the introductory text and paragraph (a) to read as follows:
§1033.740 Credit restrictions.
Use of emission credits generated under this part 1033 is restricted depending on the standards against which they were generated.
(a) *Pre-2008 credits*. NOx and PM credits generated before model year 2008 may be used under this part in the same manner as NOx and PM credits generated under this part.
* * * * *

95. Amend §1033.901 by revising paragraph (1) of the definition of "New" to read as follows:
§1033.901 Definitions.
* * * * *
New, * * *
(1) A locomotive or engine is new if its equitable or legal title has never been transferred to an ultimate purchaser. Where the equitable or legal title to a locomotive or engine is not transferred prior to its being placed into service, the locomotive or engine ceases to be new when it is placed into service. A locomotive or engine also becomes new if it is remanufactured or refurbished (as defined in this section). A remanufactured locomotive or engine ceases to be new when placed back into service. With respect to imported locomotives or locomotive engines, the term "new locomotive" or "new locomotive engine" also means a locomotive or locomotive engine that is not covered by a certificate of conformity under this part or 40 CFR part 92 at the time of importation, and that was manufactured or remanufactured after January 1, 2000, which would have been applicable to such locomotive or engine had it been manufactured or remanufactured for importation into the United States. Note that replacing an engine in one locomotive with an unremanufactured used engine from a different locomotive does not make a locomotive new.
* * * * *

96. Amend §1033.925 by revising paragraph (e) introductory text to read as follows:
§1033.925 Reporting and recordkeeping requirements.
* * * * *

Budget approves the reporting and recordkeeping specified in the applicable regulations. The following items illustrate the kind of reporting and recordkeeping we require for locomotives regulated under this part:
* * * * *

PART 1036--CONTROL OF EMISSIONS FROM NEW AND IN-USE HEAVY-DUTY HIGHWAY ENGINES

97. The authority citation for part 1036 continues to read as follows:
Authority: 42 U.S.C. 7401 - 7671q.

98. Amend §1036.1 by adding paragraph (b)(3) to read as follows:

§1036.1 Does this part apply for my engines?

* * * * *
(b) * * *
(3) The provisions of §1036.501(h)(1) apply.
* * * * *

99. Amend §1036.108 by revising paragraph (a) to read as follows:

§1036.108 Greenhouse gas emission standards.

* * * * *
(a) Emission standards. Emission standards apply for engines and optionally powertrains measured using the test procedures specified in subpart F of this part as follows:

(1) CO_2 emission standards in this paragraph (a)(1) apply based on testing as specified in subpart F of this part. The applicable test cycle for measuring CO_2 emissions differs depending on the engine family's primary intended service class and the extent to which the engines will be (or were designed to be) used in tractors. For medium and heavy heavy-duty engines certified as tractor engines, measure CO_2 emissions using the steady-state duty cycle specified in §1036.501 (referred to as the Supplemental Emission Test, or SET, even though emission sampling involves measurements from discrete modes). This is intended for engines designed to be used primarily in tractors and other line-haul applications. Note that the use of some SET-certified tractor engines in vocational applications does not affect your certification obligation under this paragraph (a)(1); see other provisions of this part and 40 CFR part 1037 for limits on using engines certified to only one cycle. For medium and heavy heavy-duty engines certified as both tractor and vocational engines, measure CO_2 emissions using the steady-state duty cycle and the transient duty cycle (sometimes referred to as the FTP engine cycle) specified in §1036.501. This is intended for engines that are designed for use in both tractor and vocational applications. For all other engines (including engines meeting spark-ignition standards), measure CO_2 emissions using the appropriate transient duty cycle specified in §1036.501.

(i) The CO_2 standard is 627 g/hp·hr for all spark-ignition engines for model years 2016 through 2020. This standard continues to apply in later model years for all spark-ignition engines that are not heavy heavy-duty engines.

(ii) The following CO_2 standards apply for compression-ignition engines (in g/hp·hr):

Table 1 of §1036.108—Compression-Ignition Engine Standards for MY 2014 – 2020

MODEL YEARS	LIGHT HEAVY-DUTY	MEDIUM HEAVY-DUTY-VOCATIONAL	HEAVY HEAVY-DUTY-VOCATIONAL	MEDIUM HEAVY-DUTY-TRACTOR	HEAVY HEAVY-DUTY-TRACTOR
2014-2016	600	600	567	502	475
2017-2020	576	576	555	487	460

(iii) The following CO_2 standards apply for compression-ignition engines and all heavy heavy-duty engines (in g/hp·hr):

Table 2 of §1036.108—Compression-Ignition Engine Standards for MY 2021 and Later

MODEL YEARS	LIGHT HEAVY-DUTY	MEDIUM HEAVY-DUTY-VOCATIONAL	HEAVY HEAVY-DUTY-VOCATIONAL	MEDIUM HEAVY-DUTY-TRACTOR	HEAVY HEAVY-DUTY-TRACTOR
2021-2023	563	545	513	473	447
2024-2026	555	538	506	461	436
2027 and later	552	535	503	457	432

(iv) You may certify spark-ignition engines to the compression-ignition standards for the appropriate model year under this paragraph (a). If you do this, those engines are treated as compression-ignition engines for all the provisions of this part.

(2) The CH_4 emission standard is 0.10 g/hp·hr when measured over the applicable transient duty cycle specified in 40 CFR part 86, subpart N. This standard begins in model year 2014 for compression-ignition engines and in model year 2016 for spark-ignition engines. Note that this standard applies for all fuel types just like the other standards of this section.

(3) The N_2O emission standard is 0.10 g/hp·hr when measured over the transient duty cycle specified in 40 CFR part 86, subpart N. This standard begins in model year 2014 for compression-ignition engines and in model year 2016 for spark-ignition engines.

* * * * *

100. Amend §1036.150 by revising paragraphs (e), (g), and (p)(2) and adding paragraph (q) to read as follows:

§1036.150 Interim provisions.

* * * * *

(e) Alternate phase-in standards. Where a manufacturer certifies all of its model year 2013 compression-ignition engines within a given primary intended service class to the applicable alternate standards of this paragraph (e), its compression-ignition engines within that primary intended service class are subject to the standards of this paragraph (e) for model years 2013 through 2016. This means that once a manufacturer chooses to certify a primary intended service class to the standards of this paragraph (e), it is not allowed to opt out of these standards. Engines certified to these standards are not eligible for early credits under paragraph (a) of this section.

VEHICLE TYPE	MODEL YEARS	LHD ENGINES	MHD ENGINES	HHD ENGINES
Tractors	2013-2015	NA	512 g/hphr	485 g/hphr
	2016 and later[a]	NA	487 g/hphr	460 g/hphr
Vocational	2013-2015	618 g/hphr	618 g/hphr	577 g/hphr
	2016 through 2020[a]	576 g/hphr	576 g/hphr	555 g/hphr

[a]Note: these alternate standards for 2016 and later are the same as the otherwise applicable standards for 2017 through 2020.

* * * * *

(g) Assigned deterioration factors. You may use assigned deterioration factors (DFs) without performing your own durability emission tests or engineering analysis as follows:

(1) You may use an assigned additive DF of 0.0 g/hp-hr for CO_2 emissions from engines that do not use advanced or off-cycle technologies. If we determine it to be consistent with good engineering judgment, we may allow you to use an assigned additive DF of 0.0 g/hp-hr for CO_2 emissions from your engines with advanced or off-cycle technologies.

(2) You may use an assigned additive DF of 0.010 g/hphr for N_2O emissions from any engine through model year 2021, and 0.020 g/hp-hr for later model years.

(3) You may use an assigned additive DF of 0.020 g/hp-hr for CH_4 emissions from any engine.

* * * * *

(p) * * *

(2) You may certify your model year 2024 through 2026 engines to the following alternative standards:

MODEL YEARS	MEDIUM HEAVY-DUTY-VOCATIONAL	HEAVY HEAVY-DUTY-VOCATIONAL	MEDIUM HEAVY-DUTY-TRACTOR	HEAVY HEAVY-DUTY-TRACTOR
2024-2026	542	510	467	442

(q) Confirmatory testing of fuel maps defined in §1036.503(b). For model years 2021 and later, where the results from Equation 1036.235-1 for a confirmatory test is less than or equal to 2.0 %, we will not replace the manufacturer's fuel maps.

101. Amend §1036.225 by revising paragraphs (e) and (f)(1) to read as follows:

§1036.225 Amending my application for certification.

* * * * *

(e) The amended application applies starting with the date you submit the amended application, as follows:

(1) For engine families already covered by a certificate of conformity, you may start producing a new or modified engine configuration any time after you send us your amended application and before we make a decision under paragraph (d) of this section. However, if we determine that the affected engines do not meet applicable requirements, we will notify you to cease production of the engines and may require you to recall the engines at no expense to the owner. Choosing to produce engines under this paragraph (e) is deemed to be consent to recall all engines that we determine do not meet applicable emission standards or other requirements and to remedy the nonconformity at no expense to the owner. If you do not provide information required under paragraph (c) of this section within 30 days after we

request it, you must stop producing the new or modified engines.

(2) [Reserved]

(f) * * *

(1) You may ask to raise your FEL for your engine family at any time before the end of the model year. In your request, you must show that you will still be able to meet the emission standards as specified in subparts B and H of this part. Use the appropriate FELs/FCLs with corresponding production volumes to calculate emission credits for the model year, as described in subpart H of this part.

* * * * *

102. Amend §1036.230 by revising paragraph (d) and adding paragraph (f) to read as follows:

§1036.230 Selecting engine families.

* * * * *

(d) Except as described in paragraph (f) of this section, engine configurations within an engine family must use equivalent greenhouse gas emission controls. Unless we approve it, you may not produce nontested configurations without the same emission control hardware included on the tested configuration. We will only approve it if you demonstrate that the exclusion of the hardware does not increase greenhouse gas emissions.

* * * * *

(f) Engine families may be divided into subfamilies with respect to compliance with CO_2 standards.

103. Amend §1036.235 by revising the introductory text and paragraphs (b) and (c) to read as follows:

§1036.235 Testing requirements for certification.

This section describes the emission testing you must perform to show compliance with the greenhouse gas emission standards in §1036.108. When testing hybrid powertrains substitute "hybrid powertrain" for "engine" as it applies to requirements for certification.

* * * * *

(b) Test your emission-data engines using the procedures and equipment specified in subpart F of this part. In the case of dual-fuel and flexible-fuel engines, measure emissions when operating with each type of fuel for which you intend to certify the engine. (Note: measurement of criteria emissions from flexible-fuel engines generally involves operation with the fuel mixture that best represents in-use operation, or with the fuel mixture with the highest emissions.)Measure CO_2, CH_4, and N_2O emissions using the specified duty cycle(s), including cold-start and hot-start testing as specified in 40 CFR part 86, subpart N. The following provisions apply regarding test cycles for demonstrating compliance with tractor and vocational standards:

(1) If you are certifying the engine for use in tractors, you must measure CO_2 emissions using the applicable SET specified in §1036.501, and measure CH_4, and N_2O emissions using the specified transient cycle.

(2) If you are certifying the engine for use in vocational applications, you must measure CO_2, CH_4, and N_2O emissions using the specified transient duty cycle, including cold-start and hot-start testing as specified in §1036.501.

(3) You may certify your engine family for both tractor and vocational use by submitting CO_2 emission data from both SET and transient cycle testing and specifying FCLs for both.

(4) Some of your engines certified for use in tractors may also be used in vocational vehicles, and some of your engines certified for use in vocational may be used in tractors. However, you may not knowingly circumvent the intent of this part (to reduce in-use emissions of CO_2) by certifying engines designed for tractors or vocational vehicles (and rarely used in the other application) to the wrong cycle. For example, we would generally not allow you to certify all your engines to the SET without certifying any to the transient cycle.

(c) We may perform confirmatory testing by measuring emissions from any of your emission-data engines. If your certification includes powertrain testing as specified in §1036.630, this paragraph (c) also applies for the powertrain test results.

(1) We may decide to do the testing at your plant or any other facility. If we do this, you must deliver the engine to a test facility we designate. The engine you provide must include appropriate manifolds, aftertreatment devices, electronic control units, and other emission-related components not normally attached directly to the engine block. If we do the testing at your plant, you must schedule it as soon as possible and make available the instruments, personnel, and equipment we need.

(2) If we measure emissions on your engine, the results of that testing become the official emission results for the engine as specified in this paragraph (c). Unless we later invalidate these data, we may decide not to consider your data in determining if your engine family meets applicable requirements.

(3) Before we test one of your engines, we may set its adjustable parameters to any point within the physically adjustable ranges.

(4) Before we test one of your engines, we may calibrate it within normal production tolerances for anything we do not consider an adjustable parameter. For example, this would apply for an engine parameter that is subject to production variability because it is adjustable during production, but is not considered an adjustable parameter (as defined in §1036.801) because it is permanently sealed. For parameters that relate to a level of performance that is itself subject to a specified range (such as maximum power output), we will generally perform any calibration under this paragraph (c)(4) in a way that keeps performance within the specified range.

(5) We may use our emission test results for steady-state, idle, cycle-average and powertrain fuel maps defined in §1036.503(b) as the official emission results. We will not replace individual points from your fuel map.

(i) We will determine fuel masses, $m_{\text{fuel[cycle]}}$, and mean idle fuel mass flow rates, $\bar{\dot{m}}_{\text{fuelidle}}$, if applicable, using the method described in §1036.535(h).

(ii) We will perform this comparison using the weighted results from GEM, using vehicles that are appropriate for the engine under test. For example, we may select vehicles that the engine went into for the previous model year.

(iii) If you supply cycle-average engine fuel maps for the highway cruise cycles instead of generating a steady-state fuel map for these cycles, we may perform a confirmatory test of your engine fuel maps for the highway cruise cycles by either of the following methods:

(A) Directly measuring the highway cruise cycle-average fuel maps.

(B) Measuring a steady-state fuel map as described in paragraph (c)(5) of this section and using it in GEM to create our own cycle-average engine fuel maps for the highway cruise cycles.

(iv) This section describes how we will replace fuel maps as a result of confirmatory testing.

(A) Weight individual duty cycle results using the vehicle categories determined in paragraph (c)(5)(i) of this section and respective weighting factors in Table 1 of 40 CFR 1037.510 to determine a composite CO_2 emission value for each vehicle configuration; then repeat the process for all the unique vehicle configurations used to generate the manufacturer's fuel maps.

(B) The average percent difference between fuel maps is calculated using the following equation:

$$difference = \left(\frac{\sum_{i=1}^{N} \frac{e_{\text{CO2compEPA}i} - e_{\text{CO2compManu}i}}{e_{\text{CO2compManu}i}}}{N} \right) \cdot 100\ \%$$

Eq. 1036.235-1

Where:

i = an indexing variable that represents one individual weighted duty cycle result for a vehicle configuration.

N = total number of vehicle configurations.

$e_{\text{CO2compEPA}i}$ = unrounded composite mass of CO_2 emissions in g/ton-mile for vehicle configuration i for the EPA confirmatory test.

$e_{\text{CO2compManu}i}$ = unrounded composite mass of CO_2 emissions in g/ton-mile for vehicle configuration i for the manufacturer-declared map.

(C) Where the unrounded average percent difference between our composite weighted fuel map and the manufacturer's is greater than or equal to 0 %, we will not replace the manufacturer's maps, and we will consider an individual engine to have passed the fuel map confirmatory test.

* * * * *

104. Revise §1036.255 to read as follows:

§1036.255 What decisions may EPA make regarding a certificate of conformity?

(a) If we determine an application is complete and shows that the engine family meets all the requirements of this part and the Act, we will issue a certificate of conformity for the engine family for that model year. We may make the approval subject to additional conditions.

(b) We may deny an application for certification if we determine that an engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.

(3) Cause any test data to become inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce engines for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend an application to include all engines being produced.

(7) Take any action that otherwise circumvents the intent of the Act or this part.

(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete after submission.

(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1036.820).

Subpart D— Testing Production Engines and Hybrid Powertrains

105. Revise the heading for subpart D to read as set forth above.

106. Amend §1036.301 by revising paragraph (b)(2) to read as follows:

§1036.301 Measurements related to GEM inputs in a selective enforcement audit.

* * * * *

(b) * * *

(2) Evaluate cycle-average fuel maps by running GEM based on simulated vehicle configurations representing the interpolated center of every group of four test points that define a boundary of cycle work and average engine speed divided by average vehicle speed. These simulated vehicle configurations are defined from the four surrounding points based on averaging values for vehicle mass, drag area (if applicable), tire rolling resistance, tire size, and axle ratio. The regulatory subcategory is defined by the regulatory subcategory of the vehicle configuration with the greatest mass from those four test points. Figure 1 of this section illustrates a determination of vehicle configurations for engines used in tractors and Vocational Heavy-Duty Vehicles (HDV) using a fixed tire size (see §1036.540(c)(3)(iii)). The vehicle configuration from the upper-left quadrant is defined by values for Tests 1, 2, 4, and 5 from Table 3 of §1036.540. Calculate vehicle mass as the average of the values from the four tests. Determine the weight reduction needed for GEM to simulate this calculated vehicle mass by comparing the average vehicle mass to the default vehicle mass for the vehicle subcategory from the four points that has the greatest mass, with the understanding that two-thirds of weight reduction for tractors is applied to vehicle weight and one-third is understood to represent increased payload. This is expressed mathematically as $M_{avg} = M_{subcategory} - 2/3 \cdot M_{reduction}$, which can be solved for $M_{reduction}$. For vocational vehicles, half of weight reduction is applied to vehicle weight and half is understood to represent increased payload. Use the following values for default vehicle masses by vehicle subcategory:

Table 1 of §1036.301—Default Vehicle Mass by Vehicle Subcategory

VEHICLE SUBCATEGORY	DEFAULT VEHICLE MASS (KG)
Vocational Light HDV	7,257
Vocational Medium HDV	11,408
Class 7 Mid-Roof Day Cab	20,910
Class 8 Mid-Roof Day Cab	29,529
Class 8 High-Roof Sleeper Cab	31,978
Heavy-Haul Tractor	53,750

* * * * *

107. Amend §1036.501 by revising paragraph (g) and adding paragraph (h) to read as follows:

§1036.501 How do I run a valid emission test?

* * * * *

(g) The following additional provisions apply for testing to demonstrate compliance with the emission standards in §1036.108 for model year 2016 through 2020 engines:

(1) Measure CO_2, CH_4, and N_2O emissions using the transient cycle specified in either 40 CFR 86.1333 or §1036.510.

(2) For engines subject to SET testing under §1036.108(a)(1), measure CO_2 emissions using the SET specified in 40 CFR 86.1362.

(h) The following additional provisions apply for testing to demonstrate compliance with the emission standards in §1036.108 for model year 2021 and later engines:

(1) If your engine is intended for installation in a vehicle equipped with stop-start technology, you may turn the engine off during the idle portions of the duty cycle to represent in-use operation, consistent with good engineering judgment. We recommend installing an engine starter motor and allowing the engine's Electronic Control Unit (ECU) to control the engine stop and start events.

(2) For engines subject to SET testing under §1036.108(a)(1), use one of the following methods to measure CO_2 emissions:

(i) Use the SET duty cycle specified in §1036.505 using either continuous or batch sampling.

(ii) Measure CO_2 emissions over the SET duty cycle specified in 40 CFR 86.1362 using continuous sampling. Integrate the test results by mode to establish separate emission rates for each mode (including the transition following each mode, as applicable). Apply the CO_2 weighting factors specified in 40 CFR 86.1362 to calculate a composite emission result.

(3) Measure CO_2, CH_4, and N_2O emissions over the transient cycle specified in either 40 CFR 86.1333 or §1036.510.

(4) Measure or calculate emissions of criteria pollutants corresponding to your measurements to demonstrate compliance with CO_2 standards. These test results are not subject to the duty-cycle standards of 40 CFR part 86, subpart A.

108. Add §1036.503 to read as follows:

§1036.503 Engine data and information for vehicle certification.

You must give vehicle manufacturers information as follows so they can certify model year 2021

and later vehicles:
(a) Identify engine make, model, fuel type, combustion type, engine family name, calibration identification, and engine displacement. Also identify which standards the engines meet.
(b) This paragraph (b) describes four different methods to generate engine fuel maps. For engines without hybrid components or mild hybrid where you choose not to include hybrid components in the test, you must generate fuel maps using either paragraphs (b)(1) or (2) of this section. For mild hybrid engines where you choose to include the hybrid components in the test and for hybrid engines, you must generate fuel maps using paragraph (b)(4) of this section. For all other hybrids, powertrains, and for vehicles where the transmission is not automatic, automated manual, manual, or dual-clutch you must use paragraph (b)(3) of this section.

(1) Combined steady-state and cycle-average. Determine steady-state engine fuel maps and fuel consumption at idle as described in §1036.535(b) and (c) respectively, and determine cycle-average engine fuel maps as described in §1036.540, excluding cycle-average fuel maps for highway cruise cycles.

(2) Cycle-average. Determine fuel consumption at idle as described in §1036.535(c) and (d), and determine cycle-average engine fuel maps as described in §1036.540, including cycle-average engine fuel maps for highway cruise cycles. In this case, you do not need to determine steady-state engine fuel maps under §1036.535(b). Fuel mapping for highway cruise cycles using cycle-average testing is an alternate method, which means that we may do confirmatory testing based on steady-state fuel mapping for highway cruise cycles even if you do not; however, we will use the steady-state fuel maps to create cycle-average fuel maps. In §1036.540 we define the vehicle configurations for testing; we may add more vehicle configurations to better represent your engine's operation for the range of vehicles in which your engines will be installed (see 40 CFR 1065.10(c)(1)).

(3) Powertrain. Generate a powertrain fuel map as described in 40 CFR 1037.550. In this case, you do not need to perform fuel mapping under §1036.535 or §1036.540. The option in 40 CFR 1037.550(b)(2) is only allowed for hybrid powertrain testing.

(4) Hybrid engine. Determine fuel consumption at idle as described in §1036.535(c) and (d), and determine cycle-average engine fuel maps as described in §1037.550, including cycle-average engine fuel maps for highway cruise cycles.

(c) Provide the following information if you generate engine fuel maps using either paragraph (b)(1), (2), or (4) of this section:

(1) Full-load torque curve for installed engines, and the full-load torque curve of the engine (parent engine) with the highest fueling rate that shares the same engine hardware, including the turbocharger, as described in 40 CFR 1065.510. You may use 40 CFR 1065.510(b)(5)(i) for engines subject to spark-ignition standards. Measure the torque curve for hybrid engines that have an RESS as described in 40 CFR 1065.510(g)(2) with the hybrid system active. For hybrid engines that do not include an RESS follow 40 CFR 1065.510(b)(5)(ii).

(2) Motoring torque map as described in 40 CFR 1065.510(c)(2) and (5) for conventional and hybrid engines, respectively. For engines with a low-speed governor, remove data points where the low speed governor is active. If you don't know when the low-speed governor is active, we recommend removing all points below 40 r/min above the low warm idle speed.

(3) Declared engine idle speed. For vehicles with manual transmissions, this is the engine speed with the transmission in neutral. For all other vehicles, this is the engine's idle speed when the transmission is in drive.

(4) The engine idle speed during the transient cycle-average fuel map.

(5) The engine idle torque during the transient cycle-average fuel map.

(d) If you generate powertrain fuel maps using paragraph (b)(3) of this section, determine the system continuous rated power according to §1036.527.

109. Amend §1036.505 to read as follows:

§1036.505 Supplemental emission test.

(a) Starting in model year 2021, you must measure CO_2 emissions using the SET duty cycle in 40 CFR 86.1362 as described in §1036.501, or using the SET duty cycle in this section.

(b) Perform SET testing with one of the following procedures:

(1) For engine testing, the SET duty cycle is based on normalized speed and torque values relative to certain maximum values. Denormalize torque as described in 40 CFR 1065.610(d). Denormalize speed as described in 40 CFR 1065.512.

(2) For hybrid powertrain and hybrid engine testing, follow 40 CFR 1037.550 to carry out the test, but do not compensate the duty cycle for the distance driven as described in 40 CFR 1037.550(g)(4), for hybrid engines select the transmission from Table 1 of §1036.540 substituting "engine" for "vehicle" and "highway cruise cycle" for "SET", and cycles do not follow 40 CFR 1037.550(j). For cycles that begin with a set of contiguous idle points, leave the transmission in neutral or park for the full initial idle segment. Place the transmission into drive within 5 seconds of the first nonzero vehicle speed setpoint. Place the transmission into park or neutral when the cycle reaches SET mode 14. Use the following vehicle parameters in place of those in 40 CFR 1037.550 to define the vehicle model in 40 CFR 1037.550(a)(3):

(i) Determine the vehicle test mass, M, as follows:

$$M = 15.1 \cdot P_{\text{contrated}}^{1.31}$$

Eq. 1036.505-1

Where:

$P_{\text{contrated}}$ = the continuous rated power of the hybrid system determined in §1036.527.

Example:

$P_{\text{contrated}}$ = 350.1 kW

$M = 15.1 \cdot 350.1^{1.31} = 32499$ kg

(ii) Determine the vehicle frontal area, A_{front}, as follows:

(A) For $M \leq 18050$ kg:

$$A_{\text{front}} = -1.69 \cdot 10^{-8} \cdot M^2 + 6.33 \cdot 10^{-4} \cdot M + 1.67$$

Eq. 1036.505-2

Example:

M = 16499 kg

$$A_{\text{front}} = -1.69 \cdot 10^{-8} \cdot 16499^2 + 6.33 \cdot 10^{-4} \cdot 16499 + 1.67 = 7.51 \text{ m}^2$$

(B) For $M > 18050$ kg, $A_{\text{front}} = 7.59 \text{ m}^2$

(iii) Determine the vehicle drag area, C_dA, as follows:

$$C_dA = \frac{\left(0.00299 \cdot A_{\text{front}} - 0.000832\right) \cdot 2 \cdot g \cdot 3.6^2}{\rho}$$

Eq. 1036.505-3

Where:

g = gravitational constant = 9.80665 m/s^2.

ρ = air density at reference conditions. Use ρ = 1.1845 kg/m^3.

Example:

$$C_{\mathrm{d}}A = \frac{\left(0.00299 \cdot 7.59 - 0.000832\right) \cdot 2 \cdot 9.80665 \cdot 3.6^2}{1.1845} = 3.08\ \mathrm{m}^2$$

(iv) Determine the coefficient of rolling resistance, C_{rr}, as follows:

$$C_{\mathrm{rr}} = 0.00513 + \frac{17.6}{M}$$

Eq. 1036.505-4

Example:

$$C_{\mathrm{rr}} = 0.00513 + \frac{17.6}{32499} = 0.0057\ \mathrm{kg/kg}$$

(v) Determine the vehicle curb mass, M_{curb}, as follows:

$$M_{\mathrm{curb}} = -0.000007376537 \cdot M^2 + 0.6038432 \cdot M$$

Eq. 1036.505-5

Example:

$$M_{\mathrm{curb}} = -0.000007376537 \cdot 32499^2 + 0.6038432 \cdot 32499 = 11833\ \mathrm{kg}$$

(vi) Determine the linear equivalent mass of rotational moment of inertias, M_{rotating}, as follows:

$$M_{\mathrm{rotating}} = 0.07 \cdot M_{\mathrm{curb}}$$

Eq. 1036.505-6

Example:

$$M_{\mathrm{rotating}} = 0.07 \cdot 11833 = 828.3\ \mathrm{kg}$$

(vii) Select a drive axle ratio, k_{a}, that represents the worst-case pair of drive axle ratio and tire size for CO_2 expected for vehicles in which the powertrain will be installed. This is typically the highest numeric axle ratio.

(viii) Select a tire radius, *r*, that represents the worst-case pair of tire size and drive axle ratio for CO_2 expected for vehicles in which the powertrain will be installed. This is typically the smallest tire radius.

(ix) If you are certifying a hybrid powertrain system without the transmission, use a default transmission efficiency of 0.95. If you certify with this configuration, you must use 40 CFR 1037.550(a)(3)(ii) to create the vehicle model along with its default transmission shift strategy. Use the transmission parameters defined in Table 1 of §1036.540 to determine transmission type and gear ratio. For Light and Medium HDVs, use the Light and Medium HDV parameters for the FTP and SET. For Tractors and Heavy HDVs, use the Tractor and Heavy HDV transient cycle parameters for the FTP and the Tractor and Heavy HDV highway cruise cycle parameters for the SET.

(x) Select axle efficiency, Eff_{axle}, according to 40 CFR 1037.550.

(c) Measure emissions using the SET duty cycle shown in Table 1 of this section to determine whether engines and hybrid powertrains meet the steady-state compression-ignition standards specified in subpart B of this part. Table 1 of this section specifies settings for engine and hybrid powertrain testing, as follows:

(1) The duty cycle for testing engines involves a schedule of normalized engine speed and torque values.

(2) The duty cycle for hybrid powertrain testing involves a schedule of vehicle speeds and road grade.

(i) Determine road grade at each point based on the continuous rated power of the hybrid powertrain system, $P_{contrated}$, in kW determined in §1036.527, the vehicle speed (A, B, or C) in mi/hr for a given SET mode, $v_{ref[speed]}$, and the specified road grade coefficients using the following equation:

$$Road\ grade = a \cdot P_{contrated}^3 + b \cdot P_{contrated}^2 \cdot v_{ref[speed]} + c \cdot P_{contrated}^2 + d \cdot v_{ref[speed]}^2 + e \cdot P_{contrated} \cdot v_{ref[speed]} + f \cdot P_{contrated} + g \cdot v_{ref[speed]} + h$$

Eq. 1036.505-7

Example:

This example is for SET mode 3a in Table 1 to §1036.505.

$P_{contrated}$ = 345.2 kW

v_{refB} = 59.3 mi/hr

$$Road\ grade = 8.296 \cdot 10^{-9} \cdot 345.2^3 + \left(-4.752 \cdot 10^{-7}\right) \cdot 345.2^2 \cdot 59.3 + 1.291 \cdot 10^{-5} \cdot 345.2^2 + 2.88 \cdot 10^{-4} \cdot 59.3^2 + 4.524 \cdot 10^{-4} \cdot 345.2 \cdot 59.3 + \left(-1.802 \cdot 10^{-2}\right) \cdot 345.2 + \left(-1.83 \cdot 10^{-1}\right) \cdot 59.3 + 8.81 = 0.53\ \%$$

(ii) Use the vehicle C speed determined in §1036.527 and determine the vehicle A and B speeds as follows:

(A) Determine vehicle A speed using the following equation:

$$v_{refA} = v_{refC} \cdot \frac{55.0}{75.0}$$

Eq. 1036.505-8

Example:

V_{refC} = 68.42 mi/hr

$$v_{refA} = 68.4 \cdot \frac{55.0}{75.0} = 50.2 \text{ mi/hr}$$

(B) Determine vehicle B speed using the following equation:

$$v_{refB} = v_{refC} \cdot \frac{65.0}{75.0}$$

Eq. 1036.505-9

Example:

$$v_{refB} = 68.4 \cdot \frac{65.0}{75.0} = 59.3 \text{ mi/hr}$$

Table 1 to §1036.505—Supplemental Emission Test Ramped-modal Duty Cycle

SET mode	Engine testing			Hybrid powertrain testing								
	Time in mode (seconds)	Engine speed[a,b]	Torque (percent)[b,c]	Vehicle speed (mi/hr)	Road-grade coefficients							
					a	***b***	***c***	***d***	***e***	***f***	***g***	***h***
1a Steady-state	124	Warm Idle	0	Warm Idle	0	0	0	0	0	0	0	0
1b Transition	20	Linear Transition	Linear Transition	Linear Transition	-1.898E-08	-5.895E-07	3.780E-05	4.706E-03	6.550E-04	-2.679E-02	-1.027E+00	1.542E+01
2a Steady-state	196	A	100	v_{refA}	-1.227E-08	-5.504E-07	3.946E-05	1.212E-03	5.289E-04	-3.116E-02	-3.227E-01	1.619E+01
2b Transition	20	Linear Transition	Linear Transition	Linear Transition	-2.305E-09	-4.873E-07	2.535E-05	8.156E-04	4.730E-04	-2.383E-02	-2.975E-01	1.277E+01
3a Steady-state	220	B	50	v_{refB}	8.296E-09	-4.752E-07	1.291E-05	2.880E-04	4.524E-04	-1.802E-02	-1.830E-01	8.810E+00
3b Transition	20	B	Linear Transition	v_{refB}	4.642E-09	-5.143E-07	1.991E-05	3.556E-04	4.873E-04	-2.241E-02	-2.051E-01	1.068E+01
4a Steady-state	220	B	75	v_{refB}	1.818E-10	-5.229E-07	2.579E-05	5.575E-04	5.006E-04	-2.561E-02	-2.399E-01	1.287E+01
4b Transition	20	Linear Transition	Linear Transition	Linear Transition	5.842E-10	-4.992E-07	2.244E-05	4.700E-04	4.659E-04	-2.203E-02	-1.761E-01	1.072E+01
5a Steady-state	268	A	50	v_{refA}	3.973E-09	-4.362E-07	1.365E-05	4.846E-04	4.158E-04	-1.606E-02	-1.908E-01	8.206E+00
5b Transition	20	A	Linear Transition	v_{refA}	-2.788E-10	-4.226E-07	1.812E-05	6.591E-04	4.158E-04	-1.846E-02	-2.201E-01	1.001E+01
6a Steady-state	268	A	75	v_{refA}	-4.216E-09	-4.891E-07	2.641E-05	8.796E-04	4.692E-04	-2.348E-02	-2.595E-01	1.226E+01
6b Transition	20	A	Linear Transition	v_{refA}	3.979E-09	-4.392E-07	1.411E-05	2.079E-04	4.203E-04	-1.658E-02	-1.655E-01	7.705E+00
7a Steady-state	268	A	25	v_{refA}	1.211E-08	-3.772E-07	6.209E-07	1.202E-04	3.578E-04	-8.420E-03	-1.248E-01	4.189E+00
7b Transition	20	Linear Transition	Linear Transition	Linear Transition	1.659E-09	-4.954E-07	2.103E-05	4.849E-04	4.776E-04	-2.194E-02	-2.551E-01	1.075E+01
8a Steady-state	196	B	100	v_{refB}	-8.232E-09	-5.707E-07	3.900E-05	8.150E-04	5.477E-04	-3.325E-02	-2.956E-01	1.689E+01
8b Transition	20	B	Linear Transition	v_{refB}	4.286E-09	-5.150E-07	2.070E-05	5.214E-04	4.882E-04	-2.291E-02	-2.271E-01	1.157E+01
9a Steady-state	196	B	25	v_{refB}	1.662E-08	-4.261E-07	-2.705E-07	2.098E-05	4.046E-04	-1.037E-02	-1.263E-01	4.751E+00

9b Transition	20	Linear Transition	Linear Transition	Linear Transition	7.492E-09	-5.451E-07	1.950E-05	2.243E-04	5.114E-04	-2.331E-02	-2.270E-01	1.062E+01
10a Steady-state	28	C	100	v_{refC}	-1.073E-09	-5.904E-07	3.477E-05	5.069E-04	5.647E-04	-3.354E-02	-2.648E-01	1.651E+01
10b Transition	20	C	Linear Transition	v_{refC}	9.957E-09	-5.477E-07	1.826E-05	2.399E-04	5.196E-04	-2.410E-02	-2.010E-01	1.128E+01
11a Steady-state	4	C	25	v_{refC}	1.916E-08	-5.023E-07	3.715E-06	3.634E-05	4.706E-04	-1.539E-02	-1.485E-01	6.827E+00
11b Transition	20	C	Linear Transition	v_{refC}	1.474E-08	-5.176E-07	1.027E-05	1.193E-04	4.911E-04	-1.937E-02	-1.713E-01	8.872E+00
12a Steady-state	4	C	75	v_{refC}	6.167E-09	-5.577E-07	2.354E-05	3.524E-04	5.319E-04	-2.708E-02	-2.253E-01	1.313E+01
12b Transition	20	C	Linear Transition	v_{refC}	1.039E-08	-5.451E-07	1.756E-05	2.257E-04	5.165E-04	-2.366E-02	-1.978E-01	1.106E+01
13a Steady-state	4	C	50	v_{refC}	6.209E-09	-5.292E-07	2.126E-05	3.475E-04	5.132E-04	-2.552E-02	-2.212E-01	1.274E+01
13b Transition	20	Linear Transition	Linear Transition	Linear Transition	4.461E-09	-6.452E-07	1.301E-05	1.420E-03	5.779E-04	-1.564E-02	1.949E-01	7.998E+00
14 Steady-state	144	Warm Idle	0	Warm Idle	0	0	0	0	0	0	0	0

[a]Engine speed terms are defined in 40 CFR part 1065.
[b]Advance from one mode to the next within a 20 second transition phase. During the transition phase, command a linear progression from the settings of the current mode to the settings of the next mode.
[c]The percent torque is relative to maximum torque at the commanded engine speed.

110. Revise §1036.510 to read as follows:

§1036.510 Transient testing.

(a) Measure emissions by testing the engine or hybrid powertrain on a dynamometer with one of the following transient duty cycles to determine whether it meets the transient emission standards:

(1) For spark-ignition engines, use the transient duty cycle described in paragraph (a) of Appendix II of this part.

(2) For compression-ignition engines, use the transient duty cycle described in paragraph (b) of Appendix II of this part.

(3) For spark-ignition hybrid powertrains, use the transient duty cycle described in paragraph (a) of Appendix II of this part.

(4) For compression-ignition hybrid powertrains, use the transient duty cycle described in paragraph (b) of Appendix II of this part.

(b) Perform the following depending on if you are testing engines or hybrid powertrains:

(1) For engine testing, the transient duty cycles are based on normalized speed and torque values relative to certain maximum values. Denormalize torque as described in 40 CFR 1065.610(d). Denormalize speed as described in 40 CFR 1065.512.

(2) For hybrid powertrain testing, follow §1036.505(b)(2) to carry out the test except replace $P_{contrated}$ with P_{rated}, the peak rated power determined in §1036.527, keep the transmission in drive for all idle segments after the initial idle segment, and for hybrid engines select the transmission from Table 1 of §1036.540 substituting "engine" for "vehicle". You may request to change the engine commanded torque at idle to better represent CITT.

(c) The transient test sequence consists of an initial run through the transient duty cycle from a cold start, 20 minutes with no engine operation, then a final run through of the same transient duty cycle. Emissions from engine starting is part of the both the cold and hot test intervals. Calculate the total emission mass of each constituent, *m*, and the total work, *W*, over each test interval according to 40 CFR 1065.650. Calculate the official transient emission result from the cold-start and hot-start test intervals using the following equation:

$$Official\ transient\ emission\ result = \frac{cold\ start\ emissions\,(g) + 6 \cdot hot\ start\ emissions\,(g)}{cold\ start\ work\,(hp \cdot hr) + 6 \cdot hot\ start\ work\,(hp \cdot hr)}$$

Eq. 1036.510-1

(d) Calculate cycle statistics and compare with the established criteria as specified in 40 CFR 1065.514 for engines and 40 CFR 1037.550 for hybrid powertrains to confirm that the test is valid.

111. Amend §1036.525 by revising paragraphs (a), (d) introductory text, and (d)(4) to read as follows:

§1036.525 Hybrid engines.

(a) For model years 2014 through 2020, if your engine system includes features that recover and store energy during engine motoring operation, test the engine as described in paragraph (d) of this section. For purposes of this section, features that recover energy between the engine and transmission are considered related to engine motoring.

* * * * *

(d) Measure emissions using the same procedures that apply for testing non-hybrid engines under this part, except as specified in this part and 40 CFR part 1065. For SET testing, deactivate the hybrid features unless we specify otherwise. The following provisions apply for testing hybrid engines:

* * * * *

(4) Limits on braking energy. Calculate brake energy fraction, x_b, as follows:

(i) Calculate x_b as the integrated negative work over the cycle divided by the integrated positive work over the cycle according to Eq. 1036.525-1. Calculate the brake energy limit for the engine, x_{bl}, according to Eq. 1036.525-2. If x_b is less than or equal to x_{bl}, use the integrated positive work for your emission calculations. If x_b is greater than x_{bl} use Eq. 1036.525-3 to calculate an adjusted value for cycle work, W_{cycle}, and use W_{cycle} as the work value for calculating emission results. You may set an instantaneous brake target that will prevent x_b from being larger than x_{bl} to avoid the need to subtract extra brake work from positive work.

$$x_b = \left|\frac{W_{neg}}{W_{pos}}\right|$$

Eq. 1036.525-1

Where:

W_{neg} = the negative work over the cycle.

W_{pos} = the positive work over the cycle.

$$x_{bl} = 4.158 \cdot 10^{-4} \cdot P_{max} + 0.2247$$

Eq. 1036.525-2

Where:

P_{max} = the maximum power of the engine with the hybrid system engaged, in kW.

$$W_{cycle} = W_{pos} - \left(\left|W_{neg}\right| - x_{bl} \cdot W_{pos}\right)$$

Eq. 1036.525-3

Where:

W_{cycle} = cycle work when x_b is greater than x_{bl}.

Example:

W_{neg} = 4.69 kW-hr

W_{pos} = 14.67 kW-hr

P_{max} = 223 kW

$$x_b = \left|\frac{4.69}{14.67}\right| = 0.31970$$

$$x_{bl} = 4.158 \cdot 10^{-4} \cdot 223 + 0.2247 = 0.317423$$

since $x_b > x_{bl}$;

$$W_{cycle} = 14.67 - \left(\left|4.69\right| - 0.317423 \cdot 14.67\right) = 14.6365 \text{ kW-hr}$$

(ii) Convert from g/kW-hr to g/hp-hr as the final step in calculating emission results.

* * * * *

112. Add §1036.527 to read as follows:

§1036.527 Powertrain system rated power determination.

This section describes how to determine the peak and continuous rated power of conventional and hybrid powertrain systems and the vehicle speed for carrying out testing according to §1036.505, §1036.510, and 40 CFR 1037.550.

(a) Set up the powertrain according to 40 CFR 1037.550, but use the vehicle parameters in

§1036.505(b)(2), except replace $P_{contrated}$ with the manufacturer declared system peak power and use applicable automatic transmission for the engine. Note that if you repeat the system rated power determination as described in paragraph (f)(4) of this section, use the measured system peak power in place of $P_{contrated}$.

(b) Prior to the start of each test interval verify the following:

(1) The state-of-charge of the rechargeable energy storage system (RESS) is ≥ 90 % of the operating range between the minimum and maximum RESS energy levels specified by the manufacturer.

(2) The conditions of all hybrid system components are within their normal operating range as declared by the manufacturer.

(3) RESS restrictions (e.g., power limiting, thermal limits, etc.) are not active.

(c) Carry out the test as follows:

(1) Warm up the powertrain by operating it. We recommend operating the powertrain at any vehicle speed and road grade that achieves approximately 75 % of its expected maximum power. Continue the warm-up until the engine coolant, block, or head absolute temperature is within ±2 % of its mean value for at least 2 min or until the engine thermostat controls engine temperature.

(2) Start the test by keying on the powertrain and letting it sit at 0 mi/hr for 50 seconds.

(3) Set maximum driver demand for a full load acceleration at 6 % road grade starting at an initial vehicle speed of 0 mi/hr.

(4) 268 seconds after the initiation of paragraph (c)(3) of this section, linearly ramp the grade from 6 % to 0 % over 300 seconds. Stop the test after the vehicle speed has stopped increasing above the maximum value observed during the test.

(d) Record the powertrain system angular speed and torque values measured at the dynamometer at 100 Hz and use these in conjunction with the vehicle model to calculate $P_{sys,vehicle}$.

(e) Calculate the system power, P_{sys}, for each data point as follows:

(1) For testing with the speed and torque measurements at the transmission input shaft, P_{sys} is equal to the calculated vehicle system peak power, $P_{sys,vehicle}$, determined in paragraphs (c) through (d) of this section.

(2) For testing with the speed and torque measurements at the axle input shaft or the wheel hubs, determine P_{sys} using the following equation:

$$P_{sys} = \frac{P_{sys,vehicle}}{\varepsilon_{trans} \cdot \varepsilon_{axle}}$$

Eq. 1036.527-1

Where:

$P_{sys,vehicle}$ = the calculated vehicle system peak power.

ε_{trans} = the default transmission efficiency = 0.95.

ε_{axle} = the default axle efficiency. Set this value = 1 for speed and torque measurement at the axle input shaft or = 0.955 at the wheel hubs.

Example:

$P_{sys,vehicle}$ = 317.6 kW

$$P_{sys} = \frac{317.6}{0.95 \cdot 0.955} = 350.1 \text{ kW}$$

(f) The system peak rated power, P_{rated}, is the highest calculated P_{sys} where the coefficient of variation (COV) < 2 %. The COV is determined as follows:

(1) Calculate the standard deviation, $\sigma(t)$.

$$\sigma(t)=\sqrt{\frac{1}{N}\cdot\sum_{i=1}^{N}\left(P_{\mathrm{sys}i}-\overline{P}_{\mu}(t)\right)^{2}}$$

Eq. 1036.527-2

Where:

N = the number of measurement intervals = 20.

$P_{\mathrm{sys}i}$ = the N samples in the 100 Hz signal previously used to calculate the respective $P_{\mu}(t)$ values at the time step t.

$\overline{P}_{\mu}(t)$ = the power vector from the results of each test run that is determined by a moving averaging of 20 consecutive samples of P_{sys} in the 100 Hz that converts $P_{\mu}(t)$ to a 5 Hz signal.

(2) The resulting 5 Hz power and covariance signals are used to determine system rated power.

(3) The coefficient of variation COV(t) shall be calculated as the ratio of the standard deviation, $\sigma(t)$, to the mean value of power, $\overline{P}_{\mu}(t)$, for each time step t.

$$COV(t)=\frac{\sigma(t)}{\overline{P}_{\mu}(t)}$$

Eq. 1036.527-3

(4) If the determined system peak rated power is not within ±3 % of the system peak rated power as declared by the manufacturer, you must repeat the procedure in paragraphs (a) through (f)(3) of this section using the measured system peak rated power determined in paragraph (f) of this section instead of the manufacturer declared value. The result from this repeat is the final determined system peak rated power.

(5) If the determined system peak rated power is within ±3 % of the system peak rated power as declared by the manufacturer, the declared system peak rated power shall be used.

(g) Determine continuous rated power as follows:

(1) For conventional powertrains, $P_{\mathrm{contrated}}$ equals P_{rated}.

(2) For hybrid powertrains, continuous rated power, $P_{\mathrm{contrated}}$, is the maximum measured power from the data collected in paragraph (c)(3) of this section that meets the requirements in paragraph (f) of this section.

(h) Vehicle C speed, v_{refC}, is determined as follows:

(1) For powertrains where P_{sys} is greater than $0.98 \cdot P_{\mathrm{contrated}}$ in top gear at more than one vehicle speed, v_{refC} is the average of the minimum and maximum vehicle speeds from the data collected in paragraph (c)(4) of this section that meets the requirements in paragraph (f) of this section.

(2) For powertrains where P_{sys} is not greater than $0.98 \cdot P_{\mathrm{contrated}}$ in top gear at more than one vehicle speed, v_{refC} is the maximum vehicle speed from the data collected in paragraph (c)(4) of this section that meets the requirements in paragraph (f) of this section where P_{sys} is great than $0.98 \cdot P_{\mathrm{contrated}}$.

113. Revise §1036.530 to read as follows:

§1036.530 Calculating greenhouse gas emission rates.

This section describes how to calculate official emission results for CO_2, CH_4, and N_2O.

(a) Calculate brake-specific emission rates for each applicable duty cycle as specified in 40 CFR

1065.650. Apply infrequent regeneration adjustment factors to your CO_2 emission results for each duty cycle as described in 40 CFR 86.004-28 starting in model year 2021. You may optionally apply infrequent regeneration adjustment factors for CH_4 and N_2O.

(b) Adjust CO_2 emission rates calculated under paragraph (a) of this section for measured test fuel properties as specified in this paragraph (b). This adjustment is intended to make official emission results independent of differences in test fuels within a fuel type. Use good engineering judgment to develop and apply testing protocols to minimize the impact of variations in test fuels.

(1) Determine your test fuel's mass-specific net energy content, $E_{\text{mfuelmeas}}$, also known as lower heating value, in MJ/kg, expressed to at least three decimal places. Determine $E_{\text{mfuelmeas}}$ as follows:

(i) For liquid fuels, determine $E_{\text{mfuelmeas}}$ according to ASTM D4809 (incorporated by reference in §1036.810). Have the sample analyzed by at least three different labs and determine the final value of your test fuel's $E_{\text{mfuelmeas}}$ as the median all of the lab results you obtained. If you have results from three different labs, we recommend you screen them to determine if additional observations are needed. To perform this screening, determine the absolute value of the difference between each lab result and the average of the other two lab results. If the largest of these three resulting absolute value differences is greater than 0.297 MJ/kg, we recommend you obtain additional results prior to determining the final value of $E_{\text{mfuelmeas}}$.

(ii) For gaseous fuels, determine $E_{\text{mfuelmeas}}$ according to ASTM D3588 (incorporated by reference in §1036.810).

(2) Determine your test fuel's carbon mass fraction, w_C, as described in 40 CFR 1065.655(d), expressed to at least three decimal places; however, you must measure fuel properties rather than using the default values specified in Table 1 of 40 CFR 1065.655.

(i) For liquid fuels, have the sample analyzed by at least three different labs and determine the final value of your test fuel's w_C as the median of all of the lab results you obtained. If you have results from three different labs, we recommend you screen them to determine if additional observations are needed. To perform this screening, determine the absolute value of the difference between each lab result and the average of the other two lab results. If the largest of these three resulting absolute value differences is greater than 1.56 percent carbon, we recommend you obtain additional results prior to determining the final value of w_C.

(ii) For gaseous fuels, have the sample analyzed by a single lab and use that result as your test fuel's w_C.

(3) If, over a period of time, you receive multiple fuel deliveries from a single stock batch of test fuel, you may use constant values for mass-specific energy content and carbon mass fraction, consistent with good engineering judgment. To use this provision, you must demonstrate that every subsequent delivery comes from the same stock batch and that the fuel has not been contaminated.

(4) Correct measured CO_2 emission rates as follows:

$$e_{\text{CO2cor}} = e_{\text{CO2}} \cdot \frac{E_{\text{mfuelmeas}}}{E_{\text{mfuelCref}} \cdot w_{\text{Cmeas}}}$$

Eq. 1036.530-1

Where:

e_{CO2} = the calculated CO_2 emission result.

$E_{mfuelmeas}$ = the mass-specific net energy content of the test fuel as determined in paragraph (b)(1) of this section. Note that dividing this value by w_{Cmeas} (as is done in this equation) equates to a carbon-specific net energy content having the same units as $E_{mfuelCref}$.
$E_{mfuelCref}$ = the reference value of carbon-mass-specific net energy content for the appropriate fuel type, as determined in Table 1 of this section.
w_{Cmeas} = carbon mass fraction of the test fuel (or mixture of test fuels) as determined in paragraph (b)(2) of this section.
Example:
e_{CO2} = 630.0 g/hp·hr
$E_{mfuelmeas}$ = 42.528 MJ/kg
$E_{mfuelCref}$ = 49.3112 MJ/kgC
w_{Cmeas} = 0.870

$$e_{CO2cor} = 630.0 \cdot \frac{42.528}{49.3112 \cdot 0.870}$$

e_{CO2cor} = 624.5 g/hp·hr

Table 1 to §1036.530—Reference fuel properties

FUEL TYPE[a]	**REFERENCE FUEL CARBON-MASS-SPECIFIC NET ENERGY CONTENT, $E_{mfuelCref}$, (MJ/kgC)**[b]	**REFERENCE FUEL CARBON MASS FRACTION, w_{Cref}**[b]
Diesel fuel	49.3112	0.874
Gasoline	50.4742	0.846
Natural Gas	66.2910	0.750
LPG	56.5218	0.820
Dimethyl Ether	55.3886	0.521
High-level ethanol-gasoline blends	50.3211	0.576

[a]For fuels that are not listed, you must ask us to approve reference fuel properties.
[b]For multi-fuel streams, such as natural gas with diesel fuel pilot injection, use good engineering judgment to determine blended values for $E_{mfuelCref}$ and w_{Cref} using the values in this table.

(c) Your official emission result for each pollutant equals your calculated brake-specific emission rate multiplied by all applicable adjustment factors, other than the deterioration factor.

114. Revise §1036.535 to read as follows:
§1036.535 Determining steady-state engine fuel maps and fuel consumption at idle.
This section describes how to determine an engine's steady-state fuel map and fuel consumption at idle for model year 2021 and later vehicles. Vehicle manufacturers may need these values to demonstrate compliance with emission standards under 40 CFR part 1037 as described in §1036.510.
(a) General test provisions. Perform fuel mapping using the procedure described in paragraph (b) of this section to establish measured fuel-consumption rates at a range of engine speed and load settings. Measure fuel consumption at idle using the procedure described in paragraph (c) of this section. If you perform cycle-average mapping for highway cruise cycles as described in §1036.540, omit mapping under paragraph (b) of the section and instead perform mapping as described in paragraph (d) of this section. Use these measured fuel-consumption values to declare fuel-consumption rates for certification as described in paragraph (e) of this section.

(1) Map the engine's torque curve and declare engine idle speed as described in §1036.503(c)(1) and (3), and perform emission measurements as described in 40 CFR 1065.501 and 1065.530 for discrete-mode steady-state testing. This section uses engine parameters and variables that are consistent with 40 CFR part 1065.

(2) Measure NO_x emissions for each specified sampling period in g/s. You may perform these measurements using a NO_x emission-measurement system that meets the requirements of 40 CFR part 1065, subpart J. Include these measured NO_x values any time you report to us your fuel consumption values from testing under this section. If a system malfunction prevents you from measuring NO_x emissions during a test under this section but the test otherwise gives valid results, you may consider this a valid test and omit the NO_x emission measurements; however, we may require you to repeat the test if we determine that you inappropriately voided the test with respect to NO_x emission measurement.

(b) Steady-state fuel mapping. Determine fuel-consumption rates for each engine configuration over a series of steady-state engine operating points consisting of pairs of speed and torque points as described in this paragraph (b). You may use shared data across an engine platform to the extent that the fuel-consumption rates remain valid. For example, if you test a high-output configuration and create a different configuration that uses the same fueling strategy but limits the engine operation to be a subset of that from the high-output configuration, you may use the fuel-consumption rates for the reduced number of mapped points for the low-output configuration, as long as the narrower map includes at least 70 points. Perform fuel mapping as follows:

(1) Generate the sequence of steady-state engine operating points as follows:

(i) Determine the required steady-state engine operating points as follows:

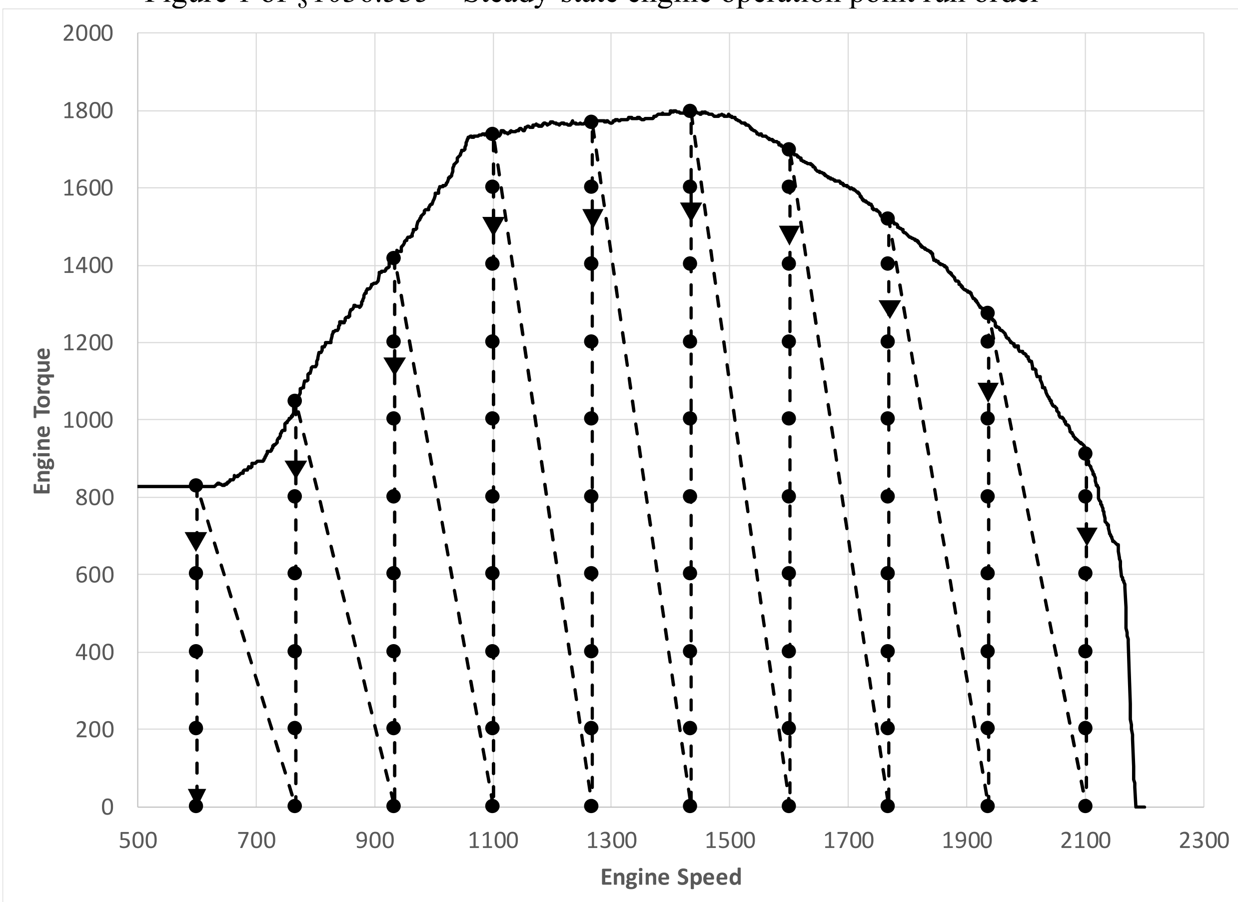
(A) For engines with an adjustable warm idle speed setpoint, select the following speed setpoints: minimum warm idle speed, $f_{nidlemin}$, the highest speed above maximum power at which 70 % of maximum power occurs, n_{hi}, and eight (or more) equally spaced points between $f_{nidlemin}$ and n_{hi}. (See 40 CFR 1065.610(c)). For engines without an adjustable warm idle speed replace minimum warm idle speed with warm idle speed, f_{nidle}.

(B) Select the following torque setpoints at each of the selected speed setpoints: zero ($T = 0$), maximum mapped torque, $T_{max\ mapped}$, and eight (or more) equally spaced points between $T = 0$ and $T_{max\ mapped}$. For each of the selected speed setpoints, replace any torque setpoints that are above the mapped torque at the selected speed setpoint, T_{max}, minus 5 percent of $T_{max\ mapped}$, with one test point at T_{max}.

(ii) Select any additional (optional) steady-state engine operating points consistent with good engineering judgment. For example you may select additional points when linear interpolation between the defined points is not a reasonable assumption for determining fuel consumption from the engine. For each additional speed setpoint, increments between torque setpoints must be no larger than one-ninth of $T_{max,mapped}$ and we recommend including a torque setpoint of T_{max}. If you select a maximum torque setpoint less than T_{max}, use good engineering judgment to select your maximum torque setpoint to avoid unrepresentative data. Note that if the test points were added for the child rating, they should still be reported in the parent fuel map. We will select at least as many points as you.

(iii) Set the run order for all of the steady-state engine operating points (both required and optional) as described in this paragraph (b)(1)(iii). Arrange the list of steady-state engine operating points such that the resulting list of paired speed and torque setpoints begins with the highest speed setpoint and highest torque setpoint followed by decreasing torque setpoints at the highest speed setpoint. This will be followed by the next lowest speed setpoint and the highest torque setpoint at that speed setpoint continuing through all the steady-state engine operating points and ending with the lowest speed ($f_{nidlemin}$) and torque setpoint ($T = 0$). The following figure provides an example of this array of points and run order.

Figure 1 of §1036.535—Steady-state engine operation point run order



(iv) The steady-state engine operating points that have the highest torque setpoint for a given speed setpoint are optional reentry points into the steady-state-fuel-mapping sequence, should you need to pause or interrupt the sequence during testing.

(v) The steady-state engine operating points that have the lowest torque setpoint for a given speed setpoint are optional exit points from the steady-state-fuel-mapping sequence, should you need to pause or interrupt the sequence during testing.

(2) If the engine has an adjustable warm idle speed setpoint, set it to its minimum value, $f_{nidlemin}$.

(3) During each test interval, control speed within ±1 % of n_{hi} and engine torque within ±5 % of $T_{max\ mapped}$ except for the following cases where both setpoints cannot be achieved because the steady-state engine operating point is near an engine operating boundary:

(i) For steady-state engine operating points that cannot be achieved and the operator demand stabilizes at minimum; control the dynamometer so it gives priority to follow the torque setpoint and let the engine govern the speed (see 40 CFR 1065.512(b)(1)). In this case, the tolerance on speed control in paragraph (b)(3) of this section does not apply and engine torque is controlled to within ±25 N·m.

(ii) For steady-state engine operating points that cannot be achieved and the operator demand stabilizes at maximum and the speed setpoint is below 90 % of n_{hi}; control the dynamometer so it gives priority to follow the speed setpoint and let the engine govern the torque (see 40 CFR 1065.512(b)(2)). In this case, the tolerance on torque control given in paragraph (b)(3) of this section does not apply.

(iii) For steady-state engine operating points that cannot be achieved and the operator demand stabilizes at maximum and the speed setpoint is at or above 90 % of n_{hi}; control the dynamometer so it gives priority to follow the torque setpoint and let the engine govern the speed (see 40 CFR 1065.512(b)(1)). In this case, the tolerance on speed control given in paragraph (b)(3) of this section does not apply.

(iv) For the steady-state engine operating points at the minimum speed setpoint and maximum torque setpoint, you may select a dynamometer control mode that gives priority to speed and an engine control mode that gives priority to torque. In this case, if the operator demand stabilizes at minimum or maximum, the tolerance on torque control in paragraph (b)(3) of this section does not apply.

(4) You may select the appropriate dynamometer and engine control modes in real-time or at any time prior based on various factors including the operating setpoint location relative to an engine operating boundary. Warm-up the engine as described in 40 CFR 1065.510(b)(2).

(5) Within 60 seconds after concluding the warm-up, linearly ramp the speed and torque setpoints over 5 seconds to the first steady-state engine operating point from paragraph (b)(1) of this section.

(6) Operate the engine at the steady-state engine operating point for (70 ±1) seconds, and then start the test interval and record measurements using one of the following methods. You must also measure and report NO_x emissions over each test interval as described in paragraph (a)(2) of this section. If you use redundant systems for the determination of fuel consumption, for example combining measurements of dilute and raw emissions when generating your map, follow the requirements of 40 CFR 1065.201(d).

(i) Indirect measurement of fuel flow. Record speed and torque and measure emissions and other inputs needed to run the chemical balance in 40 CFR 1065.655(c) for a (30 ± 1) second test interval; determine the corresponding mean values for the test interval. For dilute sampling of emissions, in addition to the background measurement provisions described in 40 CFR 1065.140 you may do the following:

(A) If you use batch sampling to measure background emissions, you may sample periodically into the bag over the course of multiple test intervals and read them as allowed in paragraph (b)(10)(i) of this section. If you use this provision, you must apply the same background readings to correct emissions from each of the applicable test intervals.

(B) You may determine background emissions by sampling from the dilution air during the non-test interval periods in the test sequence, including pauses allowed in paragraph (b)(10)(i) of this section. If you use this provision, you must allow sufficient time for stabilization of the background measurement; followed by an averaging period of at least 30 seconds. Use the average of the most recent pre-test interval and the next post-test interval background readings to correct each test interval. The most recent pre-test interval background reading must be taken no greater than 30 minutes prior to the start of the first applicable test interval and the next post-test interval background reading must be taken no later than 30 minutes after the end of the last applicable test interval. Background readings must be taken prior to the test interval for each reentry point and after the test interval for each exit point or more frequently.

(ii) Direct measurement of fuel flow. Record speed and torque and measure fuel consumption with a fuel flow meter for a (30 ±1) second test interval; determine the corresponding mean values for the test interval.

(7) After completing the test interval described in paragraph (b)(6) of this section, linearly ramp the speed and torque setpoints over 5 seconds to the next steady-state engine operating point.

(i) You may pause the steady-state-fuel-mapping sequence at any of the reentry points (as noted in paragraph (b)(1)(iv) of this section) to calibrate emission-measurement instrumentation; to read and evacuate background bag samples collected over the course of multiple test intervals; or to sample the dilution air for background emissions. This provision allows you to spend more than the 70 seconds noted in paragraph (b)(6) of this section.

(ii) If an infrequent regeneration event occurs, interrupt the steady-state-fuel-mapping sequence and allow the regeneration event to finish. You may continue to operate at the steady-state engine operating point where the event began or, using good engineering judgment, you may transition to another operating condition to reduce the regeneration event duration. You may complete any post-test interval activities to validate test intervals prior to the most recent reentry point. Once the regeneration event is finished, linearly ramp the speed and torque setpoints over 5 seconds to the most recent reentry point described in paragraph (b)(1)(iv) of this section, and restart the steady-state-fuel-mapping sequence by repeating the steps in paragraphs (b)(6) and (7) of this section for all the remaining steady-state engine operating points. Operate at the reentry point for longer than the 70 seconds in paragraph (b)(6), as needed, to bring the aftertreatment to representative thermal conditions. Void all test intervals in the steady-state-fuel-mapping sequence beginning with the reentry point and ending with the steady-state engine operating point where the regeneration event began.

(iii) You may interrupt the steady-state-fuel-mapping sequence after any of the exit points described in paragraph (b)(1)(v) of this section. To restart the steady-state-fuel-mapping sequence; begin with paragraph (b)(4) of this section and continue with paragraph (b)(5) of this section, except that the steady-state engine operating point is the next reentry point, not the first operating point from paragraph (b)(1) of this section. Follow paragraphs (b)(6) and (7) of this section until all remaining steady-state engine operating points are tested.

(iv) If the steady-state-fuel-mapping sequence is interrupted due test equipment or engine malfunction, void all test intervals in the steady-state-fuel-mapping sequence beginning with the most recent reentry point as described in paragraph (b)(1)(iv) of this section. Complete any post-test interval activities to validate test intervals prior to the most recent reentry point. Correct the malfunction and restart the steady-state-fuel-mapping sequence as described in paragraph (b)(7)(iii) of this section.

(v) If any steady-state engine test interval is voided, void all test intervals in the steady-state-fuel-mapping sequence beginning with the most recent reentry point as described in paragraph (b)(1)(iv) of this section and ending with the next exit point as described in paragraph (b)(1)(v) of this section. Rerun that segment of the steady-state-fuel-mapping sequence. If multiple test intervals are voided in multiple speed setpoints, you may exclude the speed setpoints where all of the test intervals were valid from the rerun sequence. Rerun the steady-state-fuel-mapping sequence as described in paragraph (b)(10)(iii) of this section.

(8) If you determine fuel-consumption rates using emission measurements from the raw or diluted exhaust, calculate the mean fuel mass flow rate, $\bar{\dot{m}}_{\text{fuel}}$, for each point in the fuel map using the following equation:

$$\bar{\dot{m}}_{\text{fuel}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\bar{\dot{n}}_{\text{exh}} \cdot \frac{\bar{x}_{\text{Ccombdry}}}{1 + \bar{x}_{\text{H2Oexhdry}}} - \frac{\bar{\dot{m}}_{\text{CO2DEF}}}{M_{\text{CO2}}} \right)$$

Eq. 1036.535-1

Where:

$\bar{\dot{m}}_{\text{fuel}}$ = mean fuel mass flow rate for a given fuel map setpoint, expressed to at least the nearest 0.001 g/s.

M_{C} = molar mass of carbon.

w_{Cmeas} = carbon mass fraction of fuel (or mixture of test fuels) as determined in 40 CFR 1065.655(d), except that you may not use the default properties in Table 1 of 40 CFR 1065.655 to determine α, β, and w_{C} for liquid fuels. You may not account for the contribution to α, β, γ, and δ of diesel exhaust fluid or other non-fuel fluids injected into the exhaust.

$\bar{\dot{n}}_{\text{exh}}$ = the mean raw exhaust molar flow rate from which you measured emissions according to 40 CFR 1065.655.

$\bar{x}_{\text{Ccombdry}}$ = the mean concentration of carbon from fuel and any injected fluids in the exhaust per mole of dry exhaust as determined in 40 CFR 1065.655(c).

$\bar{x}_{\text{H2Oexhdry}}$ = the mean concentration of H_2O in exhaust per mole of dry exhaust as determined in 40 CFR 1065.655(c).

$\bar{\dot{m}}_{\text{CO2DEF}}$ = the mean CO_2 mass emission rate resulting from diesel exhaust fluid decomposition as determined in paragraph (b)(9) of this section. If your engine does not use diesel exhaust fluid, or if you choose not to perform this correction, set $\bar{\dot{m}}_{\text{CO2DEF}}$ equal to 0.

M_{CO2} = molar mass of carbon dioxide.

Example:

M_{C} = 12.0107 g/mol

w_{Cmeas} = 0.869

$\bar{\dot{n}}_{\text{exh}}$ = 25.534 mol/s

$\bar{x}_{\text{Ccombdry}}$ = 0.002805 mol/mol

$\bar{x}_{\text{H2Oexhdry}}$ = 0.0353 mol/mol

$\bar{\dot{m}}_{\text{CO2DEF}}$ = 0.0726 g/s

M_{CO2} = 44.0095 g/mol

$$\bar{\dot{m}}_{\text{fuel}} = \frac{12.0107}{0.869} \cdot \left(25.534 \cdot \frac{0.002805}{1+0.0353} - \frac{0.0726}{44.0095} \right) = 0.933 \text{ g/s}$$

(9) If you determine fuel-consumption rates using emission measurements with engines that utilize diesel exhaust fluid for NO_x control, correct for the mean CO_2 mass emissions resulting from diesel exhaust fluid decomposition at each fuel map setpoint using the following equation:

$$\bar{\dot{m}}_{\text{CO2DEF}} = \bar{\dot{m}}_{\text{DEF}} \cdot \frac{M_{\text{CO2}} \cdot w_{\text{CH4N2O}}}{M_{\text{CH4N2O}}}$$

Eq. 1036.535-2

Where:

$\bar{\dot{m}}_{\text{DEF}}$ = the mean mass flow rate of injected urea solution diesel exhaust fluid for a given sampling period, determined directly from the electronic control module, or measured separately, consistent with good engineering judgment.

M_{CO2} = molar mass of carbon dioxide.

w_{CH4N2O} = mass fraction of urea in diesel exhaust fluid aqueous solution. Note that the subscript "CH4N2O" refers to urea as a pure compound and the subscript "DEF" refers to the aqueous urea diesel exhaust fluid as a solution of urea in water. You may use a default value of 32.5 % or use good engineering judgment to determine this value based on measurement.

M_{CH4N2O} = molar mass of urea.

Example:

$\bar{\dot{m}}_{\text{DEF}}$ = 0. 304 g/s

M_{CO2} = 44.0095 g/mol

w_{CH4N2O} = 32.5 % = 0.325

M_{CH4N2O} = 60.05526 g/mol

$$\bar{\dot{m}}_{\text{CO2DEF}} = 0.304 \cdot \frac{44.0095 \cdot 0.325}{60.05526} = 0.0726 \text{ g/s}$$

(c) Fuel consumption at idle. Determine fuel-consumption rates for engines certified for installation in vocational vehicles for each engine configuration over a series of engine-idle operating points consisting of pairs of speed and torque points as described in this paragraph (c). You may use shared data across engine configurations, consistent with good engineering judgment. Perform measurements as follows:

(1) Determine the required engine-idle operating points as follows:

(i) Select the following two speed setpoints:

(A) Engines with an adjustable warm idle speed setpoint: minimum warm idle speed, f_{nidlemin}, and the maximum warm idle speed, f_{nidlemax}.

(B) Engines without an adjustable warm idle speed setpoint: warm idle speed (with zero torque on the primary output shaft), f_{nidle}, and 1.15 times f_{nidle}.

(ii) Select the following two torque setpoints at each of the selected speed setpoints: 0 and 100 N·m.

(iii) You may run these four engine-idle operating points in any order.

(2) Control speed and torque as follows:

(i) Engines with an adjustable warm idle speed setpoint. For the warm-up in paragraph (c)(3) and the transition in paragraph (c)(4) of this section control both speed and torque. At any time prior to reaching the next engine-idle operating point, set the engine's adjustable warm idle speed setpoint to the speed setpoint of the next engine-idle operating point in the sequence. This may be done before or during the warm-up or during the transition. Near the end of the transition period control speed and torque as described in paragraph (b)(3)(i) of this section. Once the transition is complete; set the operator demand to minimum to allow the engine governor to control speed; and control torque with the dynamometer as described in paragraph (b)(3) of this section.

(ii) Engines without an adjustable warm idle speed setpoint. Control speed and torque with operator demand and the dynamometer for the engine-idle operating points at the higher speed setpoint as described in paragraph (b)(3) of this section. Both the speed and torque tolerances apply for these points because they are not near the engine's operating boundary and are achievable. Control speed and torque for the engine-idle operating points at the lower speed setpoint as described in paragraph (c)(2)(i) of this section except for setting the engine's adjustable warm idle speed setpoint.

(3) Warm-up the engine as described in 40 CFR 1065.510(b)(2).

(4) After concluding the warm-up procedure, linearly ramp the speed and torque setpoints over 20 seconds to operate the engine at the next engine-idle operating point from paragraph (c)(1) of this section.

(5) Operate the engine at the engine-idle operating point for (180 ±1) seconds, and then start the test interval and record measurements using one of the following methods. You must also measure and report NO_x emissions over each test interval as described in paragraph (a)(2) of this section. If you use redundant systems for the determination of fuel consumption, for example combining measurements of dilute and raw emissions when generating your map, follow the requirements of 40 CFR 1065.201(d).

(i) Indirect measurement of fuel flow. Record speed and torque and measure emissions and other inputs needed to run the chemical balance in 40 CFR 1065.655(c) for a (600 ±1) second test interval; determine the corresponding mean values for the test interval. We will use an average of indirect measurement of fuel flow with dilute sampling and direct sampling. For dilute sampling of emissions, measure background according to the provisions described in 40 CFR 1065.140, but read the background as described in paragraph (c)(7)(i) of this section. If you use batch sampling to measure background emissions, you may sample periodically into the bag over the course of multiple test intervals and read them as allowed in paragraph (b)(10)(i) of this section. If you use this provision, you must apply the same background readings to correct emissions from each of the applicable test intervals. Note that the minimum dilution ratio requirements for PM sampling in 40 CFR 1065.140(e)(2) do not apply. We recommend minimizing the CVS flow rate to minimize errors due to background correction consistent with good engineering judgment and operational constraints such as minimum flow rate for good mixing.

(ii) Direct measurement of fuel flow. Record speed and torque and measure fuel consumption with a fuel flow meter for a (600 ±1) second test interval; determine the corresponding mean values for the test interval.

(6) After completing the test interval described in paragraph (c)(5) of this section, repeat the steps in paragraphs (c)(3) to (5) of this section for all the remaining engine-idle operating points. After completing the test interval on the last engine-idle operating point, the fuel-consumption-at-idle sequence is complete.

(7) The following provisions apply for interruptions in the fuel-consumption-at-idle

sequence. These provisions are intended to produce results equivalent to running the sequence without interruption.

(i) You may pause the fuel-consumption-at-idle sequence after each test interval to calibrate emission-measurement instrumentation and to read and evacuate background bag samples collected over the course of a single test interval. This provision allows you to shut-down the engine or to spend more time at the speed/torque idle setpoint after completing the test interval before transitioning to the step in paragraph (c)(3) of this section.

(ii) If an infrequent regeneration event occurs, interrupt the fuel-consumption-at-idle sequence and allow the regeneration event to finish. You may continue to operate at the engine-idle operating point where the event began or, using good engineering judgment, you may transition to another operating condition to reduce the regeneration event duration. If the event occurs during a test interval, void that test interval. Once the regeneration event is finished, restart the fuel-consumption-at-idle sequence by repeating the steps in paragraphs (c)(3) through (5) of this section for all the remaining engine-idle operating points.

(iii) You may interrupt the fuel-consumption-at-idle sequence after any of the test intervals. Restart the fuel-consumption-at-idle sequence by repeating the steps in paragraphs (c)(3) to (5) of this section for all the remaining engine-idle operating points.

(iv) If the fuel-consumption-at-idle sequence is interrupted due to test equipment or engine malfunction, correct the malfunction and restart the fuel-consumption-at-idle sequence by repeating the steps in paragraphs (c)(3) through (5) of this section for all the remaining engine-idle operating points. If the malfunction occurred during a test interval, void that test interval.

(v) If any idle test intervals are voided, repeat the steps in paragraphs (c)(3) through (5) of this section for each of the voided engine-idle operating points.

(8) Correct the measured or calculated mean fuel mass flow rate, $\bar{\dot{m}}_{\text{fuel}}$ at each of the engine-idle operating points to account for mass-specific net energy content as described in paragraph (b)(13) of this section.

(d) <u>Steady-state fuel maps used for cycle-average fuel mapping of the cruise cycles</u>. Determine fuel-consumption rates for each engine configuration over a series of steady-state engine operating points near idle as described in this paragraph (d). You may use shared data across an engine platform to the extent that the fuel-consumption rates remain valid.

(1) Perform steady-state fuel mapping as described in paragraph (b) of this section with the following exceptions:

(i) All the required steady-state engine operating points as described in paragraph (b)(1)(i) of this section are optional.

(ii) Select speed setpoints to cover the range of idle speeds expected as follows:

(A) The minimum number of speed setpoints is two.

(B) For engines with an adjustable warm idle speed setpoint, the minimum speed setpoint must be equal to the minimum warm idle speed, f_{nidlemin}, and the maximum speed setpoint must be equal to or greater than the maximum warm idle speed, f_{nidlemax}. The minimum speed setpoint for engines without an adjustable warm idle speed setpoint, must be equal to the warm idle speed (with zero torque on the primary output shaft), f_{nidle}, and the maximum speed setpoint must be equal to or greater than 1.15 times the warm idle speed, f_{nidle}.

(iii) Select torque setpoints at each speed setpoint to cover the range of idle torques expected as follows:

(A) The minimum number of torque setpoints at each speed setpoint is three. Note that you must meet the minimum torque spacing requirements described in paragraph (b)(1)(ii) of this section.

(B) The minimum torque setpoint at each speed setpoint is zero.

(C) The maximum torque setpoint at each speed setpoint must be greater than or equal to the estimated maximum torque at warm idle (in-drive) conditions, $T_{\text{idlemaxest}}$, using the following equation. For engines with an adjustable warm idle speed setpoint, evaluate $T_{\text{idlemaxest}}$ at the maximum warm idle speed, f_{nidlemax}. For engines without an adjustable warm idle speed setpoint, use the warm idle speed (with zero torque on the primary output shaft), f_{nidle}.

$$T_{\text{idlemaxest}} = \left(\frac{T_{\text{fnstall}} \cdot f_{\text{nidle}}^2}{f_{\text{fnstall}}^2} + \frac{P_{\text{acc}}}{f_{\text{nidle}}} \right) \cdot 1.1$$

Eq. 1036.535-3

Where:

T_{fnstall} = the maximum engine torque at f_{nstall}.

f_{nidle} = the applicable engine idle speed as described in this paragraph (d).

f_{nstall} = the stall speed of the torque converter; use f_{ntest} or 2250 r/min, whichever is lower.

P_{acc} = accessory power for the vehicle class; use 1500 W for Vocational Light HDV, 2500 W for Vocational Medium HDV, and 3500 W for Tractors and Vocational Heavy HDV.

Example:

T_{fnstall} = 1870 N·m

f_{ntest} = 1740.8 r/min = 182.30 rad/s

f_{nstall} = 1740.8 r/min = 182.30 rad/s

f_{nidle} = 700 r/min = 73.30 rad/s

P_{acc} = 1500 W

$$T_{\text{idlemaxest}} = \left(\frac{1870 \cdot 73.30^2}{182.30^2} + \frac{1500}{73.30} \right) \cdot 1.1 = 355.07\ \text{N} \cdot \text{m}$$

(2) Remove the points from the default map that are below 115 % of the maximum speed and 115% of the maximum torque of the boundaries of the points measured in paragraph (d)(1) of this section.

(3) Add the points measured in paragraph (d)(1) of this section.

(e) Carbon balance verification. The provisions related to carbon balance verification in §1036.543 apply to test intervals in this section.

(f) Correction for net energy content. Correct the measured or calculated mean fuel mass flow rate, $\bar{\dot{m}}_{\text{fuel}}$ at each engine operating condition as specified in paragraphs (b), (c), and (d) of this section to a mass-specific net energy content of a reference fuel using the following equation:

$$\bar{\dot{m}}_{\text{fuelcor}} = \bar{\dot{m}}_{\text{fuel}} \cdot \frac{E_{\text{mfuelmeas}}}{E_{\text{mfuelCref}} \cdot w_{\text{Cref}}}$$

Eq. 1036.535-4

Where:

$E_{\text{mfuelmeas}}$ = the mass-specific net energy content of the test fuel as determined in §1036.530(b)(1).
$E_{\text{mfuelCref}}$ = the reference value of carbon-mass-specific net energy content for the appropriate fuel. Use the values shown in Table 1 of §1036.530 for the designated fuel types, or values we approve for other fuel types.
w_{Cref} = the reference value of carbon mass fraction for the test fuel as shown in Table 1 of §1036.530 for the designated fuels. For other fuels, use the reference carbon mass fraction of diesel fuel for engines subject to compression-ignition standards, and use the reference carbon mass fraction of gasoline for engines subject to spark-ignition standards.
Example:
$\bar{\dot{m}}_{\text{fuel}} = 0.933$ g/s
$E_{\text{mfuelmeas}} = 42.7984$ MJ/kgC
$E_{\text{mfuelCref}} = 49.3112$ MJ/kgC
$w_{\text{Cref}} = 0.874$

$$\bar{\dot{m}}_{\text{fuel}} = 0.933 \cdot \frac{42.7984}{49.3112 \cdot 0.874} = 0.927 \text{ g/s}$$

(g) Measured vs. declared fuel-consumption rates. Select fuel-consumption rates in g/s to characterize the engine's fuel maps. These declared values may not be lower than any corresponding measured values determined in paragraphs (b) through (d) of this section. This includes if you use multiple measurement methods as allowed in paragraph (b)(7) of this section. You may select any value that is at or above the corresponding measured value. These declared fuel-consumption rates, which serve as emission standards under §1036.108, are the values that vehicle manufacturers will use for certification under 40 CFR part 1037. Note that production engines are subject to GEM cycle-weighted limits as described in §1036.301. If you perform the carbon balance error verification in §1036.543, for each fuel map data point:

(1) If you pass the ϵ_{rC} verification, you must declare fuel-consumption rates no lower than the average of the direct and indirect fuel measurements.

(2) If you pass either the ϵ_{aC} verification or ϵ_{aCrate} verification and fail the ϵ_{rC} verification, you must declare fuel-consumption rates no lower than the indirect fuel measurement.

(3) If you don't pass the ϵ_{rC}, ϵ_{aC}, and ϵ_{aCrate} verifications, you must declare fuel-consumption rates no lower than the highest rate for the direct and indirect fuel measurements.

(h) EPA measured fuel-consumption rates. If we pass the carbon mass relative error for a test interval (ϵ_{rC}) verification, the official fuel-consumption rate result will be the average of the direct and indirect fuel measurements. If we pass either the carbon mass absolute error for a test interval (ϵ_{aC}) verification or carbon mass rate absolute error for a test interval (ϵ_{aCrate}) verification and fail the ϵ_{rC} verification, the official fuel-consumption rate result will be the indirect fuel measurement.

115. Revise §1036.540 to read as follows:

§1036.540 Determining cycle-average engine fuel maps.

(a) Overview. This section describes how to determine an engine's cycle-average fuel maps for model year 2021 and later vehicles with transient cycles. This may also apply for highway cruise cycles as described in §1036.510. Vehicle manufacturers may need one or both of these to demonstrate compliance with emission standards under 40 CFR part 1037. Generating cycle-average engine fuel maps consists of the following steps:

(1) Determine the engine's torque maps as described in §1036.510(a).

(2) Determine the engine's steady-state fuel map and fuel consumption at idle as described in §1036.535.
(3) Simulate several different vehicle configurations using GEM (see 40 CFR 1037.520) to create new engine duty cycles, as described in paragraph (c) of this section. The transient vehicle duty cycles for this simulation are in 40 CFR part 1037, Appendix I; the highway cruise cycles with grade are in 40 CFR part 1037, Appendix IV. Note that GEM simulation relies on vehicle service classes as described in 40 CFR 1037.140.
(4) Test the engines using the new duty cycles to determine fuel consumption, cycle work, and average vehicle speed as described in paragraph (d) of this section and establish GEM inputs for those parameters for further vehicle simulations as described in paragraph (e) of this section.

(b) General test provisions. The following provisions apply for testing under this section:
(1) To perform fuel mapping under this section for hybrid engines, make sure the engine and its hybrid features are appropriately configured to represent the hybrid features in your testing.
(2) Measure NO_x emissions for each specified sampling period in grams. You may perform these measurements using a NO_x emission-measurement system that meets the requirements of 40 CFR part 1065, subpart J. Include these measured NO_x values any time you report to us your fuel consumption values from testing under this section. If a system malfunction prevents you from measuring NO_x emissions during a test under this section but the test otherwise gives valid results, you may consider this a valid test and omit the NO_x emission measurements; however, we may require you to repeat the test if we determine that you inappropriately voided the test with respect to NO_x emission measurement.
(3) This section uses engine parameters and variables that are consistent with 40 CFR part 1065.
(4) For variable-speed gaseous-fueled engines with a single-point fuel injection system, apply all of the following statistical criteria to validate the transient duty cycle in 40 CFR part 1037, Appendix I:

Parameter	Speed	Torque	Power
Slope, a_1	$0.950 \leq a_1 \leq 1.030$	$0.830 \leq a_1 \leq 1.030$	$0.830 \leq a_1 \leq 1.030$
Absolute value of intercept, $\lvert a_0 \rvert$	≤ 10 % of warm idle	≤ 3 % of maximum mapped torque	≤ 2 % of maximum mapped power
Standard error of the estimate, *SEE*	≤ 5 % of maximum test speed	≤ 15 % of maximum mapped torque	≤ 15 % of maximum mapped power
Coefficient of determination, r^2	≥ 0.970	≥ 0.700	≥ 0.750

(c) Create engine duty cycles. Use GEM to simulate several different vehicle configurations to create transient and highway cruise engine duty cycles corresponding to each vehicle configuration, as follows:
(1) Set up GEM to simulate vehicle operation based on your engine's torque maps, steady-state fuel maps, engine minimum warm-idle speed and fuel consumption at idle as described in paragraphs (a)(1) and (2) of this section, as well as 40 CFR 1065.405(b). For engines without an adjustable warm idle speed replace minimum warm idle speed with warm idle speed, f_{nidle}.
(2) Set up GEM with transmission parameters for different vehicle service classes and

vehicle duty cycles as described in Table 1 of this section. For automatic transmissions set neutral idle to "Y" in the vehicle file. These values are based on automatic or automated manual transmissions, but they apply for all transmission types.

Table 1 to §1036.540—Assigned Transmission Parameters

	LIGHT HDV AND MEDIUM HDV		**TRACTORS AND HEAVY HDV, TRANSIENT CYCLE**		**TRACTORS AND HEAVY HDV, HIGHWAY CRUISE CYCLE**	
Transmission Type	Automatic Transmission		Automatic Transmission		Automated Manual Transmission	
Gear Number	Gear Ratio	Torque Limit (N·m)	Gear Ratio	Torque Limit (N·m)	Gear Ratio	Torque Limit (N·m)
1	3.10	T_{max}	3.51	T_{max}	12.8	T_{max}
2	1.81		1.91		9.25	
3	1.41		1.43		6.76	
4	1.00		1.00		4.90	
5	0.71		0.74		3.58	
6	0.61		0.64		2.61	
7	—				1.89	
8					1.38	
9					1.00	
10					0.73	
Lockup Gear	3				—	

(3) Run GEM for each simulated vehicle configuration as follows:

(i) Use one of the following equations to determine tire size, $\frac{f_{ntire}}{v_{vehicle}}$, and drive axle ratio, k_a, at each of the defined engine speeds in Tables 2 through 4 of this section:

(A) Select a value for $\left[\frac{f_{ntire}}{v_{vehicle}}\right]_{[speed]}$ and solve for $k_{a[speed]}$ using the following equation:

$$k_{a[speed]} = \frac{f_{n[speed]}}{\left[\frac{f_{ntire}}{v_{vehicle}}\right]_{[speed]} \cdot k_{topgear} \cdot v_{ref}}$$

Eq. 1036.540-1

Where:

$f_{n[speed]}$ = engine's angular speed as determined in paragraph (c)(3)(ii) or (iii) of this section.

$k_{topgear}$ = transmission gear ratio in the highest available gear from Table 1 of this section (for powertrain testing use actual top gear ratio).

v_{ref} = reference speed. Use 65 mi/hr for the transient cycle and the 65 mi/hr highway cruise cycle, and use 55 mi/hr for the 55 mi/hr highway cruise cycle.

(B) Select a value for $k_{a[speed]}$ and solve for $\left[\frac{f_{ntire}}{v_{vehicle}}\right]_{[speed]}$ using the following equation:

$$\left[\frac{f_{ntire}}{v_{vehicle}}\right]_{[speed]} = \frac{f_{n[speed]}}{k_{a[speed]} \cdot k_{topgear} \cdot v_{ref}}$$

Eq. 1036.540-2

Example:

This example is for a vocational Light HDV or vocational Medium HDV with a 6-speed automatic transmission at B speed (Test 3 or 4 in Table 2 of this section).

f_{nrefB} = 1870 r/min = 31.17 r/s

k_{aB} = 4.0

$k_{topgear}$ = 0.61

v_{ref} = 65 mi/hr = 29.06 m/s

$$\left[\frac{f_{ntire}}{v_{vehicle}}\right]_{B} = \frac{31.17}{4.0 \cdot 0.61 \cdot 29.06} = 0.4396 \text{ r/m}$$

(ii) Test at least eight different vehicle configurations for engines that will be installed in vocational Light HDV or vocational Medium HDV using vehicles in Table 2 of this section. For example, if your engines will be installed in vocational Medium HDV and vocational Heavy HDV, you might select Tests 2, 4, 6, and 8 of Table 2 of this section to represent vocational Medium HDV and Tests 2, 3, 4, 6, and 9 of Table 3 of this section to represent vocational Heavy HDV. You may test your engine using additional vehicle configurations with different k_a and C_{rr} values to represent a wider range of in-use vehicle configurations. For all vehicle configurations set the drive axle configuration to 4×2. For powertrain testing, set $M_{rotating}$ to 340 kg and Eff_{axle} to 0.955 for all vehicle configurations. Set the axle ratio, k_a, and tire size, $\frac{f_{ntire}}{v_{vehicle}}$, for each vehicle configuration based on the corresponding designated engine speed (f_{nrefA} , f_{nrefB}, f_{nrefC}, or f_{ntest}) at 65 mi/hr for the transient cycle and the 65 mi/hr highway cruise cycle, and at 55 mi/hr for the 55 mi/hr highway cruise cycle. These vehicle speeds apply equally for engines subject to spark-ignition standards. Use the following settings specific to each vehicle configuration:

Table 2 to §1036.540—Vehicle Configurations for Testing Vocational Light HDV or Vocational Medium HDV

	VEHICLE CONFIGURATION NUMBER							
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**
C_{rr} (kg/tonne)	6.2	7.7	6.2	7.7	6.2	7.7	6.2	7.7
$\frac{f_{ntire}}{v_{vehicle}}$ and k_a for CI engines at engine speed	A	A	B	B	C	C	Maximum test speed	Maximum test speed
$\frac{f_{ntire}}{v_{vehicle}}$ and k_a for SI engines at engine speed	Minimum NTE exclusion speed	Minimum NTE exclusion speed	A	A	B	B	C	C
GEM Regulatory Subcategory	LHD	MHD	LHD	MHD	LHD	MHD	LHD	MHD
M (kg)[a]	7,257	11,408	7,257	11,408	7,257	11,408	7,257	11,408
C_dA[a]	3.4	5.4	3.4	5.4	3.4	5.4	3.4	5.4

[a]Note that M and C_dA are applicable for powertrain testing only since GEM contains default M and C_dA values for each vocational regulatory category.

(iii) Test nine different vehicle configurations for engines that will be installed in vocational Heavy HDV and for tractors that are not heavy-haul tractors. Test six different vehicle configurations for heavy-haul tractors. You may test your engines for additional configurations with different k_a, C_dA, and C_{rr} values to represent a wider range of in-use vehicle configurations. Set C_{rr} to 6.9 for all nine defined vehicle configurations. For class 7 and 8 vehicle configurations set the drive axle configuration to 4×2 and 6×4 respectively. For powertrain testing, set Eff_{axle} to 0.955 for all vehicle configurations. Set the axle ratio, k_a, and tire size, $\frac{f_{ntire}}{v_{vehicle}}$, for each vehicle configuration based on the corresponding designated engine speed (B, f_{ntest}, or the minimum NTE exclusion speed as determined in 40 CFR 86.1370(b)(1)) at 65 mi/hr for the transient duty cycle and the 65 mi/hr highway cruise duty cycle, and at 55 mi/hr for the 55 mi/hr highway cruise duty cycle. Use the settings specific to each vehicle configuration as shown in Table 3 or Table 4 of this section, as appropriate. Engines subject to testing under both Table 3 and Table 4 of this section need not repeat overlapping vehicle configurations, so complete fuel mapping requires testing 12 (not 15) vehicle configurations for those engines. However, this does not apply if you choose to create two separate maps from the vehicle configurations defined in Table 3 and Table 4 of this section. Note that $M_{rotating}$ is needed for powertrain testing but not for engine testing. Tables 3 and 4 follow:

Table 3 of §1036.540—Vehicle Configurations for Testing General Purpose Tractors and Vocational Heavy HDV

	VEHICLE CONFIGURATION NUMBER								
	1	2	3	4	5	6	7	8	9
C_dA	5.4	4.7	4.0	5.4	4.7	4.0	5.4	4.7	4.0
$M_{rotating}$ (kg)	1,021	794	794	1,021	794	794	1,021	794	794
$\frac{f_{ntire}}{v_{vehicle}}$ and k_a at engine speed	Minimum NTE exclusion speed	Minimum NTE exclusion speed	Minimum NTE exclusion speed	B	B	B	Maximum test speed	Maximum test speed	Maximum test speed
GEM Regulatory Subcategory	C8_SC_HR	C8_DC_MR	C7_DC_MR	C8_SC_HR	C8_DC_MR	C7_DC_MR	C8_SC_HR	C8_DC_MR	C7_DC_MR
Vehicle Weight Reduction (lbs)[a]	0	13,275	6,147	0	13,275	6,147	0	13,275	6,147
M (kg)[b]	31,978	25,515	19,051	31,978	25,515	19,051	31,978	25,515	19,051

[a]Note that vehicle weight reduction is not applicable for powertrain testing, since *M* is the total mass that is to be simulated.
[b]Note that *M* is applicable for powertrain testing only since GEM contains default *M* values for each vocational regulatory category.

Table 4 of §1036.540—Vehicle Configurations for Testing Heavy-Haul Tractors

	VEHICLE CONFIGURATION NUMBER					
	1	2	3	4	5	6
C_dA	5.0	5.4	5.0	5.4	5.0	5.4
$M_{rotating}$ (kg)	1,021	1,021	1,021	1,021	1,021	1,021
$\frac{f_{ntire}}{v_{vehicle}}$ and k_a at engine speed	Minimum NTE exclusion speed	Minimum NTE exclusion speed	B	B	Maximum test speed	Maximum test speed
GEM Regulatory Subcategory	C8_HH	C8_SC_HR	C8_HH	C8_SC_HR	C8_HH	C8_SC_HR
M (kg)	53,751	31,978	53,751	31,978	53,751	31,978

(iv) If the engine will be installed in a combination of vehicles defined in paragraphs (ii) and (iii) of this section, use good engineering judgment to select at least nine vehicle configurations from Table 2 and Table 3 of this section that best represent the range of vehicles your engine will be sold in. If there are not nine representative configurations you must add vehicles, that you define, to reach a total of at least nine vehicles. For example, if your engines will be installed in vocational Medium HDV and vocational Heavy HDV, select Tests 2, 4, 6 and 8 of Table 2 of this section to represent Medium HDV and Tests 3, 6, and 9 of Table 3 of this section to represent vocational Heavy HDV and add two more vehicles that you define. You may test your engine using additional vehicle configurations with different k_a and C_{rr} values to represent a wider range of in-use vehicle configurations.

(v) Use the defined values in Tables 1 through 4 of this section to set up GEM with the correct regulatory subcategory and vehicle weight reduction, if applicable, to achieve the target vehicle mass, *M*, for each test.

(4) Use the GEM output of instantaneous engine speed and engine flywheel torque for each of the vehicle configurations to generate a 10 Hz transient duty cycle corresponding to each vehicle configuration operating over each vehicle duty cycle.

(d) Test the engine with GEM cycles. Test the engine over each of the transient engine duty cycles generated in paragraph (c) of this section as follows:

(1) Determine the sequence of engine duty cycles (both required and optional) for the cycle-average-fuel-mapping sequence as follows:

(i) Sort the list of engine duty cycles into three separate groups by vehicle duty cycle; transient vehicle duty cycle, 55 mi/hr highway cruise duty cycle, and the 65 mi/hr highway cruise duty cycle.

(ii) Within each group of engine duty cycles derived from the same vehicle duty cycle, order the duty cycles as follows: Select the engine duty cycle with the highest reference cycle work; followed by the cycle with the lowest cycle work; followed by the cycle with next highest cycle work; followed by the cycle with the next lowest cycle work; until all the cycles are selected.

(iii) For each engine duty cycle, preconditioning cycles will be needed to start the cycle-average-fuel-mapping sequence.

(A) For the first and second cycle in each sequence, the two preconditioning cycles are the first cycle in the sequence, the transient vehicle duty cycle with the highest reference cycle work. This cycle is run twice for preconditioning prior to starting the sequence for either of the first two cycles.

(B) For all other cycles, the two preconditioning cycles are the previous two cycles in the sequence.

(2) If the engine has an adjustable warm idle speed setpoint, set it to its minimum value, $f_{nidlemin}$.

(3) During each test interval, control speed and torque to meet the cycle validation criteria in 40 CFR 1065.514, except as noted in this paragraph (d)(3). Note that 40 CFR part 1065 does not allow subsampling of the 10 Hz GEM generated reference cycle. If the range of reference speeds is less than 10 percent of the mean reference speed, you only need to meet the standard error of the estimate in Table 2 of 40 CFR 1065.514 for the speed regression.

(4) Warm-up the engine as described in 40 CFR 1065.510(b)(2).

(5) Transition between duty cycles as follows:

(i) For transient duty cycles, start the next cycle within 10 seconds after the conclusion of the preceding cycle. Note that this applies to transitioning from both the preconditioning cycles and tests for record.

(ii) For cruise cycles, linearly ramp to the next cycle over 5 seconds and stabilize for 15 seconds prior to starting the next cycle. Note that this applies to transitioning from both the preconditioning cycles and tests for record.

(6) Operate the engine over the engine duty cycle and record measurements using one of the methods described in (d)(6)(i) or (ii) of this section. You must also measure and report NO_x emissions over each test interval as described in paragraph (a)(2) of this section. If you use redundant systems for the determination of fuel consumption, for example combining measurements of dilute and raw emissions when generating your map, follow the requirements of 40 CFR 1065.201(d).

(i) Indirect measurement of fuel flow. Record speed and torque and measure emissions and other inputs needed to run the chemical balance in 40 CFR 1065.655(c) for the test interval defined by the first engine duty cycle; determine the corresponding mean values for the test interval. For dilute sampling of emissions, in addition to the background measurement provisions described in 40 CFR 1065.140, you may do the following:

(A) Measure background as described in §1036.535(b)(7)(i)(A) but read the background as described in paragraph (d)(9)(i) of this section.

(B) Measure background as described in §1036.535(b)(7)(i)(B) but read the background as described in paragraph (d)(9)(i) of this section.

(ii) Direct measurement of fuel flow. Record speed and torque and measure fuel consumption with a fuel flow meter for the test interval defined by the first engine duty cycle; determine the corresponding mean values for the test interval.

(7) Repeat the steps in paragraph (d)(6) of this section for all the remaining engine duty cycles.

(8) Repeat the steps in paragraphs (d)(4) through (7) of this section for all the applicable groups of duty cycles (e.g., transient vehicle duty cycle, 55 mi/hr highway cruise duty cycle, and the 65 mi/hr highway cruise duty cycle).

(9) The following provisions apply for interruptions in the cycle-average-fuel-mapping sequence. These provisions are intended to produce results equivalent to running the sequence without interruption.

(i) You may pause the cycle-average-fuel-mapping sequence after each test interval to calibrate emission-measurement instrumentation, to read and evacuate background bag samples collected over the course of multiple test intervals, or to sample the dilution air for background emissions. This provision requires you to shut-down the engine during the pause. If the pause is longer than 30 minutes, restart the engine and restart the cycle-average-fuel-mapping sequence at the step in paragraph (d)(4) of this section. Otherwise, restart the engine and restart the cycle-average-fuel-mapping sequence at the step in paragraph (d)(5) of this section.

(ii) If an infrequent regeneration event occurs, interrupt the cycle-average-fuel-mapping sequence and allow the regeneration event to finish. You may continue to operate the engine over the engine duty cycle where the event began or, using good engineering judgment, you may transition to another operating condition to reduce the regeneration event duration.

(A) Determine which cycles in the sequence to void as follows:

(*1*) If the regeneration event began during a test interval, the cycle associated with that test interval must be voided.

(*2*) If you used dilute sampling to measure emissions and you used batch sampling to measure background emissions that were sampled periodically into the bag over the course of multiple test intervals and you are unable to read the background bag (e.g., sample volume too small), void all cycles associated with that background bag.

(*3*) If you used dilute sampling to measure emissions and you used the option to sample periodically from the dilution air and you did not meet all the requirements for this option as described in paragraph (d)(6)(i)(B) of this section, void all cycles associated with those background readings.

(*4*) If the regeneration event began during a non-test-interval period of the sequence and the provisions in paragraphs (d)(9)(ii)(A)(*2*) and (*3*) of this section do not apply, you do not need to void any cycles.

(B) Determine the cycle to restart the sequence. Identify the cycle associated with the last valid test interval. The next cycle in the sequence is the cycle to be used to restart the sequence.

(C) Once the regeneration event is finished, restart the sequence at the cycle determined in paragraph (d)(9)(ii)(B) of this section instead of the first cycle of the sequence. If the engine is not already warm, restart the sequence at paragraph (d)(4) of this section. Otherwise, restart at paragraph (d)(5) of this section.

(iii) If the cycle-average-fuel-mapping sequence is interrupted due to test equipment or engine malfunction, correct the malfunction and follow the steps in paragraphs (d)(9)(ii)(A) through (C) of this section to restart the sequence. Treat the detection of the malfunction as the beginning of the regeneration event.

(iv) If any test interval in the cycle-average-fuel-mapping sequence is voided, you must rerun that test interval as described in this paragraph (d)(9)(iv). You may rerun the whole sequence or any contiguous part of the sequence. If you end up with multiple valid test intervals for a given cycle, use the last valid test interval for determining the cycle-average fuel map. If the engine has been shut-down for more than 30 minutes or if it is not already warm, restart the sequence at paragraph (d)(4) of this section. Otherwise, restart at paragraph (d)(5) of this section. Repeat the steps in paragraphs (d)(6) and (d)(7) of this section until you complete the whole sequence or part of the sequence. The following examples illustrate possible scenarios for completing only part of the sequence:

(A) If you voided only the test interval associated with the fourth cycle in the sequence, you may restart the sequence using the second and third cycles as the preconditioning cycles and stop after completing the test interval associated with the fourth cycle.

(B) If you voided the test intervals associated with the fourth and sixth cycles, you may restart the sequence using the second and third cycles as the preconditioning cycles and stop after completing the test interval associated with the sixth cycle. If the test interval associated with the fifth cycle in this sequence was valid, it must be used for determining the cycle-average fuel map instead of the original one.

(10) For plug-in hybrid engines, precondition the battery and then complete all back-to-back tests for each vehicle configuration according to 40 CFR 1066.501 before moving to the next vehicle configuration.

(11) You may send signals to the engine controller during the test, such as current transmission gear and vehicle speed, if that allows engine operation during the test to better represent in-use operation.

(12) For hybrid powertrains with no plug-in capability, correct for the net energy change of the energy storage device as described in 40 CFR 1066.501. For plug-in hybrid engines, follow 40 CFR 1066.501 to determine End-of-Test for charge-depleting operation; to do this, you must get our advance approval for a utility factor curve. We will approve your utility factor curve if you can show that you created it from sufficient in-use data of vehicles in the same application as the vehicles in which the PHEV engine will be installed.

(13) Calculate the fuel mass flow rate, m_{fuel}, for each duty cycle using one of the following equations:

(i) Determine fuel-consumption rates using emission measurements from the raw or diluted exhaust, calculate the mass of fuel for each duty cycle, $m_{\text{fuel[cycle]}}$, as follows:

(A) For calculations that use continuous measurement of emissions and continuous CO_2 from urea, calculate $m_{fuel[cycle]}$ using the following equation:

$$m_{fuel[cycle]} = \frac{M_C}{w_{Cmeas}} \cdot \left(\sum_{i=1}^{N} \left(\dot{n}_{exhi} \cdot \frac{x_{Ccombdryi}}{1 + x_{H2Oexhdryi}} \cdot \Delta t \right) - \frac{1}{M_{CO2}} \sum_{i=1}^{N} \left(\dot{m}_{CO2DEFi} \cdot \Delta t \right) \right)$$

Eq. 1036.540-3

Where:

M_C = molar mass of carbon.

w_{Cmeas} = carbon mass fraction of fuel (or mixture of test fuels) as determined in 40 CFR 1065.655(d), except that you may not use the default properties in Table 1 of 40 CFR 1065.655 to determine α, β, and w_C for liquid fuels.

i = an indexing variable that represents one recorded emission value.

N = total number of measurements over the duty cycle.

$\dot{n}_{exh}$ = exhaust molar flow rate from which you measured emissions.

$x_{Ccombdry}$ = amount of carbon from fuel and any injected fluids in the exhaust per mole of dry exhaust as determined in 40 CFR 1065.655(c).

$x_{H2Oexhdry}$ = amount of H_2O in exhaust per mole of exhaust as determined in 40 CFR 1065.655(c).

$\Delta t = 1/f_{record}$

M_{CO2} = molar mass of carbon dioxide.

$\dot{m}_{CO2DEFi}$ = mass emission rate of CO_2 resulting from diesel exhaust fluid decomposition over the duty cycle as determined from §1036.535(b)(10). If your engine does not utilize diesel exhaust fluid for emission control, or if you choose not to perform this correction, set $\dot{m}_{CO2DEF_i}$ equal to 0.

Example:

M_C = 12.0107 g/mol

w_{Cmeas} = 0.867

N = 6680

$\dot{n}_{exh1}$ = 2.876 mol/s

$\dot{n}_{exh2}$ = 2.224 mol/s

$x_{Ccombdry1} = 2.61 \cdot 10^{-3}$ mol/mol

$x_{Ccombdry2} = 1.91 \cdot 10^{-3}$ mol/mol

$x_{H2Oexh1} = 3.53 \cdot 10^{-2}$ mol/mol

$x_{H2Oexh2} = 3.13 \cdot 10^{-2}$ mol/mol

f_{record} = 10 Hz

Δt = 1/10 = 0.1 s

M_{CO2} = 44.0095 g/mol

$\dot{m}_{CO2DEF1}$ = 0.0726 g/s

$\dot{m}_{CO2DEF2}$ = 0.0751 g/s

$$m_{\text{fueltransientTest1}} = \frac{12.0107}{0.867} \cdot \left(\left(\begin{array}{l} 2.876 \cdot \frac{2.61 \cdot 10^{-3}}{1+3.53 \cdot 10^{-2}} \cdot 0.1 + \\ 2.224 \cdot \frac{1.91 \cdot 10^{-3}}{1+3.13 \cdot 10^{-2}} \cdot 0.1 + \\ \ldots + \dot{n}_{\text{exh6680}} \cdot \frac{x_{\text{Ccombdr6680}}}{1+x_{\text{H2Oexhdry6680}}} \cdot \Delta t_{6680} \end{array} \right) - \frac{1}{44.0095} \cdot \left(0.0726 \cdot 1.0 + 0.0751 \cdot 1.0 + \ldots + \dot{m}_{\text{CO2DEF6680}} \cdot \Delta t_{6680} \right) \right)$$

$m_{\text{fueltransientTest1}}$ = 1619.6 g

(B) If you measure batch emissions and continuous CO_2 from urea, calculate $m_{\text{fuel[cycle]}}$ using the following equation:

$$m_{\text{fuel[cycle]}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\frac{\bar{x}_{\text{Ccombdry}}}{1+\bar{x}_{\text{H2Oexhdry}}} \cdot \sum_{i=1}^{N} \left(\dot{n}_{\text{exh}i} \cdot \Delta t \right) - \frac{1}{M_{\text{CO2}}} \sum_{i=1}^{N} \left(\dot{m}_{\text{CO2DEF}i} \cdot \Delta t \right) \right)$$

Eq. 1036.540-4

(C) If you measure continuous emissions and batch CO_2 from urea, calculate $m_{\text{fuel[cycle]}}$ using the following equation:

$$m_{\text{fuel[cycle]}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\sum_{i=1}^{N} \left(\dot{n}_{\text{exh}i} \cdot \frac{x_{\text{Ccombdry}i}}{1+x_{\text{H2Oexhdry}i}} \cdot \Delta t \right) - \frac{m_{\text{CO2DEF}}}{M_{\text{CO2}}} \right)$$

Eq. 1036.540-5

(D) If you measure batch emissions and batch CO_2 from urea, calculate $m_{\text{fuel[cycle]}}$ using the following equation:

$$m_{\text{fuel[cycle]}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\frac{\bar{x}_{\text{Ccombdry}}}{1+\bar{x}_{\text{H2Oexhdry}}} \cdot \sum_{i=1}^{N} \left(\dot{n}_{\text{exh}i} \cdot \Delta t \right) - \frac{m_{\text{CO2DEF}}}{M_{\text{CO2}}} \right)$$

Eq. 1036.540-6

(ii) Manufacturers may choose to measure fuel mass flow rate. Calculate the mass of fuel for each duty cycle, $m_{\text{fuel[cycle]}}$, as follows:

$$m_{\text{fuel}} = \sum_{i=1}^{N} \dot{m}_{\text{fuel}i} \cdot \Delta t$$

Eq. 1036.540-7

Where:

i = an indexing variable that represents one recorded value.

N = total number of measurements over the duty cycle. For batch fuel mass measurements, set N = 1.

$\dot{m}_{\text{fuel}i}$ = the fuel mass flow rate, for each point, i, starting from i = 1.

$\Delta t = 1/f_{\text{record}}$

f_{record} = the data recording frequency.

Example:

N = 6680

$\dot{m}_{\text{fuel1}}$ = 1.856 g/s

$\dot{m}_{\text{fuel2}}$ = 1.962 g/s

f_{record} = 10 Hz
Δt = 1/10 = 0.1 s
$m_{fueltransient} = (1.856 + 1.962 + ... + \dot{m}_{fuel6680}) \cdot 0.1$
$m_{fueltransient}$ = 111.95 g

(14) The provisions related to carbon balance error verification in §1036.543 apply to test intervals in this section.

(15) Correct the measured or calculated fuel mass flow rate, m_{fuel}, for each test result to a mass-specific net energy content of a reference fuel as described in §1036.535(e), replacing $\bar{\dot{m}}_{fuel}$ with m_{fuel} in Eq. 1036.535-4.

(16) For engines designed for plug-in hybrid electric vehicles, the mass of fuel for each cycle, $m_{fuel[cycle]}$, is the utility factor-weighted fuel mass. This is done by calculating m_{fuel} for the full charge-depleting and charge-sustaining portions of the test and weighting the results, using the following equation:

$$m_{fuel[cycle],plug\text{-}in} = m_{fuel[cycle],CD} \cdot UF_{D,CD} + m_{fuel[cycle],CS} \cdot \left(1 - UF_{D,CD}\right)$$

Eq. 1036.540-8

Where:

$m_{fuel[cycle],CD}$ = total mass of fuel for all the tests in the charge-depleting portion of the test.

$UF_{D,CD}$ = utility factor fraction at distance D_{CD} as determined by interpolating the approved utility factor curve.

$m_{fuel[cycle],CS}$ = total mass of fuel for all the tests in the charge-sustaining portion of the test.

$$D_{CD} = \sum_{i=1}^{N} \left(v_i \cdot \Delta t_i\right)$$

Eq. 1036.540-9

Where:

v = vehicle velocity at each time step. For tests completed under this section, v is the vehicle velocity in the GEM duty-cycle file. For tests under 40 CFR 1037.550, v is the vehicle velocity as determined by Eq. 1037.550-1. Note that this should include complete and incomplete charge-depleting tests.

(e) Determine GEM inputs. Use the results of engine testing in paragraph (d) of this section to determine the GEM inputs for the transient duty cycle and optionally for each of the highway cruise cycles corresponding to each simulated vehicle configuration as follows:

(1) Your declared fuel mass consumption, $m_{fuel[cycle]}$. Using the calculated fuel mass consumption values described in paragraph (d) of this section, declare values using the method described in §1036.535(g).

(2) We will determine $m_{fuel[cycle]}$ values using the method described in §1036.535(h).

(3) Engine output speed per unit vehicle speed, $\left[\frac{\bar{f}_{nengine}}{\bar{v}_{vehicle}}\right]_{[cycle]}$, by taking the average engine speed measured during the engine test while the vehicle is moving and dividing it by the average vehicle speed provided by GEM. Note that the engine cycle created by GEM has a flag to indicate when the vehicle is moving.

(4) Positive work determined according to 40 CFR 1065, $W_{[cycle]}$, by using the engine speed and engine torque measured during the engine test while the vehicle is moving. Note that the engine cycle created by GEM has a flag to indicate when the vehicle is moving.

(5) The engine idle speed and torque, by taking the average engine speed and torque measured during the engine test while the vehicle is not moving. Note that the engine cycle created by GEM has a flag to indicate when the vehicle is moving.

(6) The following table illustrates the GEM data inputs corresponding to the different vehicle configurations for a given duty cycle:

Table 5 of §1036.540—Example vehicle configuration test result output matrix for Class 8 vocational vehicles

	VEHICLE CONFIGURATION NUMBER								
	1	2	3	4	5	6	7	8	9
$m_{\text{fuel[cycle]}}$									
$\left[\dfrac{\bar{f}_{\text{nengine}}}{\bar{v}_{\text{vehicle}}}\right]_{\text{[cycle]}}$									
$W_{\text{[cycle]}}$									
$\bar{f}_{\text{nidle}}{}^{a}$									
$\bar{T}_{\text{idle}}{}^{a}$									

[a]Idle speed and torque apply only for the transient duty cycle.

116. Add §1036.543 to subpart F to read as follows:

§1036.543 Carbon balance error verification.

A carbon balance error verification compares independent assessments of the flow of carbon through the system (engine plus aftertreatment). We will, and you may optionally, verify carbon balance error according to 40 CFR part 1065.543. This applies to all test intervals in §1036.535 (b), (c), and (d); §1036.540; and 40 CFR 1037.550.

117. Amend §1036.620 by revising paragraphs (a) and (b)(1)(iii) to read as follows:

§1036.620 Alternate CO_2 standards based on model year 2011 compression-ignition engines.

* * * * *

(a) The standards of this section are determined from the measured emission rate of the test engine of the applicable baseline 2011 engine family or families as described in paragraphs (b) and (c) of this section. Calculate the CO_2 emission rate of the baseline test engine using the same equations used for showing compliance with the otherwise applicable standard. The alternate CO_2 standard for light and medium heavy-duty vocational-certified engines (certified for CO_2 using the transient cycle) is equal to the baseline emission rate multiplied by 0.975. The alternate CO_2 standard for tractor-certified engines (certified for CO_2 using the SET duty cycle) and all other heavy heavy-duty engines is equal to the baseline emission rate multiplied by 0.970. The in-use FEL for these engines is equal to the alternate standard multiplied by 1.03.

(b) * * *

(1) * * *

(iii) Calculate separate adjustments for emissions over the SET duty cycle and the transient cycle.

* * * * *

118. Amend §1036.701 by revising paragraphs (i) and (j) to read as follows:

§1036.701 General provisions.

* * * * *

(i) Unless the regulations explicitly allow it, you may not calculate Phase 1credits more than once for any emission reduction. For example, if you generate Phase 1CO_2 emission credits for a hybrid engine under this part for a given vehicle, no one may generate CO_2 emission credits for that same hybrid engine and the associated vehicle under 40 CFR part 1037. However, Phase 1 credits could be generated for identical vehicles using engines that did not generate credits under this part.

(j) Credits you generate with compression-ignition engines in 2020 and earlier model years may be used in model year 2021 and later as follows:

(1) For credit-generating engines certified to the tractor engine standards in §1036.108, you may use credits calculated relative to the tractor engine standards.

(2) For credit-generating engines certified to the vocational engine standards in §1036.108, you may optionally carry over adjusted vocational credits from an averaging set, and you may use credits calculated relative to the emission levels in the following table:

Table 1 of §1036.701—Emission Levels for Credit Calculation

Medium Heavy-Duty Engines	**Heavy Heavy-Duty Engines**
558 g/hp·hr	525 g/hp·hr

* * * * *

119\. Amend §1036.705 by revising paragraphs (b)(2) and (5) to read as follows:

§1036.705 Generating and calculating emission credits.

* * * * *

(b) * * *

(2) For tractor engines:

Emission credits (Mg) = (Std – FCL) · (CF) · (Volume) · (UL) · (10^{-6})

Where:

Std = the emission standard, in g/hp-hr, that applies under subpart B of this part for engines not participating in the ABT program of this subpart (the "otherwise applicable standard").

FCL = the Family Certification Level for the engine family, in g/hp-hr, measured over the SET duty cycle rounded to the same number of decimal places as the emission standard.

CF = a transient cycle conversion factor (hp-hr/mile), calculated by dividing the total (integrated) horsepower-hour over the duty cycle (average of tractor-engine configurations weighted by their production volumes) by 6.3 miles for engines subject to spark-ignition standards and 6.5 miles for engines subject to compression-ignition standards. This represents the average work performed by tractor engines in the family over the mileage represented by operation over the duty cycle. Note that this calculation requires you to use the transient cycle conversion factor even for engines certified to standards based on the SET duty cycle.

Volume = the number of tractor engines eligible to participate in the averaging, banking, and trading program within the given engine family during the model year, as described in paragraph (c) of this section.

UL = the useful life for the given engine family, in miles.

* * * * *

(5) You may generate CO_2 emission credits from a model year 2021 or later medium heavy-duty engine family subject to spark-ignition standards for exchanging with other engine families only if the engines in the family are gasoline-fueled. You may generate CO_2 credits from non-gasoline engine families only for the purpose of offsetting CH_4 and/or N_2O emissions within the same engine family as described in paragraph (d) of this section.

* * * * *

120. Amend §1036.801 by:

a. Revising the definitions for Auxiliary emission control device", "Heavy-duty vehicle", "Hybrid".

b. Adding definitions for "Hybrid engine", "Hybrid powertrain", and "Mild hybrid" in alphabetical order.

c. Revising the definition for "Steady-state".

The new and revised definitions read as follows:

§1036.801 Definitions.

* * * * *

Auxiliary emission control device means any element of design that senses temperature, motive speed, engine speed (r/min), transmission gear, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission control system.

* * * * *

Heavy-duty vehicle means any motor vehicle above 8,500 pounds GVWR. An incomplete vehicle is also a heavy-duty vehicle if it has a curb weight above 6,000 pounds or a basic vehicle frontal area greater than 45 square feet. *Curb weight* and *Basic vehicle frontal area* have the meaning given in 40 CFR 86.1803.

Hybrid means an engine or powertrain that includes energy storage features other than a conventional battery system or conventional flywheel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Note that certain provisions in this part treat hybrid engines and hybrid powertrains intended for vehicles that include regenerative braking different than those intended for vehicles that do not include regenerative braking.

Hybrid engine means a hybrid system with features for storing and recovering energy that are integral to the engine or are otherwise upstream of the vehicle's transmission other than a conventional battery system or conventional flywheel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Examples of hybrids that could be considered hybrid engines are P0, P1, and P2 hybrids where hybrid features are connected to the front end of the engine, at the crankshaft, or connected between the clutch and the transmission where the clutch upstream of the hybrid feature is in addition to the transmission clutch(s), respectively. Note other examples of systems that qualify as hybrid engines are systems that recover kinetic energy and use it to power an electric heater in the aftertreatment.

Hybrid powertrain means a powertrain that includes energy storage features other than a conventional battery system or conventional flywheel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Note other examples of systems that qualify as hybrid powertrains are systems that recover kinetic energy and use it to power an electric heater in the aftertreatment.

*   *   *   *   *

Mild hybrid means a hybrid engine or powertrain with regenerative braking capability where the system recovers less than 20 percent of the total braking energy over the transient cycle defined in Appendix I of 40 CFR part 1037.

*   *   *   *   *

Steady-state has the meaning given in 40 CFR 1065.1001. This includes fuel mapping and idle testing where engine speed and load are held at a finite set of nominally constant values.

*   *   *   *   *

121. Amend §1036.805 by revising paragraphs (b) through (f) and adding paragraph (g) to read as follows:

§1036.805 Symbols, abbreviations, and acronyms.

*   *   *   *   *

(b) Symbols for quantities. This part uses the following symbols and units of measure for various quantities:

SYMBOL	QUANTITY	UNIT	UNIT SYMBOL	UNIT IN TERMS OF SI BASE UNITS
α	atomic hydrogen-to-carbon ratio	mole per mole	mol/mol	1
A	Area	square meter	m^2	m^2
β	atomic oxygen-to-carbon ratio	mole per mole	mol/mol	1
C_dA	drag area	meter squared	m^2	m^2
C_{rr}	coefficient of rolling resistance	kilogram per metric ton	kg/tonne	10^{-3}
D	distance	miles or meters	mi or m	m
ε	efficiency			
ϵ	Difference or error quantity			
e	mass weighted emission result	grams/ton-mile	g/ton-mi	g/kg-km
Eff	efficiency			
E_m	mass-specific net energy content	megajoules/kilogram	MJ/kg	$m^2\cdot s^{-2}$
f_n	angular speed (shaft)	revolutions per minute	r/min	$\pi\cdot 30\cdot s^{-1}$
g	gravitational acceleration	meters per second squared	m/s^2	$m\cdot s^{-2}$
i	indexing variable			
k_a	drive axle ratio			1
$k_{topgear}$	highest available transmission gear			
m	Mass	pound mass or kilogram	lbm or kg	kg
M	molar mass	gram per mole	g/mol	$10^{-3}\cdot kg\cdot mol^{-1}$
M	vehicle mass	kilogram	kg	kg
$M_{rotating}$	inertial mass of rotating components	kilogram	kg	kg
N	total number in a series			
P	Power	kilowatt	kW	$10^3\cdot m^2\cdot kg\cdot s^{-3}$
ρ	mass density	kilogram per cubic meter	kg/m^3	$m^{-3}\cdot kg$
r	tire radius	meter	m	m

SEE	standard error of the estimate			
σ	standard deviation			
T	torque (moment of force)	newton meter	N·m	$m^2 \cdot kg \cdot s^{-2}$
t	Time	second	s	s
Δt	time interval, period, 1/frequency	second	s	s
UF	utility factor			
v	Speed	miles per hour or meters per second	mi/hr or m/s	$m \cdot s^{-1}$
W	Work	kilowatt-hour	kW·hr	$3.6 \cdot m^2 \cdot kg \cdot s^{-1}$
w_C	carbon mass fraction	gram/gram	g/g	1
w_{CH4N2O}	urea mass fraction	gram/gram	g/g	1
x	amount of substance mole fraction	mole per mole	mol/mol	1
x_b	brake energy fraction			
x_{bl}	brake energy limit			

(c) Superscripts. This part uses the following superscripts for modifying quantity symbols:

SUPERSCRIPT	MEANING
overbar (such as $\bar{y}$)	arithmetic mean
overdot (such as $\dot{y}$)	quantity per unit time

(d) Subscripts. This part uses the following subscripts for modifying quantity symbols:

SUBSCRIPT	MEANING
65	65 miles per hour
A	A speed
A	absolute (e.g., absolute difference or error)
Acc	accessory
App	approved
Axle	axle
B	B speed
C	C speed
C	carbon mass
Ccombdry	carbon from fuel per mole of dry exhaust
CD	charge-depleting
CO2DEF	CO_2 resulting from diesel exhaust fluid decomposition
comb	combustion
comp	composite
Cor	corrected
CS	charge-sustaining
Cycle	test cycle
DEF	diesel exhaust fluid
engine	engine
Exh	raw exhaust
Front	frontal
Fuel	fuel
H2Oexhaustdry	H_2O in exhaust per mole of exhaust
Hi	high
I	an individual of a series
Idle	idle

M	mass
Max	maximum
mapped	mapped
Meas	measured quantity
Neg	negative
Pos	positive
R	relative (e.g., relative difference or error)
Rate	rate (divided by time)
Rated	rated
record	record
Ref	reference quantity
speed	speed
Stall	stall
Test	test
Tire	tire
transient	transient
M	vector
vehicle	vehicle

(e) Other acronyms and abbreviations. This part uses the following additional abbreviations and acronyms:

ACRONYM	MEANING
ABT	averaging, banking, and trading
AECD	auxiliary emission control device
ASTM	American Society for Testing and Materials
BTU	British thermal units
CD	charge-depleting
CFR	Code of Federal Regulations
CI	Compression-ignition
COV	coefficient of variation
CS	charge-sustaining
DEF	diesel exhaust fluid
DF	deterioration factor
DOT	Department of Transportation
E85	gasoline blend including nominally 85 percent denatured ethanol
ECU	Electronic Control Unit
EPA	Environmental Protection Agency
FCL	Family Certification Level
FEL	Family Emission Limit
GEM	Greenhouse gas Emissions Model
g/hp-hr	grams per brake horsepower-hour
GVWR	gross vehicle weight rating
HDV	heavy-duty vehicle
LPG	liquefied petroleum gas
NARA	National Archives and Records Administration
NHTSA	National Highway Traffic Safety Administration
NTE	not-to-exceed
RESS	rechargeable energy storage system
RMC	ramped-modal cycle
SCR	selective catalytic reduction

SEE	standard error of the estimate
SET	Supplemental Emission Test
SI	spark-ignition
U.S.	United States
U.S.C.	United States Code

(f) Constants. This part uses the following constants:

SYMBOL	QUANTITY	VALUE
g	gravitational constant	9.80665 $m \cdot s^{-2}$

(g) Prefixes. This part uses the following prefixes to define a quantity:

SYMBOL	QUANTITY	VALUE
µ	micro	10^{-6}
m	milli	10^{-3}
c	centi	10^{-2}
k	kilo	10^{3}
M	mega	10^{6}

122. Revise §1036.810 to read as follows:

§1036.810 Incorporation by reference.

Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a document in the *Federal Register* and the material must be available to the public. All approved material is available for inspection at U.S. EPA, Air and Radiation Docket and Information Center, WJC West Building, Room 3334, 1301 Constitution Ave., NW., Washington, DC 20460, www.epa.gov/dockets, (202) 202-1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202–741–6030, or go to www.archives.gov/federal-register/cfr/ibr-locations.html.

(a) ASTM International, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428-2959, (877) 909–2786, www.astm.org/.

(1) ASTM D3588-98 (Reapproved 2017)e1, Standard Practice for Calculating Heat Value, Compressibility Factor, and Relative Density of Gaseous Fuels, approved April 1, 2017, (“ASTM D3588”), IBR approved for §1036.530(b).

(2) ASTM D4809-13, Standard Test Method for Heat of Combustion of Liquid Hydrocarbon Fuels by Bomb Calorimeter (Precision Method), approved May 1, 2013, (“ASTM D4809”), IBR approved for §1036.530(b).

(b) National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070, (301) 975-6478, or www.nist.gov.

(1) NIST Special Publication 811, Guide for the Use of the International System of Units (SI), 2008 Edition, March 2008, IBR approved for §1036.805.

(2) [Reserved]

123. Amend §1036.825 by revising paragraph (a) to read as follows:

§1036.825 Reporting and recordkeeping requirements.

(a) This part includes various requirements to submit and record data or other information.

Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. We may review these records at any time. You must promptly give us organized, written records in English if we ask for them. We may require you to submit written records in an electronic format.
* * * * *

124. Redesignate Appendix I to part 1036 as Appendix III to part 1036.

125. Add Appendix I to part 1036 to read as follows:

Appendix I to Part 1036—Summary of Previous Emission Standards

The following standards, which EPA originally adopted under 40 CFR part 85 or part 86, apply to compression-ignition engines produced before model year 2007 and to spark-ignition engines produced before model year 2008:

(a) Smoke. Smoke standards applied for compression-ignition engines based on opacity measurement using the test procedures in 40 CFR part 86, subpart I, as follows:

(1) Engines were subject to the following smoke standards for model years 1970 through 1973:

(i) 40 percent during the engine acceleration mode.

(ii) 20 percent during the engine lugging mode.

(2) The smoke standards in 40 CFR 86.11 started to apply in model year 1974.

(b) Idle CO. A standard of 0.5 percent of exhaust gas flow at curb idle applied through model year 2016 to the following engines:

(1) Spark-ignition engines with aftertreatment starting in model year 1987. This standard applied only for gasoline-fueled engines through model year 1997. Starting in model year 1998, the same standard applied for engines fueled by methanol, LPG, and natural gas. The idle CO standard no longer applied for engines certified to meet onboard diagnostic requirements starting in model year 2005.

(2) Methanol-fueled compression-ignition engines starting in model year 1990. This standard also applied for natural gas and LPG engines starting in model year 1997. The idle CO standard no longer applied for engines certified to meet onboard diagnostic requirements starting in model year 2007.

(c) Crankcase emissions. The requirement to design engines to prevent crankcase emissions applied starting with the following engines:

(1) Spark-ignition engines starting in model year 1968. This standard applied only for gasoline-fueled engines through model year 1989, and applied for spark-ignition engines using other fuels starting in model year 1990.

(2) Naturally aspirated diesel-fueled engines starting in model year 1985.

(3) Methanol-fueled compression-ignition engines starting in model year 1990.

(4) Naturally aspirated gaseous-fueled engines starting in model year 1997, and all other gaseous-fueled engines starting in 1998.

(d) Early steady-state standards. The following criteria standards applied to heavy-duty engines based on steady-state measurement procedures:

Table 1 to Appendix I—Early Steady-State Emission Standards for Heavy-Duty Engines

Model Year	Fuel	Pollutant		
		HC	NO_x + HC	CO
1970-1973	gasoline	275 ppm	—	1.5 volume percent
1974-1978	gasoline and diesel	—	16 g/hp·hr	40 g/hp·hr
1979-1984[a]	gasoline and diesel	—	5 g/hp·hr for diesel 5.0 g/hp·hr for gasoline	25 g/hp·hr

[a]An optional NO_x + HC standard of 10 g/hp·hr applied in 1979 through 1984 in conjunction with a separate HC standard of 1.5 g/hp·hr.

(e) Transient emission standards for spark-ignition engines. The following criteria standards applied for spark-ignition engines based on transient measurement using the test procedures in 40 CFR part 86, subpart N. Starting in model year 1991, manufacturers could generate or use emission credits for NO_x and NO_x + NMHC standards. Table 2 follows:

Table 2 to Appendix I—Transient Emission Standards for Spark-Ignition Engines[a,b]

Model Year	Pollutant (g/hp·hr)			
	HC	CO	NO_x	NO_x + NMHC
1985-1987	1.1	14.4	10.6	—
1988-1990	1.1	14.4	6.0	—
1991-1997	1.1	14.4	5.0	—
1998-2004[c]	1.1	14.4	4.0	—
2005-2007	—	14.4	—	1.0[d]

[a]Standards applied only for gasoline-fueled engines through model year 1989. Standards started to apply for methanol in model year 1990, and for LPG and natural gas in model year 1998.
[b]Engines intended for installation only in heavy-duty vehicles above 14,000 pounds GVWR were subject to an HC standard of 1.9 g/hp·hr for model years 1987 through 2004, and a CO standard of 37.1 g/hp·hr for model years 1987 through 2007. In addition, for model years 1987 through 2007, up to 5 percent of a manufacturer's sales of engines intended for installation in heavy-duty vehicles at or below 14,000 pounds GVWR could be certified to the alternative HC and CO standards.
[c]For natural gas engines in model years 1998 through 2004, the NO_x standard was 5.0 g/hp·hr; the HC standards were 1.7 g/hp·hr for engines intended for installation only in vehicles above 14,000 pounds GVWR, and 0.9 g/hp·hr for other engines.
[d]Manufacturers could delay the 1.0 g/hp·hr NO_x + NMHC standard until model year 2008 by meeting an alternate NO_x + NMHC standard of 1.5 g/hp·hr applied for model years 2004 through 2007.

(f) Transient emission standards for compression-ignition engines. The following criteria standards applied for compression-ignition engines based on transient measurement using the test procedures in 40 CFR part 86, subpart N. Starting in model year 1991, manufacturers could generate or use emission credits for NO_x, NO_x + NMHC, and PM standards. Table 3 follows:

Table 3 to Appendix I—Transient Emission Standards for Compression-Ignition Engines[a]

Model Year	Pollutant (g/hp·hr)				
	HC	CO	NO_x	NO_x + NMHC	PM
1985-1987	1.3	15.5	10.7	—	—
1988-1989	1.3	15.5	10.7	—	0.60
1990	1.3	15.5	6.0	—	0.60
1991-1992	1.3	15.5	5.0	—	0.25
1993	1.3	15.5	5.0	—	0.25 truck 0.10 bus
1994-1995	1.3	15.5	5.0	—	0.10 truck 0.07 urban bus
1996-1997	1.3	15.5	5.0	—	0.10 truck 0.05 urban bus[b]
1998-2003	1.3	15.5	4.0	—	0.10 truck 0.05 urban bus[b]
2004-2006	—	15.5	—	2.4[c]	0.10 truck 0.05 urban bus[b]

[a]Standards applied only for diesel-fueled engines through model year 1989. Standards started to apply for methanol in model year 1990, and for LPG and natural gas in model year 1997. An alternate HC standard of 1.2 g/hp·hr applied for natural gas engines for model years 1997 through 2003.
[b]The in-use PM standard for urban bus engines in model years 1996 through 2006 was 0.07 g/hp·hr.
[c]An optional NO_x + NMHC standard of 2.5 g/hp·hr applied in 2004 through 2006 in conjunction with a separate NMHC standard of 0.5 g/hp·hr.

126. Add Appendix II to part 1036 to read as follows:

Appendix II to Part 1036—Transient Duty Cycles

(a) This appendix specifies transient duty cycles for the engine and powertrain testing described in §1036.510, as follows:

(1) The transient duty cycle for testing engines involves a schedule of normalized engine speed and torque values.

(2) The transient duty cycles for powertrain testing involves a schedule of vehicle speeds and road grade. Determine road grade at each point based on the peak rated power of the powertrain system, P_{rated}, determined in §1036.527 and road grade coefficients using the following equation:

$$Road\ grade = a \cdot P_{rated}^2 + b \cdot P_{rated} + c$$

(b) The following transient duty cycle applies for spark-ignition engines and powertrains:

Record (seconds)	Engine testing		Powertrain testing			
	Normalized revolutions per minute (percent)	Normalized torque (percent)	Vehicle speed (mi/hr)	Road grade coefficients		
				a	*b*	*c*
1	0	0	0	0	0	0
2	0	0	0	0	0	0
3	0	0	0	1.837E-05	-1.876E-02	2.369E+00
4	0	0	0	2.756E-05	-2.814E-02	3.553E+00
5	0	0	0	2.756E-05	-2.814E-02	3.553E+00
6	0	0	0	2.756E-05	-2.814E-02	3.553E+00
7	0	0	0	2.756E-05	-2.814E-02	3.553E+00

8	0	0	0	2.756E-05	-2.814E-02	3.553E+00
9	0	0	0	2.756E-05	-2.814E-02	3.553E+00
10	0	0	0	2.756E-05	-2.814E-02	3.553E+00
11	0	0	0	2.756E-05	-2.814E-02	3.553E+00
12	0	0	0	2.756E-05	-2.814E-02	3.553E+00
13	0	0	0	2.756E-05	-2.814E-02	3.553E+00
14	0	0	0	2.756E-05	-2.814E-02	3.553E+00
15	0	0	0	2.756E-05	-2.814E-02	3.553E+00
16	0	0	0	2.756E-05	-2.814E-02	3.553E+00
17	0	0	0	2.756E-05	-2.814E-02	3.553E+00
18	0	0	0	2.756E-05	-2.814E-02	3.553E+00
19	0	0	0	2.756E-05	-2.814E-02	3.553E+00
20	0	0	0	2.756E-05	-2.814E-02	3.553E+00
21	0	0	0	2.756E-05	-2.814E-02	3.553E+00
22	0	0	0	2.756E-05	-2.814E-02	3.553E+00
23	0	0	0	2.756E-05	-2.814E-02	3.553E+00
24	0	0	0	2.756E-05	-2.814E-02	3.553E+00
25	7.00	44.40	0	2.756E-05	-2.814E-02	3.553E+00
26	16.00	85.40	3.04	2.756E-05	-2.814E-02	3.553E+00
27	27.00	97.80	5.59	2.756E-05	-2.814E-02	3.553E+00
28	38.00	100.00	8.37	2.756E-05	-2.814E-02	3.553E+00
29	45.00	100.00	11.06	2.756E-05	-2.814E-02	3.553E+00
30	51.00	100.00	13.63	2.756E-05	-2.814E-02	3.553E+00
31	54.00	97.50	15.87	2.756E-05	-2.814E-02	3.553E+00
32	53.00	90.00	18.09	2.756E-05	-2.814E-02	3.553E+00
33	49.00	75.20	20.66	2.756E-05	-2.814E-02	3.553E+00
34	45.00	50.00	22.26	9.186E-06	-9.380E-03	1.184E+00
35	40.00	10.00	22.08	-9.186E-06	9.380E-03	-1.184E+00
36	34.00	2.30	20.58	-2.756E-05	2.814E-02	-3.553E+00
37	27.00	0	18.65	-2.756E-05	2.814E-02	-3.553E+00
38	21.00	2.30	16.50	-2.756E-05	2.814E-02	-3.553E+00
39	16.00	12.00	14.19	-2.756E-05	2.814E-02	-3.553E+00
40	12.00	35.30	11.65	-2.756E-05	2.814E-02	-3.553E+00
41	8.50	4.90	9.16	-2.756E-05	2.814E-02	-3.553E+00
42	5.00	(a)	8.01	-2.756E-05	2.814E-02	-3.553E+00
43	3.00	(a)	6.86	-2.756E-05	2.814E-02	-3.553E+00
44	0	0	3.19	-2.756E-05	2.814E-02	-3.553E+00
45	0	0	0	-2.756E-05	2.814E-02	-3.553E+00
46	0	0	0	-2.756E-05	2.814E-02	-3.553E+00
47	0	0	0	-1.587E-05	1.622E-02	-2.202E+00
48	0	0	0	-4.187E-06	4.310E-03	-8.511E-01
49	0	0	0	7.498E-06	-7.604E-03	5.001E-01
50	0	0	0	7.498E-06	-7.604E-03	5.001E-01

51	3.00	10.00	1.05	7.498E-06	-7.604E-03	5.001E-01
52	11.00	40.20	2.13	7.498E-06	-7.604E-03	5.001E-01
53	20.00	53.00	3.26	7.498E-06	-7.604E-03	5.001E-01
54	27.50	64.80	4.31	7.498E-06	-7.604E-03	5.001E-01
55	32.00	78.00	5.35	7.498E-06	-7.604E-03	5.001E-01
56	32.00	78.00	6.38	7.498E-06	-7.604E-03	5.001E-01
57	27.50	56.00	7.42	7.498E-06	-7.604E-03	5.001E-01
58	26.00	24.40	8.45	7.498E-06	-7.604E-03	5.001E-01
59	24.00	([a])	9.43	7.498E-06	-7.604E-03	5.001E-01
60	23.00	([a])	10.18	7.498E-06	-7.604E-03	5.001E-01
61	24.00	([a])	10.71	7.498E-06	-7.604E-03	5.001E-01
62	27.00	([a])	11.10	7.498E-06	-7.604E-03	5.001E-01
63	34.00	([a])	11.62	7.498E-06	-7.604E-03	5.001E-01
64	44.00	28.00	12.44	7.498E-06	-7.604E-03	5.001E-01
65	57.00	74.40	13.55	7.498E-06	-7.604E-03	5.001E-01
66	60.00	74.40	14.69	7.498E-06	-7.604E-03	5.001E-01
67	53.00	33.60	15.42	7.498E-06	-7.604E-03	5.001E-01
68	48.00	([a])	16.06	7.498E-06	-7.604E-03	5.001E-01
69	44.00	([a])	16.64	7.498E-06	-7.604E-03	5.001E-01
70	40.00	([a])	17.36	8.991E-06	-9.177E-03	2.234E+00
71	40.00	7.00	17.86	1.048E-05	-1.075E-02	3.968E+00
72	44.00	22.70	18.05	1.198E-05	-1.232E-02	5.701E+00
73	46.00	30.00	18.09	1.198E-05	-1.232E-02	5.701E+00
74	46.00	32.00	18.19	1.198E-05	-1.232E-02	5.701E+00
75	44.00	25.00	18.55	1.198E-05	-1.232E-02	5.701E+00
76	40.00	18.00	19.04	1.198E-05	-1.232E-02	5.701E+00
77	37.00	14.00	19.58	1.198E-05	-1.232E-02	5.701E+00
78	36.00	10.00	19.90	1.198E-05	-1.232E-02	5.701E+00
79	34.00	0	19.99	1.198E-05	-1.232E-02	5.701E+00
80	34.00	([a])	19.85	1.198E-05	-1.232E-02	5.701E+00
81	32.00	([a])	19.73	1.198E-05	-1.232E-02	5.701E+00
82	31.00	([a])	19.70	1.198E-05	-1.232E-02	5.701E+00
83	36.00	39.90	19.84	1.198E-05	-1.232E-02	5.701E+00
84	42.00	84.70	20.10	1.198E-05	-1.232E-02	5.701E+00
85	48.00	90.00	20.44	1.198E-05	-1.232E-02	5.701E+00
86	50.00	90.00	20.98	1.198E-05	-1.232E-02	5.701E+00
87	50.00	90.00	21.52	1.198E-05	-1.232E-02	5.701E+00
88	47.00	85.00	22.06	1.198E-05	-1.232E-02	5.701E+00
89	43.00	75.00	22.24	1.198E-05	-1.232E-02	5.701E+00
90	38.00	60.00	22.35	1.198E-05	-1.232E-02	5.701E+00
91	36.00	36.00	22.37	3.992E-06	-4.107E-03	1.900E+00
92	36.00	7.50	22.35	-3.992E-06	4.107E-03	-1.900E+00
93	36.30	([a])	22.27	-1.198E-05	1.232E-02	-5.701E+00

94	45.00	64.50	22.05	-1.198E-05	1.232E-02	-5.701E+00
95	53.00	67.00	21.79	-1.198E-05	1.232E-02	-5.701E+00
96	58.00	64.50	21.50	-1.198E-05	1.232E-02	-5.701E+00
97	62.00	60.30	21.20	-1.198E-05	1.232E-02	-5.701E+00
98	63.00	55.50	20.90	-1.198E-05	1.232E-02	-5.701E+00
99	62.00	52.30	20.59	-1.198E-05	1.232E-02	-5.701E+00
100	61.00	47.00	20.42	-1.198E-05	1.232E-02	-5.701E+00
101	55.00	44.00	20.25	-1.198E-05	1.232E-02	-5.701E+00
102	50.00	39.00	20.07	-1.198E-05	1.232E-02	-5.701E+00
103	45.00	36.00	19.75	-1.198E-05	1.232E-02	-5.701E+00
104	40.00	34.00	19.38	-1.198E-05	1.232E-02	-5.701E+00
105	36.00	30.00	19.00	-1.198E-05	1.232E-02	-5.701E+00
106	34.00	25.80	18.61	-1.198E-05	1.232E-02	-5.701E+00
107	32.00	20.00	18.20	-1.198E-05	1.232E-02	-5.701E+00
108	30.00	14.60	17.75	-1.198E-05	1.232E-02	-5.701E+00
109	26.00	10.00	17.27	-1.198E-05	1.232E-02	-5.701E+00
110	23.00	0	16.75	-1.198E-05	1.232E-02	-5.701E+00
111	18.00	([a])	16.20	-1.198E-05	1.232E-02	-5.701E+00
112	16.00	([a])	15.66	-1.198E-05	1.232E-02	-5.701E+00
113	18.00	([a])	15.15	-1.198E-05	1.232E-02	-5.701E+00
114	20.00	27.60	14.65	-1.198E-05	1.232E-02	-5.701E+00
115	17.00	4.00	14.16	-1.198E-05	1.232E-02	-5.701E+00
116	14.00	([a])	13.67	-1.198E-05	1.232E-02	-5.701E+00
117	12.00	([a])	12.59	-1.198E-05	1.232E-02	-5.701E+00
118	9.00	([a])	10.93	-1.198E-05	1.232E-02	-5.701E+00
119	7.00	([a])	9.28	-1.198E-05	1.232E-02	-5.701E+00
120	7.00	([a])	7.62	-1.198E-05	1.232E-02	-5.701E+00
121	5.00	([a])	5.96	-1.198E-05	1.232E-02	-5.701E+00
122	4.00	([a])	4.30	-1.198E-05	1.232E-02	-5.701E+00
123	3.00	([a])	2.64	-1.198E-05	1.232E-02	-5.701E+00
124	2.00	([a])	0.99	-1.198E-05	1.232E-02	-5.701E+00
125	0	0	0.19	-1.198E-05	1.232E-02	-5.701E+00
126	0	0	0	-1.198E-05	1.232E-02	-5.701E+00
127	0	0	0	-1.198E-05	1.232E-02	-5.701E+00
128	0	0	0	5.354E-07	1.492E-03	-6.315E+00
129	0	0	0	1.305E-05	-9.337E-03	-6.929E+00
130	5.00	8.00	3.25	2.556E-05	-2.017E-02	-7.543E+00
131	8.00	16.30	5.47	2.556E-05	-2.017E-02	-7.543E+00
132	10.00	27.50	6.71	2.556E-05	-2.017E-02	-7.543E+00
133	8.00	27.50	6.71	2.556E-05	-2.017E-02	-7.543E+00
134	5.00	9.00	6.71	2.556E-05	-2.017E-02	-7.543E+00
135	2.00	1.80	6.55	8.520E-06	-6.722E-03	-2.514E+00
136	0	0	6.01	-8.520E-06	6.722E-03	2.514E+00

137	0	0	5.15	-2.556E-05	2.017E-02	7.543E+00
138	0	0	3.90	-2.556E-05	2.017E-02	7.543E+00
139	0	0	2.19	-2.556E-05	2.017E-02	7.543E+00
140	0	0	0	-2.556E-05	2.017E-02	7.543E+00
141	0	0	0	-9.124E-06	5.441E-03	6.132E+00
142	0	0	0	7.313E-06	-9.284E-03	4.722E+00
143	0	0	0	2.375E-05	-2.401E-02	3.312E+00
144	0	0	0	2.375E-05	-2.401E-02	3.312E+00
145	0	0	0	2.375E-05	-2.401E-02	3.312E+00
146	0	0	0	2.375E-05	-2.401E-02	3.312E+00
147	0	0	0	2.375E-05	-2.401E-02	3.312E+00
148	0	0	0	2.375E-05	-2.401E-02	3.312E+00
149	2.00	4.80	0	2.375E-05	-2.401E-02	3.312E+00
150	1.00	4.50	0	2.375E-05	-2.401E-02	3.312E+00
151	0	0	0	2.375E-05	-2.401E-02	3.312E+00
152	0	0	0	2.375E-05	-2.401E-02	3.312E+00
153	0	0	0	2.375E-05	-2.401E-02	3.312E+00
154	0	0	0	2.375E-05	-2.401E-02	3.312E+00
155	0	0	0	2.375E-05	-2.401E-02	3.312E+00
156	0	0	0	2.375E-05	-2.401E-02	3.312E+00
157	0	0	0	2.375E-05	-2.401E-02	3.312E+00
158	0	0	0	2.375E-05	-2.401E-02	3.312E+00
159	0	0	0	2.375E-05	-2.401E-02	3.312E+00
160	0	0	0	2.375E-05	-2.401E-02	3.312E+00
161	0	0	0	2.375E-05	-2.401E-02	3.312E+00
162	0	0	0	2.375E-05	-2.401E-02	3.312E+00
163	0	0	0	2.375E-05	-2.401E-02	3.312E+00
164	0	0	0	2.375E-05	-2.401E-02	3.312E+00
165	0	0	0	2.375E-05	-2.401E-02	3.312E+00
166	0	0	0	2.375E-05	-2.401E-02	3.312E+00
167	8.00	27.00	1.95	2.375E-05	-2.401E-02	3.312E+00
168	18.00	65.00	3.70	2.375E-05	-2.401E-02	3.312E+00
169	23.00	82.50	5.53	2.375E-05	-2.401E-02	3.312E+00
170	23.00	88.00	7.22	2.375E-05	-2.401E-02	3.312E+00
171	21.00	88.00	8.64	2.375E-05	-2.401E-02	3.312E+00
172	18.00	81.30	10.33	2.375E-05	-2.401E-02	3.312E+00
173	17.00	32.00	11.18	7.917E-06	-8.003E-03	1.104E+00
174	15.00	([a])	10.57	-7.917E-06	8.003E-03	-1.104E+00
175	13.00	([a])	9.33	-2.375E-05	2.401E-02	-3.312E+00
176	11.00	([a])	7.87	-2.375E-05	2.401E-02	-3.312E+00
177	8.00	([a])	6.27	-2.375E-05	2.401E-02	-3.312E+00
178	6.00	([a])	4.58	-2.375E-05	2.401E-02	-3.312E+00
179	4.00	([a])	3.81	-2.375E-05	2.401E-02	-3.312E+00

180	2.00	([a])	2.35	-2.375E-05	2.401E-02	-3.312E+00
181	0	0	0	-2.375E-05	2.401E-02	-3.312E+00
182	0	0	0	-2.375E-05	2.401E-02	-3.312E+00
183	0	0	0	-1.078E-05	1.103E-02	-1.145E+00
184	0	0	0	2.190E-06	-1.954E-03	1.022E+00
185	0	0	0	1.516E-05	-1.494E-02	3.189E+00
186	0	0	0	1.516E-05	-1.494E-02	3.189E+00
187	0	0	0	1.516E-05	-1.494E-02	3.189E+00
188	0	0	0	1.516E-05	-1.494E-02	3.189E+00
189	0	0	0	1.516E-05	-1.494E-02	3.189E+00
190	0	0	0	1.516E-05	-1.494E-02	3.189E+00
191	0	0	0	1.516E-05	-1.494E-02	3.189E+00
192	0	0	0	1.516E-05	-1.494E-02	3.189E+00
193	0	0	0	1.516E-05	-1.494E-02	3.189E+00
194	0	0	0	1.516E-05	-1.494E-02	3.189E+00
195	0	0	0	1.516E-05	-1.494E-02	3.189E+00
196	0	0	0	1.516E-05	-1.494E-02	3.189E+00
197	0	0	0	1.516E-05	-1.494E-02	3.189E+00
198	0	0	0	1.516E-05	-1.494E-02	3.189E+00
199	0	0	0	1.516E-05	-1.494E-02	3.189E+00
200	0	0	0	1.516E-05	-1.494E-02	3.189E+00
201	0	0	0	1.516E-05	-1.494E-02	3.189E+00
202	0	0	0	1.516E-05	-1.494E-02	3.189E+00
203	0	0	0	1.516E-05	-1.494E-02	3.189E+00
204	0	4.00	0	1.516E-05	-1.494E-02	3.189E+00
205	0.50	7.70	1.60	1.516E-05	-1.494E-02	3.189E+00
206	5.00	14.00	4.24	1.516E-05	-1.494E-02	3.189E+00
207	11.00	24.70	7.50	1.516E-05	-1.494E-02	3.189E+00
208	15.00	42.30	9.18	1.516E-05	-1.494E-02	3.189E+00
209	16.00	70.00	10.11	1.516E-05	-1.494E-02	3.189E+00
210	17.00	70.00	10.34	1.516E-05	-1.494E-02	3.189E+00
211	17.00	50.00	10.46	1.516E-05	-1.494E-02	3.189E+00
212	16.00	26.30	9.93	1.516E-05	-1.494E-02	3.189E+00
213	14.00	5.00	8.70	1.516E-05	-1.494E-02	3.189E+00
214	10.00	([a])	7.43	1.516E-05	-1.494E-02	3.189E+00
215	10.00	([a])	9.14	1.516E-05	-1.494E-02	3.189E+00
216	14.00	73.30	9.72	1.516E-05	-1.494E-02	3.189E+00
217	18.00	83.00	9.84	1.516E-05	-1.494E-02	3.189E+00
218	19.00	84.80	10.02	1.516E-05	-1.494E-02	3.189E+00
219	18.00	84.80	9.92	5.053E-06	-4.979E-03	1.063E+00
220	16.00	82.80	9.14	-5.053E-06	4.979E-03	-1.063E+00
221	11.00	74.00	8.23	-1.516E-05	1.494E-02	-3.189E+00
222	7.00	8.50	6.64	-1.516E-05	1.494E-02	-3.189E+00

223	4.00	0	4.51	-1.516E-05	1.494E-02	-3.189E+00
224	0	0	0	-1.516E-05	1.494E-02	-3.189E+00
225	0	0	0	-1.516E-05	1.494E-02	-3.189E+00
226	0	0	0	-6.857E-06	6.357E-03	-2.057E+00
227	0	0	0	1.446E-06	-2.223E-03	-9.251E-01
228	0	0	0	9.749E-06	-1.080E-02	2.071E-01
229	0	0	0	9.749E-06	-1.080E-02	2.071E-01
230	0	0	0	9.749E-06	-1.080E-02	2.071E-01
231	0	0	0	9.749E-06	-1.080E-02	2.071E-01
232	0	0	0	9.749E-06	-1.080E-02	2.071E-01
233	6.00	17.60	0	9.749E-06	-1.080E-02	2.071E-01
234	6.00	19.60	0	9.749E-06	-1.080E-02	2.071E-01
235	5.00	14.00	0	9.749E-06	-1.080E-02	2.071E-01
236	3.00	9.80	0	9.749E-06	-1.080E-02	2.071E-01
237	1.00	5.50	0	9.749E-06	-1.080E-02	2.071E-01
238	0	3.00	0	9.749E-06	-1.080E-02	2.071E-01
239	0	0	0	9.749E-06	-1.080E-02	2.071E-01
240	0	0	0	9.749E-06	-1.080E-02	2.071E-01
241	0	0	0	9.749E-06	-1.080E-02	2.071E-01
242	0	0	0	9.749E-06	-1.080E-02	2.071E-01
243	0	0	0	9.749E-06	-1.080E-02	2.071E-01
244	0	0	0	9.749E-06	-1.080E-02	2.071E-01
245	0	0	0	9.749E-06	-1.080E-02	2.071E-01
246	0	0	0	9.749E-06	-1.080E-02	2.071E-01
247	0	0	0	9.749E-06	-1.080E-02	2.071E-01
248	0	0	0	9.749E-06	-1.080E-02	2.071E-01
249	0	0	0	9.749E-06	-1.080E-02	2.071E-01
250	0	0	0	9.749E-06	-1.080E-02	2.071E-01
251	0	0	0	9.749E-06	-1.080E-02	2.071E-01
252	0	0	0	9.749E-06	-1.080E-02	2.071E-01
253	0	0	0	9.749E-06	-1.080E-02	2.071E-01
254	0	0	0	9.749E-06	-1.080E-02	2.071E-01
255	0	0	0	9.749E-06	-1.080E-02	2.071E-01
256	0	0	0	9.749E-06	-1.080E-02	2.071E-01
257	0	0	0	9.749E-06	-1.080E-02	2.071E-01
258	0	0	0	9.749E-06	-1.080E-02	2.071E-01
259	0	0	0	9.749E-06	-1.080E-02	2.071E-01
260	0	0	0	9.749E-06	-1.080E-02	2.071E-01
261	0	0	0	9.749E-06	-1.080E-02	2.071E-01
262	0	0	0	9.749E-06	-1.080E-02	2.071E-01
263	0	0	0	9.749E-06	-1.080E-02	2.071E-01
264	0	0	0	9.749E-06	-1.080E-02	2.071E-01
265	0	0	0	9.749E-06	-1.080E-02	2.071E-01

266	0	0	0	9.749E-06	-1.080E-02	2.071E-01
267	0	0	0	9.749E-06	-1.080E-02	2.071E-01
268	0	0	0	9.749E-06	-1.080E-02	2.071E-01
269	0	0	0	9.749E-06	-1.080E-02	2.071E-01
270	0	0	0	9.749E-06	-1.080E-02	2.071E-01
271	0	0	0	9.749E-06	-1.080E-02	2.071E-01
272	0	0	0	9.749E-06	-1.080E-02	2.071E-01
273	0	0	0	9.749E-06	-1.080E-02	2.071E-01
274	0	0	0	9.749E-06	-1.080E-02	2.071E-01
275	0	0	0	9.749E-06	-1.080E-02	2.071E-01
276	0	0	0	9.749E-06	-1.080E-02	2.071E-01
277	0	0	0	9.749E-06	-1.080E-02	2.071E-01
278	0	0	0	9.749E-06	-1.080E-02	2.071E-01
279	0	0	0	9.749E-06	-1.080E-02	2.071E-01
280	0	0	0	9.749E-06	-1.080E-02	2.071E-01
281	0	7.00	0	9.749E-06	-1.080E-02	2.071E-01
282	1.00	10.00	0	9.749E-06	-1.080E-02	2.071E-01
283	2.00	11.50	0	9.749E-06	-1.080E-02	2.071E-01
284	1.00	10.00	0	9.749E-06	-1.080E-02	2.071E-01
285	0	0	0	9.749E-06	-1.080E-02	2.071E-01
286	0	0	0	9.749E-06	-1.080E-02	2.071E-01
287	0	0	0	9.749E-06	-1.080E-02	2.071E-01
288	0	0	0	9.749E-06	-1.080E-02	2.071E-01
289	0	0	0	9.749E-06	-1.080E-02	2.071E-01
290	0	0	0	9.749E-06	-1.080E-02	2.071E-01
291	0	0	0	9.749E-06	-1.080E-02	2.071E-01
292	0	0	0	9.749E-06	-1.080E-02	2.071E-01
293	0	0	0	9.749E-06	-1.080E-02	2.071E-01
294	0	0	0	9.749E-06	-1.080E-02	2.071E-01
295	0	0	0	9.749E-06	-1.080E-02	2.071E-01
296	0	0	0	9.749E-06	-1.080E-02	2.071E-01
297	0	0	0	9.749E-06	-1.080E-02	2.071E-01
298	0	0	0	9.749E-06	-1.080E-02	2.071E-01
299	0	28.00	0	9.749E-06	-1.080E-02	2.071E-01
300	0	30.00	0	9.749E-06	-1.080E-02	2.071E-01
301	2.00	32.00	0.55	9.749E-06	-1.080E-02	2.071E-01
302	6.00	34.00	1.92	9.749E-06	-1.080E-02	2.071E-01
303	14.00	36.00	3.18	9.749E-06	-1.080E-02	2.071E-01
304	19.00	36.00	4.80	9.749E-06	-1.080E-02	2.071E-01
305	24.50	36.00	6.63	9.749E-06	-1.080E-02	2.071E-01
306	24.50	36.00	7.87	9.749E-06	-1.080E-02	2.071E-01
307	24.00	30.00	8.32	9.749E-06	-1.080E-02	2.071E-01
308	19.00	24.00	9.66	9.749E-06	-1.080E-02	2.071E-01

309	13.00	18.00	11.46	9.749E-06	-1.080E-02	2.071E-01
310	9.00	14.00	13.28	9.749E-06	-1.080E-02	2.071E-01
311	7.00	8.00	14.61	9.749E-06	-1.080E-02	2.071E-01
312	6.00	0	14.39	9.749E-06	-1.080E-02	2.071E-01
313	4.00	3.00	13.50	9.749E-06	-1.080E-02	2.071E-01
314	3.00	6.80	12.41	9.749E-06	-1.080E-02	2.071E-01
315	0	0	11.30	9.749E-06	-1.080E-02	2.071E-01
316	0	0	11.25	9.749E-06	-1.080E-02	2.071E-01
317	0	0	12.29	9.749E-06	-1.080E-02	2.071E-01
318	0	0	13.26	9.749E-06	-1.080E-02	2.071E-01
319	0	0	13.66	9.749E-06	-1.080E-02	2.071E-01
320	0	0	14.27	9.749E-06	-1.080E-02	2.071E-01
321	0	0	15.17	9.749E-06	-1.080E-02	2.071E-01
322	0	0	16.05	9.749E-06	-1.080E-02	2.071E-01
323	0	18.00	16.49	9.749E-06	-1.080E-02	2.071E-01
324	3.00	40.00	17.52	9.749E-06	-1.080E-02	2.071E-01
325	8.00	86.00	18.06	9.749E-06	-1.080E-02	2.071E-01
326	18.00	97.00	18.18	9.749E-06	-1.080E-02	2.071E-01
327	38.00	100.00	18.95	9.749E-06	-1.080E-02	2.071E-01
328	45.50	100.00	20.48	9.749E-06	-1.080E-02	2.071E-01
329	45.00	96.00	20.48	3.250E-06	-3.601E-03	6.902E-02
330	44.00	84.40	19.50	-3.250E-06	3.601E-03	-6.902E-02
331	43.00	53.60	18.43	-9.749E-06	1.080E-02	-2.071E-01
332	41.00	5.00	17.44	-9.749E-06	1.080E-02	-2.071E-01
333	43.00	47.60	16.77	-9.749E-06	1.080E-02	-2.071E-01
334	44.00	90.00	16.36	-9.749E-06	1.080E-02	-2.071E-01
335	45.00	90.00	16.34	-9.749E-06	1.080E-02	-2.071E-01
336	44.00	73.00	16.79	-9.749E-06	1.080E-02	-2.071E-01
337	40.00	54.00	16.34	-9.749E-06	1.080E-02	-2.071E-01
338	38.00	34.70	15.13	-9.749E-06	1.080E-02	-2.071E-01
339	36.00	10.00	13.72	-9.749E-06	1.080E-02	-2.071E-01
340	35.00	10.00	12.04	-9.749E-06	1.080E-02	-2.071E-01
341	35.00	10.00	10.44	-9.749E-06	1.080E-02	-2.071E-01
342	35.50	60.00	9.71	-9.749E-06	1.080E-02	-2.071E-01
343	36.00	57.90	9.81	-9.749E-06	1.080E-02	-2.071E-01
344	37.00	53.00	10.65	-9.749E-06	1.080E-02	-2.071E-01
345	39.00	50.00	11.42	-9.749E-06	1.080E-02	-2.071E-01
346	40.50	50.00	10.54	-9.749E-06	1.080E-02	-2.071E-01
347	43.00	50.00	8.87	-9.749E-06	1.080E-02	-2.071E-01
348	45.00	50.00	9.26	-3.250E-06	3.601E-03	-6.902E-02
349	48.00	50.00	10.33	3.250E-06	-3.601E-03	6.902E-02
350	51.00	52.00	10.79	9.749E-06	-1.080E-02	2.071E-01
351	56.00	58.70	11.80	9.749E-06	-1.080E-02	2.071E-01

352	64.00	70.00	14.06	9.749E-06	-1.080E-02	2.071E-01
353	68.00	70.00	16.77	9.749E-06	-1.080E-02	2.071E-01
354	70.00	70.00	18.83	9.749E-06	-1.080E-02	2.071E-01
355	65.50	64.60	22.12	9.749E-06	-1.080E-02	2.071E-01
356	61.00	28.90	24.10	9.749E-06	-1.080E-02	2.071E-01
357	55.00	([a])	25.97	9.749E-06	-1.080E-02	2.071E-01
358	50.00	([a])	27.04	9.749E-06	-1.080E-02	2.071E-01
359	45.00	([a])	27.18	9.749E-06	-1.080E-02	2.071E-01
360	38.00	([a])	28.34	9.749E-06	-1.080E-02	2.071E-01
361	28.00	([a])	29.69	9.749E-06	-1.080E-02	2.071E-01
362	19.00	([a])	29.86	9.749E-06	-1.080E-02	2.071E-01
363	14.00	([a])	29.51	9.749E-06	-1.080E-02	2.071E-01
364	7.00	([a])	29.91	9.749E-06	-1.080E-02	2.071E-01
365	2.00	([a])	30.99	9.749E-06	-1.080E-02	2.071E-01
366	3.00	5.00	32.55	9.749E-06	-1.080E-02	2.071E-01
367	7.00	25.00	33.43	9.749E-06	-1.080E-02	2.071E-01
368	9.00	38.00	33.56	3.250E-06	-3.601E-03	6.902E-02
369	7.00	17.00	33.36	-3.250E-06	3.601E-03	-6.902E-02
370	4.00	2.00	32.65	-9.749E-06	1.080E-02	-2.071E-01
371	3.00	([a])	31.80	-9.749E-06	1.080E-02	-2.071E-01
372	3.00	([a])	30.92	-9.749E-06	1.080E-02	-2.071E-01
373	11.00	70.00	30.42	-9.749E-06	1.080E-02	-2.071E-01
374	15.00	97.60	29.73	-9.749E-06	1.080E-02	-2.071E-01
375	16.00	100.00	28.65	-9.749E-06	1.080E-02	-2.071E-01
376	19.00	100.00	27.50	-9.749E-06	1.080E-02	-2.071E-01
377	26.00	100.00	26.22	-9.749E-06	1.080E-02	-2.071E-01
378	29.00	95.00	24.69	-9.749E-06	1.080E-02	-2.071E-01
379	25.00	63.00	23.13	-9.749E-06	1.080E-02	-2.071E-01
380	19.00	([a])	21.68	-9.749E-06	1.080E-02	-2.071E-01
381	12.00	([a])	20.25	-9.749E-06	1.080E-02	-2.071E-01
382	8.00	([a])	15.73	-9.749E-06	1.080E-02	-2.071E-01
383	5.00	([a])	10.93	-9.749E-06	1.080E-02	-2.071E-01
384	2.00	([a])	6.12	-9.749E-06	1.080E-02	-2.071E-01
385	1.00	([a])	1.31	-9.749E-06	1.080E-02	-2.071E-01
386	0	0	0	-9.749E-06	1.080E-02	-2.071E-01
387	0	0	0	-9.749E-06	1.080E-02	-2.071E-01
388	0	0	0	-9.749E-06	1.080E-02	-2.071E-01
389	0	0	0	-9.749E-06	1.080E-02	-2.071E-01
390	0	0	0	-9.749E-06	1.080E-02	-2.071E-01
391	0	0	0	-9.749E-06	1.080E-02	-2.071E-01
392	0	0	0	-9.749E-06	1.080E-02	-2.071E-01
393	0	0	0	-1.165E-06	1.625E-03	1.971E+00
394	0	0	0	7.420E-06	-7.553E-03	4.149E+00

395	0	0	0	1.600E-05	-1.673E-02	6.327E+00
396	0	0	0	1.600E-05	-1.673E-02	6.327E+00
397	0	0	0	1.600E-05	-1.673E-02	6.327E+00
398	0	0	0	1.600E-05	-1.673E-02	6.327E+00
399	0	0	0	1.600E-05	-1.673E-02	6.327E+00
400	0	0	0	1.600E-05	-1.673E-02	6.327E+00
401	0	0	0	1.600E-05	-1.673E-02	6.327E+00
402	0	0	0	1.600E-05	-1.673E-02	6.327E+00
403	0	0	0	1.600E-05	-1.673E-02	6.327E+00
404	0	0	0	1.600E-05	-1.673E-02	6.327E+00
405	0	0	0	1.600E-05	-1.673E-02	6.327E+00
406	0	0	0	1.600E-05	-1.673E-02	6.327E+00
407	0	0	0	1.600E-05	-1.673E-02	6.327E+00
408	0	0	0	1.600E-05	-1.673E-02	6.327E+00
409	0	0	0	1.600E-05	-1.673E-02	6.327E+00
410	0	0	0	1.600E-05	-1.673E-02	6.327E+00
411	0	0	0	1.600E-05	-1.673E-02	6.327E+00
412	0	0	0	1.600E-05	-1.673E-02	6.327E+00
413	0	0	0	1.600E-05	-1.673E-02	6.327E+00
414	0	0	0	1.600E-05	-1.673E-02	6.327E+00
415	0	0	0	1.600E-05	-1.673E-02	6.327E+00
416	0	0	0	1.600E-05	-1.673E-02	6.327E+00
417	0	0	0	1.600E-05	-1.673E-02	6.327E+00
418	0	0	0	1.600E-05	-1.673E-02	6.327E+00
419	4.00	20.00	0	1.600E-05	-1.673E-02	6.327E+00
420	4.00	20.00	0	1.600E-05	-1.673E-02	6.327E+00
421	0	0	0	1.600E-05	-1.673E-02	6.327E+00
422	0	0	0	1.600E-05	-1.673E-02	6.327E+00
423	0	0	0	1.600E-05	-1.673E-02	6.327E+00
424	0	0	0	1.600E-05	-1.673E-02	6.327E+00
425	0	0	0	1.600E-05	-1.673E-02	6.327E+00
426	0	0	0	1.600E-05	-1.673E-02	6.327E+00
427	0	0	0	1.600E-05	-1.673E-02	6.327E+00
428	0	0	0	1.600E-05	-1.673E-02	6.327E+00
429	0	0	0	1.600E-05	-1.673E-02	6.327E+00
430	2.00	0	1.18	1.600E-05	-1.673E-02	6.327E+00
431	6.00	2.00	2.85	1.600E-05	-1.673E-02	6.327E+00
432	14.00	28.80	4.57	1.600E-05	-1.673E-02	6.327E+00
433	20.00	30.00	7.42	1.600E-05	-1.673E-02	6.327E+00
434	24.40	11.00	10.79	1.600E-05	-1.673E-02	6.327E+00
435	24.00	10.00	13.51	1.600E-05	-1.673E-02	6.327E+00
436	24.00	12.00	15.48	1.600E-05	-1.673E-02	6.327E+00
437	28.00	52.00	16.82	1.600E-05	-1.673E-02	6.327E+00

438	32.00	52.00	17.86	1.600E-05	-1.673E-02	6.327E+00
439	34.00	46.00	18.70	1.600E-05	-1.673E-02	6.327E+00
440	34.00	30.00	19.11	1.600E-05	-1.673E-02	6.327E+00
441	34.50	30.00	19.28	1.600E-05	-1.673E-02	6.327E+00
442	35.00	30.00	19.38	1.600E-05	-1.673E-02	6.327E+00
443	36.00	35.00	19.53	1.600E-05	-1.673E-02	6.327E+00
444	39.00	40.00	19.57	1.600E-05	-1.673E-02	6.327E+00
445	45.00	50.00	19.09	1.600E-05	-1.673E-02	6.327E+00
446	49.00	56.00	18.20	1.600E-05	-1.673E-02	6.327E+00
447	50.00	(a)	17.14	1.600E-05	-1.673E-02	6.327E+00
448	45.00	(a)	15.90	1.600E-05	-1.673E-02	6.327E+00
449	39.00	(a)	14.42	1.600E-05	-1.673E-02	6.327E+00
450	34.00	(a)	13.86	1.600E-05	-1.673E-02	6.327E+00
451	28.00	(a)	15.45	1.600E-05	-1.673E-02	6.327E+00
452	25.00	(a)	17.32	1.600E-05	-1.673E-02	6.327E+00
453	21.00	(a)	18.03	1.600E-05	-1.673E-02	6.327E+00
454	18.00	(a)	18.19	1.600E-05	-1.673E-02	6.327E+00
455	15.00	(a)	18.30	1.600E-05	-1.673E-02	6.327E+00
456	12.00	(a)	18.40	1.600E-05	-1.673E-02	6.327E+00
457	18.00	(a)	18.33	1.600E-05	-1.673E-02	6.327E+00
458	29.00	19.80	18.68	1.600E-05	-1.673E-02	6.327E+00
459	40.00	54.00	19.10	5.335E-06	-5.577E-03	2.109E+00
460	52.00	82.00	18.69	-5.335E-06	5.577E-03	-2.109E+00
461	64.00	95.00	17.89	-1.600E-05	1.673E-02	-6.327E+00
462	71.00	99.00	17.23	-1.600E-05	1.673E-02	-6.327E+00
463	77.00	100.00	16.65	-1.600E-05	1.673E-02	-6.327E+00
464	84.00	100.00	15.76	-1.600E-05	1.673E-02	-6.327E+00
465	85.00	99.00	14.53	-1.600E-05	1.673E-02	-6.327E+00
466	85.00	95.00	13.07	-1.600E-05	1.673E-02	-6.327E+00
467	84.00	90.00	11.26	-1.600E-05	1.673E-02	-6.327E+00
468	82.00	84.60	9.32	-1.600E-05	1.673E-02	-6.327E+00
469	80.00	78.50	8.04	-1.600E-05	1.673E-02	-6.327E+00
470	78.00	78.50	8.15	-7.218E-06	7.554E-03	-2.785E+00
471	77.00	70.00	9.43	1.567E-06	-1.623E-03	7.568E-01
472	76.00	65.50	10.80	1.035E-05	-1.080E-02	4.299E+00
473	74.00	61.50	12.16	1.035E-05	-1.080E-02	4.299E+00
474	72.00	56.00	14.25	1.035E-05	-1.080E-02	4.299E+00
475	70.00	52.00	16.38	1.035E-05	-1.080E-02	4.299E+00
476	68.00	46.00	17.48	1.035E-05	-1.080E-02	4.299E+00
477	66.50	40.00	17.41	1.035E-05	-1.080E-02	4.299E+00
478	65.00	32.00	16.78	1.035E-05	-1.080E-02	4.299E+00
479	63.00	26.00	16.06	1.035E-05	-1.080E-02	4.299E+00
480	61.00	25.60	15.24	1.035E-05	-1.080E-02	4.299E+00

481	61.00	72.00	14.69	1.035E-05	-1.080E-02	4.299E+00
482	61.00	78.00	15.38	1.035E-05	-1.080E-02	4.299E+00
483	58.00	72.00	16.86	1.035E-05	-1.080E-02	4.299E+00
484	50.00	64.00	17.35	1.035E-05	-1.080E-02	4.299E+00
485	44.00	55.00	16.98	1.035E-05	-1.080E-02	4.299E+00
486	35.00	40.00	16.57	1.035E-05	-1.080E-02	4.299E+00
487	26.00	20.00	16.12	1.035E-05	-1.080E-02	4.299E+00
488	21.00	([a])	15.67	1.035E-05	-1.080E-02	4.299E+00
489	18.00	([a])	15.46	1.035E-05	-1.080E-02	4.299E+00
490	16.00	([a])	15.52	1.035E-05	-1.080E-02	4.299E+00
491	19.00	([a])	15.89	1.035E-05	-1.080E-02	4.299E+00
492	24.00	2.00	16.77	1.035E-05	-1.080E-02	4.299E+00
493	32.00	68.50	18.08	1.035E-05	-1.080E-02	4.299E+00
494	45.00	78.00	19.31	1.035E-05	-1.080E-02	4.299E+00
495	51.00	86.00	20.11	1.035E-05	-1.080E-02	4.299E+00
496	58.00	92.00	20.75	1.035E-05	-1.080E-02	4.299E+00
497	64.00	97.00	21.23	1.035E-05	-1.080E-02	4.299E+00
498	71.00	100.00	21.40	1.035E-05	-1.080E-02	4.299E+00
499	73.00	98.00	21.51	1.035E-05	-1.080E-02	4.299E+00
500	73.00	94.00	22.18	1.035E-05	-1.080E-02	4.299E+00
501	73.00	86.00	22.48	1.035E-05	-1.080E-02	4.299E+00
502	73.00	82.00	22.49	1.035E-05	-1.080E-02	4.299E+00
503	76.00	84.00	23.27	1.035E-05	-1.080E-02	4.299E+00
504	80.00	98.00	24.39	1.035E-05	-1.080E-02	4.299E+00
505	84.00	100.00	25.09	1.035E-05	-1.080E-02	4.299E+00
506	85.00	100.00	25.26	1.035E-05	-1.080E-02	4.299E+00
507	84.00	100.00	25.15	1.035E-05	-1.080E-02	4.299E+00
508	81.00	92.00	24.80	1.035E-05	-1.080E-02	4.299E+00
509	75.00	80.00	24.30	1.035E-05	-1.080E-02	4.299E+00
510	73.00	70.00	23.92	1.035E-05	-1.080E-02	4.299E+00
511	70.00	60.00	23.82	1.035E-05	-1.080E-02	4.299E+00
512	67.00	53.00	23.75	1.035E-05	-1.080E-02	4.299E+00
513	65.00	45.00	24.34	1.035E-05	-1.080E-02	4.299E+00
514	63.00	36.50	25.03	1.035E-05	-1.080E-02	4.299E+00
515	62.00	28.00	25.13	1.035E-05	-1.080E-02	4.299E+00
516	61.00	22.50	25.14	1.035E-05	-1.080E-02	4.299E+00
517	60.00	23.00	25.14	1.035E-05	-1.080E-02	4.299E+00
518	60.00	24.00	25.15	1.035E-05	-1.080E-02	4.299E+00
519	60.00	24.00	25.15	1.035E-05	-1.080E-02	4.299E+00
520	60.00	26.00	25.16	1.035E-05	-1.080E-02	4.299E+00
521	61.00	60.00	25.17	1.035E-05	-1.080E-02	4.299E+00
522	62.00	64.00	25.24	1.035E-05	-1.080E-02	4.299E+00
523	63.00	64.00	25.41	1.035E-05	-1.080E-02	4.299E+00

524	64.00	64.00	26.56	1.035E-05	-1.080E-02	4.299E+00
525	62.00	64.00	28.84	1.035E-05	-1.080E-02	4.299E+00
526	56.00	60.00	31.08	1.035E-05	-1.080E-02	4.299E+00
527	53.00	([a])	32.37	1.035E-05	-1.080E-02	4.299E+00
528	49.00	([a])	32.70	1.035E-05	-1.080E-02	4.299E+00
529	47.00	([a])	32.76	1.035E-05	-1.080E-02	4.299E+00
530	46.00	([a])	32.82	6.288E-06	-6.906E-03	2.331E+00
531	45.00	([a])	32.88	2.223E-06	-3.012E-03	3.623E-01
532	45.00	30.00	33.19	-1.842E-06	8.816E-04	-1.606E+00
533	46.00	50.00	33.89	-1.842E-06	8.816E-04	-1.606E+00
534	46.00	50.00	35.07	-1.842E-06	8.816E-04	-1.606E+00
535	47.00	50.00	36.61	-1.842E-06	8.816E-04	-1.606E+00
536	47.00	50.00	37.63	-1.842E-06	8.816E-04	-1.606E+00
537	47.00	30.00	38.05	-1.842E-06	8.816E-04	-1.606E+00
538	46.00	12.00	38.67	-1.842E-06	8.816E-04	-1.606E+00
539	45.00	10.50	39.32	-1.842E-06	8.816E-04	-1.606E+00
540	44.00	10.00	39.54	-1.842E-06	8.816E-04	-1.606E+00
541	41.00	10.00	39.55	-1.842E-06	8.816E-04	-1.606E+00
542	37.00	9.00	39.56	-1.842E-06	8.816E-04	-1.606E+00
543	36.00	2.00	39.58	-1.842E-06	8.816E-04	-1.606E+00
544	35.00	([a])	39.59	-1.842E-06	8.816E-04	-1.606E+00
545	38.00	67.00	39.61	-1.842E-06	8.816E-04	-1.606E+00
546	35.00	([a])	39.60	-1.842E-06	8.816E-04	-1.606E+00
547	31.00	15.00	39.69	-1.842E-06	8.816E-04	-1.606E+00
548	28.00	55.00	39.99	-1.842E-06	8.816E-04	-1.606E+00
549	34.00	44.00	40.39	-1.842E-06	8.816E-04	-1.606E+00
550	35.00	38.50	41.01	-1.842E-06	8.816E-04	-1.606E+00
551	36.00	38.50	41.65	-1.842E-06	8.816E-04	-1.606E+00
552	36.00	38.50	41.69	-1.842E-06	8.816E-04	-1.606E+00
553	37.00	38.50	41.17	-1.842E-06	8.816E-04	-1.606E+00
554	39.00	36.00	40.47	-1.842E-06	8.816E-04	-1.606E+00
555	42.00	27.00	39.83	-1.842E-06	8.816E-04	-1.606E+00
556	45.00	62.00	39.39	-1.842E-06	8.816E-04	-1.606E+00
557	48.00	45.00	39.14	-1.842E-06	8.816E-04	-1.606E+00
558	51.00	15.00	38.99	-1.842E-06	8.816E-04	-1.606E+00
559	51.00	8.00	38.88	-1.842E-06	8.816E-04	-1.606E+00
560	51.00	6.00	38.86	-1.842E-06	8.816E-04	-1.606E+00
561	48.00	10.00	39.17	-1.842E-06	8.816E-04	-1.606E+00
562	46.00	11.00	39.37	-6.139E-07	2.939E-04	-5.353E-01
563	44.00	13.00	38.63	6.139E-07	-2.939E-04	5.353E-01
564	41.00	17.00	36.96	1.842E-06	-8.816E-04	1.606E+00
565	37.00	20.00	34.87	1.842E-06	-8.816E-04	1.606E+00
566	34.00	20.00	32.73	1.842E-06	-8.816E-04	1.606E+00

567	30.00	17.00	30.53	1.842E-06	-8.816E-04	1.606E+00
568	26.00	14.00	28.27	1.842E-06	-8.816E-04	1.606E+00
569	23.00	7.00	26.02	1.842E-06	-8.816E-04	1.606E+00
570	19.00	2.00	23.76	1.842E-06	-8.816E-04	1.606E+00
571	15.00	([a])	21.37	1.842E-06	-8.816E-04	1.606E+00
572	11.00	([a])	18.79	1.842E-06	-8.816E-04	1.606E+00
573	8.00	([a])	16.06	1.842E-06	-8.816E-04	1.606E+00
574	5.00	([a])	13.05	1.842E-06	-8.816E-04	1.606E+00
575	2.00	([a])	9.54	1.842E-06	-8.816E-04	1.606E+00
576	0	0	4.59	1.842E-06	-8.816E-04	1.606E+00
577	0	0	0	1.842E-06	-8.816E-04	1.606E+00
578	0	0	0	1.842E-06	-8.816E-04	1.606E+00
579	0	0	0	1.842E-06	-8.816E-04	1.606E+00
580	0	0	0	1.842E-06	-8.816E-04	1.606E+00
581	0	0	0	8.289E-06	-7.507E-03	1.023E+00
582	0	0	0	1.474E-05	-1.413E-02	4.394E-01
583	4.00	15.00	0	2.118E-05	-2.076E-02	-1.439E-01
584	19.00	31.00	0.78	2.118E-05	-2.076E-02	-1.439E-01
585	30.00	46.00	1.94	2.118E-05	-2.076E-02	-1.439E-01
586	37.00	68.00	3.83	2.118E-05	-2.076E-02	-1.439E-01
587	40.00	76.00	5.98	2.118E-05	-2.076E-02	-1.439E-01
588	41.00	77.00	8.07	2.118E-05	-2.076E-02	-1.439E-01
589	40.50	78.00	10.09	2.118E-05	-2.076E-02	-1.439E-01
590	40.00	77.00	10.29	2.118E-05	-2.076E-02	-1.439E-01
591	40.00	64.00	7.34	2.118E-05	-2.076E-02	-1.439E-01
592	38.00	10.00	3.27	2.118E-05	-2.076E-02	-1.439E-01
593	38.00	25.00	3.24	2.118E-05	-2.076E-02	-1.439E-01
594	40.00	50.00	5.98	2.118E-05	-2.076E-02	-1.439E-01
595	40.00	36.00	8.48	2.118E-05	-2.076E-02	-1.439E-01
596	40.00	31.00	11.00	2.118E-05	-2.076E-02	-1.439E-01
597	40.00	31.00	13.62	2.118E-05	-2.076E-02	-1.439E-01
598	41.00	37.00	16.07	2.118E-05	-2.076E-02	-1.439E-01
599	42.00	97.00	18.51	2.118E-05	-2.076E-02	-1.439E-01
600	43.00	100.00	21.51	1.588E-05	-1.615E-02	-7.554E-01
601	45.00	100.00	24.71	1.058E-05	-1.153E-02	-1.367E+00
602	47.00	100.00	27.57	5.283E-06	-6.920E-03	-1.978E+00
603	48.00	100.00	30.04	5.283E-06	-6.920E-03	-1.978E+00
604	49.00	100.00	32.22	5.283E-06	-6.920E-03	-1.978E+00
605	51.00	97.00	34.28	5.283E-06	-6.920E-03	-1.978E+00
606	52.00	94.00	36.22	5.283E-06	-6.920E-03	-1.978E+00
607	53.00	90.00	38.08	5.283E-06	-6.920E-03	-1.978E+00
608	54.00	87.00	39.83	5.283E-06	-6.920E-03	-1.978E+00
609	56.00	86.00	41.63	5.283E-06	-6.920E-03	-1.978E+00

610	56.00	85.00	43.18	5.283E-06	-6.920E-03	-1.978E+00
611	55.50	85.00	44.33	5.283E-06	-6.920E-03	-1.978E+00
612	55.00	81.00	45.38	5.283E-06	-6.920E-03	-1.978E+00
613	54.00	77.00	46.14	5.283E-06	-6.920E-03	-1.978E+00
614	53.00	72.00	46.39	5.283E-06	-6.920E-03	-1.978E+00
615	52.00	67.00	46.34	5.283E-06	-6.920E-03	-1.978E+00
616	49.00	60.00	46.24	5.283E-06	-6.920E-03	-1.978E+00
617	46.00	45.00	46.14	5.283E-06	-6.920E-03	-1.978E+00
618	45.00	12.00	46.05	5.283E-06	-6.920E-03	-1.978E+00
619	44.00	10.00	46.13	5.283E-06	-6.920E-03	-1.978E+00
620	44.00	10.00	46.49	5.283E-06	-6.920E-03	-1.978E+00
621	45.00	12.00	46.78	5.283E-06	-6.920E-03	-1.978E+00
622	46.00	14.00	46.81	5.283E-06	-6.920E-03	-1.978E+00
623	47.00	24.00	46.95	5.283E-06	-6.920E-03	-1.978E+00
624	49.00	88.00	47.37	5.283E-06	-6.920E-03	-1.978E+00
625	50.00	90.00	47.62	2.349E-06	-3.713E-03	-1.409E+00
626	51.00	90.00	47.58	-5.848E-07	-5.058E-04	-8.401E-01
627	52.00	90.00	48.00	-3.519E-06	2.701E-03	-2.710E-01
628	53.00	90.00	48.46	-3.519E-06	2.701E-03	-2.710E-01
629	54.00	90.00	48.45	-3.519E-06	2.701E-03	-2.710E-01
630	54.00	90.00	48.40	-3.519E-06	2.701E-03	-2.710E-01
631	54.00	87.00	48.59	-3.519E-06	2.701E-03	-2.710E-01
632	54.00	84.00	49.30	-3.519E-06	2.701E-03	-2.710E-01
633	54.00	80.00	50.02	-3.519E-06	2.701E-03	-2.710E-01
634	53.50	77.00	50.27	-3.519E-06	2.701E-03	-2.710E-01
635	53.00	76.00	50.00	-3.519E-06	2.701E-03	-2.710E-01
636	53.00	75.00	49.73	-3.519E-06	2.701E-03	-2.710E-01
637	52.00	73.00	49.57	-3.519E-06	2.701E-03	-2.710E-01
638	51.00	69.00	49.31	-3.519E-06	2.701E-03	-2.710E-01
639	50.00	65.00	49.29	-3.519E-06	2.701E-03	-2.710E-01
640	50.00	60.00	49.71	-3.519E-06	2.701E-03	-2.710E-01
641	49.00	55.00	50.02	-3.519E-06	2.701E-03	-2.710E-01
642	49.00	50.00	50.05	-3.519E-06	2.701E-03	-2.710E-01
643	49.00	50.00	50.07	-3.519E-06	2.701E-03	-2.710E-01
644	49.50	60.00	50.33	-3.519E-06	2.701E-03	-2.710E-01
645	49.50	65.00	50.75	-3.519E-06	2.701E-03	-2.710E-01
646	50.00	70.00	51.03	-3.519E-06	2.701E-03	-2.710E-01
647	50.50	75.00	51.47	-3.519E-06	2.701E-03	-2.710E-01
648	51.00	80.00	51.92	-3.519E-06	2.701E-03	-2.710E-01
649	52.00	85.00	51.93	-3.519E-06	2.701E-03	-2.710E-01
650	53.00	90.00	51.90	-4.549E-06	3.697E-03	-6.366E-01
651	54.00	90.00	51.87	-5.579E-06	4.693E-03	-1.002E+00
652	55.00	90.00	51.85	-6.609E-06	5.688E-03	-1.368E+00

653	55.00	88.00	51.82	-6.609E-06	5.688E-03	-1.368E+00
654	55.00	84.00	51.82	-6.609E-06	5.688E-03	-1.368E+00
655	55.00	79.00	52.54	-6.609E-06	5.688E-03	-1.368E+00
656	55.00	74.00	53.59	-6.609E-06	5.688E-03	-1.368E+00
657	55.00	69.00	54.19	-6.609E-06	5.688E-03	-1.368E+00
658	55.00	64.00	54.26	-6.609E-06	5.688E-03	-1.368E+00
659	55.00	59.00	54.07	-6.609E-06	5.688E-03	-1.368E+00
660	55.00	54.00	53.93	-6.609E-06	5.688E-03	-1.368E+00
661	55.00	49.00	53.92	-6.609E-06	5.688E-03	-1.368E+00
662	55.00	44.50	53.90	-6.609E-06	5.688E-03	-1.368E+00
663	55.00	39.00	53.89	-6.609E-06	5.688E-03	-1.368E+00
664	55.00	34.00	53.88	-6.609E-06	5.688E-03	-1.368E+00
665	55.00	27.00	53.87	-6.609E-06	5.688E-03	-1.368E+00
666	55.00	18.00	53.85	-6.609E-06	5.688E-03	-1.368E+00
667	55.00	8.00	53.81	-6.609E-06	5.688E-03	-1.368E+00
668	55.00	6.00	53.67	-6.609E-06	5.688E-03	-1.368E+00
669	55.00	13.00	53.67	-6.609E-06	5.688E-03	-1.368E+00
670	55.00	27.00	54.32	-6.609E-06	5.688E-03	-1.368E+00
671	55.50	30.00	54.88	-6.609E-06	5.688E-03	-1.368E+00
672	56.00	30.00	54.87	-6.609E-06	5.688E-03	-1.368E+00
673	57.00	30.00	54.86	-6.609E-06	5.688E-03	-1.368E+00
674	58.00	34.00	54.75	-6.609E-06	5.688E-03	-1.368E+00
675	59.00	46.00	54.28	-5.500E-06	4.582E-03	-7.225E-01
676	59.00	89.00	53.84	-4.390E-06	3.477E-03	-7.706E-02
677	59.00	90.00	54.02	-3.280E-06	2.371E-03	5.683E-01
678	59.00	91.00	54.48	-3.280E-06	2.371E-03	5.683E-01
679	59.00	91.00	54.76	-3.280E-06	2.371E-03	5.683E-01
680	60.00	91.00	54.84	-3.280E-06	2.371E-03	5.683E-01
681	60.00	91.00	54.87	-3.280E-06	2.371E-03	5.683E-01
682	60.50	90.00	54.90	-3.280E-06	2.371E-03	5.683E-01
683	61.00	89.00	54.93	-3.280E-06	2.371E-03	5.683E-01
684	61.50	88.00	54.97	-3.280E-06	2.371E-03	5.683E-01
685	62.00	83.00	55.00	-3.280E-06	2.371E-03	5.683E-01
686	63.00	73.00	55.03	-3.280E-06	2.371E-03	5.683E-01
687	65.00	70.00	55.06	-3.280E-06	2.371E-03	5.683E-01
688	66.00	71.00	55.10	-3.280E-06	2.371E-03	5.683E-01
689	67.00	74.00	55.12	-3.280E-06	2.371E-03	5.683E-01
690	67.50	79.00	55.15	-3.280E-06	2.371E-03	5.683E-01
691	68.00	85.00	55.16	-3.280E-06	2.371E-03	5.683E-01
692	68.50	90.00	55.18	-3.280E-06	2.371E-03	5.683E-01
693	69.00	94.00	55.33	-3.280E-06	2.371E-03	5.683E-01
694	69.50	96.00	55.85	-3.280E-06	2.371E-03	5.683E-01
695	70.00	98.00	56.52	-3.280E-06	2.371E-03	5.683E-01

696	70.50	100.00	57.05	-3.280E-06	2.371E-03	5.683E-01
697	71.00	100.00	57.31	-3.280E-06	2.371E-03	5.683E-01
698	72.00	100.00	57.35	-3.280E-06	2.371E-03	5.683E-01
699	72.00	100.00	57.34	-3.280E-06	2.371E-03	5.683E-01
700	72.00	100.00	57.34	-2.967E-06	2.047E-03	8.641E-01
701	72.00	100.00	57.33	-2.653E-06	1.723E-03	1.160E+00
702	72.00	100.00	57.33	-2.340E-06	1.399E-03	1.456E+00
703	72.00	100.00	57.33	-2.340E-06	1.399E-03	1.456E+00
704	72.00	100.00	57.32	-2.340E-06	1.399E-03	1.456E+00
705	72.00	100.00	57.31	-2.340E-06	1.399E-03	1.456E+00
706	72.00	100.00	57.30	-2.340E-06	1.399E-03	1.456E+00
707	72.50	100.00	57.39	-2.340E-06	1.399E-03	1.456E+00
708	73.00	100.00	57.71	-2.340E-06	1.399E-03	1.456E+00
709	73.50	100.00	58.14	-2.340E-06	1.399E-03	1.456E+00
710	74.00	100.00	58.34	-2.340E-06	1.399E-03	1.456E+00
711	74.00	100.00	58.34	-2.340E-06	1.399E-03	1.456E+00
712	74.50	100.00	58.33	-2.340E-06	1.399E-03	1.456E+00
713	75.00	100.00	58.33	-2.340E-06	1.399E-03	1.456E+00
714	75.00	100.00	58.32	-2.340E-06	1.399E-03	1.456E+00
715	75.00	100.00	58.31	-2.340E-06	1.399E-03	1.456E+00
716	75.00	100.00	58.30	-2.340E-06	1.399E-03	1.456E+00
717	75.00	100.00	58.30	-2.340E-06	1.399E-03	1.456E+00
718	75.00	100.00	58.30	-2.340E-06	1.399E-03	1.456E+00
719	75.00	100.00	58.30	-2.340E-06	1.399E-03	1.456E+00
720	75.00	100.00	58.48	-2.340E-06	1.399E-03	1.456E+00
721	75.00	100.00	58.92	-2.340E-06	1.399E-03	1.456E+00
722	75.00	100.00	59.26	-2.340E-06	1.399E-03	1.456E+00
723	75.00	98.00	59.34	-2.340E-06	1.399E-03	1.456E+00
724	75.00	90.00	59.32	-2.340E-06	1.399E-03	1.456E+00
725	75.00	34.00	59.37	-3.622E-06	2.640E-03	9.220E-01
726	74.00	15.00	59.67	-4.905E-06	3.881E-03	3.883E-01
727	72.00	3.00	60.11	-6.187E-06	5.122E-03	-1.455E-01
728	70.00	([a])	60.32	-6.187E-06	5.122E-03	-1.455E-01
729	69.00	([a])	60.30	-6.187E-06	5.122E-03	-1.455E-01
730	68.00	([a])	60.29	-6.187E-06	5.122E-03	-1.455E-01
731	70.50	53.00	60.27	-6.187E-06	5.122E-03	-1.455E-01
732	73.00	80.00	60.26	-6.187E-06	5.122E-03	-1.455E-01
733	75.00	88.00	60.25	-6.187E-06	5.122E-03	-1.455E-01
734	77.00	94.00	60.18	-6.187E-06	5.122E-03	-1.455E-01
735	79.00	97.00	59.83	-6.187E-06	5.122E-03	-1.455E-01
736	82.00	97.00	59.36	-6.187E-06	5.122E-03	-1.455E-01
737	85.00	98.00	59.65	-6.187E-06	5.122E-03	-1.455E-01
738	85.00	98.00	60.12	-6.187E-06	5.122E-03	-1.455E-01

739	87.00	97.00	59.80	-6.187E-06	5.122E-03	-1.455E-01
740	90.00	95.00	59.82	-6.187E-06	5.122E-03	-1.455E-01
741	92.00	90.00	60.18	-6.187E-06	5.122E-03	-1.455E-01
742	93.00	88.00	60.27	-6.187E-06	5.122E-03	-1.455E-01
743	94.00	86.00	60.31	-6.187E-06	5.122E-03	-1.455E-01
744	95.00	83.00	60.35	-6.187E-06	5.122E-03	-1.455E-01
745	96.00	79.00	60.37	-6.187E-06	5.122E-03	-1.455E-01
746	97.00	74.00	60.35	-6.187E-06	5.122E-03	-1.455E-01
747	98.00	68.00	60.33	-6.187E-06	5.122E-03	-1.455E-01
748	99.00	62.00	60.30	-6.187E-06	5.122E-03	-1.455E-01
749	100.00	54.00	60.26	-6.187E-06	5.122E-03	-1.455E-01
750	100.00	30.00	60.45	-7.791E-06	6.722E-03	-9.485E-01
751	100.00	22.00	61.12	-9.395E-06	8.322E-03	-1.752E+00
752	100.00	20.00	61.91	-1.100E-05	9.923E-03	-2.555E+00
753	100.00	22.00	62.23	-1.100E-05	9.923E-03	-2.555E+00
754	100.00	30.00	62.19	-1.100E-05	9.923E-03	-2.555E+00
755	100.00	65.00	62.17	-1.100E-05	9.923E-03	-2.555E+00
756	100.00	76.00	62.19	-1.100E-05	9.923E-03	-2.555E+00
757	100.00	80.00	62.24	-1.100E-05	9.923E-03	-2.555E+00
758	100.00	78.00	62.28	-1.100E-05	9.923E-03	-2.555E+00
759	100.00	72.00	62.30	-1.100E-05	9.923E-03	-2.555E+00
760	100.00	54.00	62.79	-1.100E-05	9.923E-03	-2.555E+00
761	95.00	30.00	63.22	-1.100E-05	9.923E-03	-2.555E+00
762	85.00	12.00	63.11	-1.100E-05	9.923E-03	-2.555E+00
763	68.00	([a])	62.97	-1.100E-05	9.923E-03	-2.555E+00
764	57.00	([a])	62.82	-1.100E-05	9.923E-03	-2.555E+00
765	56.00	([a])	62.67	-1.100E-05	9.923E-03	-2.555E+00
766	57.00	([a])	62.52	-1.100E-05	9.923E-03	-2.555E+00
767	57.00	([a])	62.37	-1.100E-05	9.923E-03	-2.555E+00
768	57.00	22.00	62.32	-1.100E-05	9.923E-03	-2.555E+00
769	58.00	40.00	62.45	-1.100E-05	9.923E-03	-2.555E+00
770	59.00	45.00	62.64	-1.100E-05	9.923E-03	-2.555E+00
771	59.00	46.00	62.69	-1.100E-05	9.923E-03	-2.555E+00
772	59.50	45.00	62.66	-1.100E-05	9.923E-03	-2.555E+00
773	60.00	33.00	62.62	-1.100E-05	9.923E-03	-2.555E+00
774	60.00	0	62.59	-1.100E-05	9.923E-03	-2.555E+00
775	60.00	([a])	62.55	-1.027E-05	9.176E-03	-2.095E+00
776	60.00	([a])	62.51	-9.541E-06	8.429E-03	-1.636E+00
777	60.00	34.00	62.44	-8.813E-06	7.683E-03	-1.177E+00
778	60.00	50.00	62.37	-8.813E-06	7.683E-03	-1.177E+00
779	60.00	60.00	62.29	-8.813E-06	7.683E-03	-1.177E+00
780	60.00	69.00	62.21	-8.813E-06	7.683E-03	-1.177E+00
781	60.00	75.00	62.15	-8.813E-06	7.683E-03	-1.177E+00

782	60.00	79.00	62.46	-8.813E-06	7.683E-03	-1.177E+00
783	61.00	83.00	63.40	-8.813E-06	7.683E-03	-1.177E+00
784	61.00	84.00	63.97	-8.813E-06	7.683E-03	-1.177E+00
785	61.00	85.00	63.98	-8.813E-06	7.683E-03	-1.177E+00
786	62.00	85.00	63.94	-8.813E-06	7.683E-03	-1.177E+00
787	62.00	85.00	63.93	-8.813E-06	7.683E-03	-1.177E+00
788	62.00	85.00	63.92	-8.813E-06	7.683E-03	-1.177E+00
789	63.00	85.00	63.92	-8.813E-06	7.683E-03	-1.177E+00
790	63.00	85.00	63.91	-8.813E-06	7.683E-03	-1.177E+00
791	64.00	85.00	64.21	-8.813E-06	7.683E-03	-1.177E+00
792	64.00	85.00	64.61	-8.813E-06	7.683E-03	-1.177E+00
793	64.00	85.00	64.50	-8.813E-06	7.683E-03	-1.177E+00
794	64.00	85.00	64.05	-8.813E-06	7.683E-03	-1.177E+00
795	64.00	85.00	63.83	-8.813E-06	7.683E-03	-1.177E+00
796	64.00	84.50	63.81	-8.813E-06	7.683E-03	-1.177E+00
797	64.00	84.00	63.79	-8.813E-06	7.683E-03	-1.177E+00
798	64.00	83.00	63.77	-8.813E-06	7.683E-03	-1.177E+00
799	64.00	82.00	63.76	-8.813E-06	7.683E-03	-1.177E+00
800	64.00	81.00	63.75	-8.873E-06	7.725E-03	-1.104E+00
801	64.00	77.00	63.73	-8.933E-06	7.767E-03	-1.032E+00
802	64.00	72.00	63.72	-8.993E-06	7.810E-03	-9.592E-01
803	65.00	67.00	63.70	-8.993E-06	7.810E-03	-9.592E-01
804	66.00	64.00	63.69	-8.993E-06	7.810E-03	-9.592E-01
805	67.00	60.00	63.69	-8.993E-06	7.810E-03	-9.592E-01
806	69.00	62.30	63.68	-8.993E-06	7.810E-03	-9.592E-01
807	72.00	84.00	64.10	-8.993E-06	7.810E-03	-9.592E-01
808	73.00	90.50	64.60	-8.993E-06	7.810E-03	-9.592E-01
809	74.00	91.00	64.73	-8.993E-06	7.810E-03	-9.592E-01
810	74.00	90.00	64.73	-8.993E-06	7.810E-03	-9.592E-01
811	74.00	84.50	64.73	-8.993E-06	7.810E-03	-9.592E-01
812	73.00	74.00	64.72	-8.993E-06	7.810E-03	-9.592E-01
813	72.00	66.00	64.71	-8.993E-06	7.810E-03	-9.592E-01
814	71.00	60.00	64.71	-8.993E-06	7.810E-03	-9.592E-01
815	70.00	54.00	64.70	-8.993E-06	7.810E-03	-9.592E-01
816	69.00	50.00	64.69	-8.993E-06	7.810E-03	-9.592E-01
817	68.00	49.00	64.68	-8.993E-06	7.810E-03	-9.592E-01
818	68.00	48.00	64.82	-8.993E-06	7.810E-03	-9.592E-01
819	68.00	48.00	65.27	-8.993E-06	7.810E-03	-9.592E-01
820	68.00	48.50	65.65	-8.993E-06	7.810E-03	-9.592E-01
821	68.00	49.00	65.71	-8.993E-06	7.810E-03	-9.592E-01
822	68.00	51.00	65.72	-8.993E-06	7.810E-03	-9.592E-01
823	68.00	53.50	65.72	-8.993E-06	7.810E-03	-9.592E-01
824	68.00	55.00	65.72	-8.993E-06	7.810E-03	-9.592E-01

825	68.00	58.00	65.71	-8.993E-06	7.810E-03	-9.592E-01
826	68.00	60.00	65.70	-8.993E-06	7.810E-03	-9.592E-01
827	68.00	62.00	65.69	-8.993E-06	7.810E-03	-9.592E-01
828	68.00	64.00	65.67	-8.993E-06	7.810E-03	-9.592E-01
829	68.00	67.00	65.27	-8.993E-06	7.810E-03	-9.592E-01
830	69.00	68.50	64.33	-8.993E-06	7.810E-03	-9.592E-01
831	70.00	70.00	63.65	-8.993E-06	7.810E-03	-9.592E-01
832	70.00	70.00	63.50	-8.993E-06	7.810E-03	-9.592E-01
833	70.00	70.00	63.49	-8.993E-06	7.810E-03	-9.592E-01
834	70.00	70.00	63.49	-8.993E-06	7.810E-03	-9.592E-01
835	70.00	70.00	63.37	-8.993E-06	7.810E-03	-9.592E-01
836	70.00	70.00	63.01	-8.993E-06	7.810E-03	-9.592E-01
837	71.00	66.00	62.60	-8.993E-06	7.810E-03	-9.592E-01
838	73.00	64.00	62.44	-8.993E-06	7.810E-03	-9.592E-01
839	75.00	64.00	62.45	-8.993E-06	7.810E-03	-9.592E-01
840	77.00	98.00	62.47	-5.933E-06	4.759E-03	5.464E-01
841	79.00	100.00	62.50	-2.873E-06	1.709E-03	2.052E+00
842	81.00	100.00	62.52	1.865E-07	-1.342E-03	3.558E+00
843	82.00	100.00	62.54	1.865E-07	-1.342E-03	3.558E+00
844	83.00	100.00	62.57	1.865E-07	-1.342E-03	3.558E+00
845	84.00	98.00	62.70	1.865E-07	-1.342E-03	3.558E+00
846	84.00	94.00	62.90	1.865E-07	-1.342E-03	3.558E+00
847	85.00	93.00	63.11	1.865E-07	-1.342E-03	3.558E+00
848	86.00	94.00	63.32	1.865E-07	-1.342E-03	3.558E+00
849	87.00	98.00	63.53	1.865E-07	-1.342E-03	3.558E+00
850	89.00	100.00	63.74	1.865E-07	-1.342E-03	3.558E+00
851	92.00	100.00	62.20	1.865E-07	-1.342E-03	3.558E+00
852	95.00	100.00	62.67	1.865E-07	-1.342E-03	3.558E+00
853	97.50	100.00	63.19	1.865E-07	-1.342E-03	3.558E+00
854	100.00	100.00	63.62	1.865E-07	-1.342E-03	3.558E+00
855	100.00	100.00	64.06	1.865E-07	-1.342E-03	3.558E+00
856	100.00	100.00	64.19	6.218E-08	-4.474E-04	1.186E+00
857	100.00	100.00	63.87	-6.218E-08	4.474E-04	-1.186E+00
858	100.00	97.00	63.38	-1.865E-07	1.342E-03	-3.558E+00
859	96.00	([a])	62.62	-1.865E-07	1.342E-03	-3.558E+00
860	94.00	([a])	61.32	-1.865E-07	1.342E-03	-3.558E+00
861	91.00	([a])	59.72	-1.865E-07	1.342E-03	-3.558E+00
862	88.00	([a])	58.30	-1.865E-07	1.342E-03	-3.558E+00
863	86.00	([a])	57.08	-1.865E-07	1.342E-03	-3.558E+00
864	84.00	([a])	55.85	-1.865E-07	1.342E-03	-3.558E+00
865	82.00	([a])	54.61	-1.865E-07	1.342E-03	-3.558E+00
866	79.00	([a])	53.36	-1.865E-07	1.342E-03	-3.558E+00
867	77.00	([a])	52.10	-1.865E-07	1.342E-03	-3.558E+00

868	75.00	([a])	50.74	-1.865E-07	1.342E-03	-3.558E+00
869	73.00	([a])	49.34	-1.865E-07	1.342E-03	-3.558E+00
870	72.00	([a])	48.05	-1.865E-07	1.342E-03	-3.558E+00
871	72.00	([a])	46.82	-1.865E-07	1.342E-03	-3.558E+00
872	72.00	([a])	45.61	-1.865E-07	1.342E-03	-3.558E+00
873	71.00	8.00	44.37	-1.865E-07	1.342E-03	-3.558E+00
874	68.00	9.00	43.06	-1.865E-07	1.342E-03	-3.558E+00
875	64.00	([a])	41.65	-1.865E-07	1.342E-03	-3.558E+00
876	58.00	([a])	40.32	-1.865E-07	1.342E-03	-3.558E+00
877	56.00	53.00	39.28	-1.865E-07	1.342E-03	-3.558E+00
878	56.00	67.00	38.40	-1.865E-07	1.342E-03	-3.558E+00
879	56.00	70.00	37.30	-1.865E-07	1.342E-03	-3.558E+00
880	56.00	67.00	35.79	-1.865E-07	1.342E-03	-3.558E+00
881	55.00	60.00	34.14	-1.865E-07	1.342E-03	-3.558E+00
882	54.00	60.00	32.69	-1.865E-07	1.342E-03	-3.558E+00
883	49.00	75.00	31.38	-1.865E-07	1.342E-03	-3.558E+00
884	38.00	80.00	29.63	-1.865E-07	1.342E-03	-3.558E+00
885	30.00	78.00	27.22	-1.865E-07	1.342E-03	-3.558E+00
886	25.00	53.00	25.01	-1.865E-07	1.342E-03	-3.558E+00
887	18.00	32.00	23.09	-1.865E-07	1.342E-03	-3.558E+00
888	14.00	16.00	20.23	-1.865E-07	1.342E-03	-3.558E+00
889	9.00	3.00	17.20	-1.865E-07	1.342E-03	-3.558E+00
890	5.00	([a])	12.61	-1.865E-07	1.342E-03	-3.558E+00
891	1.00	([a])	7.43	-1.865E-07	1.342E-03	-3.558E+00
892	0	0	2.81	-1.865E-07	1.342E-03	-3.558E+00
893	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
894	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
895	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
896	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
987	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
898	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
899	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
900	0	0	0	-1.865E-07	1.342E-03	-3.558E+00
901	0	0	0	8.801E-06	-7.855E-03	-7.493E-01
902	0	0	0	1.779E-05	-1.705E-02	2.059E+00
903	0	0	0	2.678E-05	-2.625E-02	4.867E+00
904	0	0	0	2.678E-05	-2.625E-02	4.867E+00
905	0	0	0	2.678E-05	-2.625E-02	4.867E+00
906	0	0	0	2.678E-05	-2.625E-02	4.867E+00
907	0	0	0	2.678E-05	-2.625E-02	4.867E+00
908	0	0	0	2.678E-05	-2.625E-02	4.867E+00
909	0	0	0	2.678E-05	-2.625E-02	4.867E+00
910	0	0	0	2.678E-05	-2.625E-02	4.867E+00

911	0	0	0	2.678E-05	-2.625E-02	4.867E+00
912	0	0	0	2.678E-05	-2.625E-02	4.867E+00
913	0	0	0	2.678E-05	-2.625E-02	4.867E+00
914	0	0	0	2.678E-05	-2.625E-02	4.867E+00
915	0	0	0	2.678E-05	-2.625E-02	4.867E+00
916	0	0	0	2.678E-05	-2.625E-02	4.867E+00
917	0	0	0	2.678E-05	-2.625E-02	4.867E+00
918	0	0	0	2.678E-05	-2.625E-02	4.867E+00
919	0	0	0	2.678E-05	-2.625E-02	4.867E+00
920	4.50	47.00	2.63	2.678E-05	-2.625E-02	4.867E+00
921	12.00	85.00	4.93	2.678E-05	-2.625E-02	4.867E+00
922	30.00	97.00	7.24	2.678E-05	-2.625E-02	4.867E+00
923	42.00	100.00	9.73	2.678E-05	-2.625E-02	4.867E+00
924	51.00	100.00	11.91	2.678E-05	-2.625E-02	4.867E+00
925	54.00	100.00	14.16	2.678E-05	-2.625E-02	4.867E+00
926	54.00	97.00	16.04	2.678E-05	-2.625E-02	4.867E+00
927	52.00	90.00	17.98	2.678E-05	-2.625E-02	4.867E+00
928	48.00	75.00	20.21	2.678E-05	-2.625E-02	4.867E+00
929	44.00	57.00	22.03	2.678E-05	-2.625E-02	4.867E+00
930	37.00	47.00	22.35	8.925E-06	-8.749E-03	1.622E+00
931	29.00	40.00	21.52	-8.925E-06	8.749E-03	-1.622E+00
932	24.00	34.00	20.04	-2.678E-05	2.625E-02	-4.867E+00
933	21.00	27.00	18.29	-2.678E-05	2.625E-02	-4.867E+00
934	22.00	24.00	16.40	-2.678E-05	2.625E-02	-4.867E+00
935	22.50	22.00	14.40	-2.678E-05	2.625E-02	-4.867E+00
936	20.00	16.00	12.23	-2.678E-05	2.625E-02	-4.867E+00
937	15.00	7.00	9.84	-2.678E-05	2.625E-02	-4.867E+00
938	10.00	0	8.55	-2.678E-05	2.625E-02	-4.867E+00
939	5.00	([a])	7.56	-2.678E-05	2.625E-02	-4.867E+00
940	2.00	([a])	6.14	-2.678E-05	2.625E-02	-4.867E+00
941	1.00	([a])	2.60	-2.678E-05	2.625E-02	-4.867E+00
942	0	0	0	-2.678E-05	2.625E-02	-4.867E+00
943	0	0	0	-2.678E-05	2.625E-02	-4.867E+00
944	0	0	0	-1.658E-05	1.607E-02	-3.386E+00
945	1.00	0	1.06	-6.376E-06	5.889E-03	-1.905E+00
946	5.00	20.00	2.16	3.823E-06	-4.291E-03	-4.241E-01
947	15.00	43.00	3.30	3.823E-06	-4.291E-03	-4.241E-01
948	28.00	52.00	4.37	3.823E-06	-4.291E-03	-4.241E-01
949	34.00	64.00	5.42	3.823E-06	-4.291E-03	-4.241E-01
950	37.00	74.00	6.47	3.823E-06	-4.291E-03	-4.241E-01
951	37.50	90.00	7.51	3.823E-06	-4.291E-03	-4.241E-01
952	37.00	56.00	8.55	3.823E-06	-4.291E-03	-4.241E-01
953	36.00	27.00	9.55	3.823E-06	-4.291E-03	-4.241E-01

954	35.00	([a])	10.25	3.823E-06	-4.291E-03	-4.241E-01
955	33.00	([a])	10.78	3.823E-06	-4.291E-03	-4.241E-01
956	29.00	([a])	11.16	3.823E-06	-4.291E-03	-4.241E-01
957	29.00	([a])	11.76	3.823E-06	-4.291E-03	-4.241E-01
958	29.00	([a])	12.59	3.823E-06	-4.291E-03	-4.241E-01
959	34.00	30.00	13.80	3.823E-06	-4.291E-03	-4.241E-01
960	38.00	75.00	14.85	3.823E-06	-4.291E-03	-4.241E-01
961	34.00	70.00	15.59	3.823E-06	-4.291E-03	-4.241E-01
962	31.00	25.00	16.20	3.823E-06	-4.291E-03	-4.241E-01
963	28.00	([a])	16.82	3.823E-06	-4.291E-03	-4.241E-01
964	26.00	([a])	17.55	3.823E-06	-4.291E-03	-4.241E-01
965	24.00	([a])	17.91	3.823E-06	-4.291E-03	-4.241E-01
966	23.00	4.00	18.08	3.823E-06	-4.291E-03	-4.241E-01
967	23.00	22.00	18.10	3.823E-06	-4.291E-03	-4.241E-01
968	24.00	30.00	18.31	3.823E-06	-4.291E-03	-4.241E-01
969	23.00	32.00	18.67	3.823E-06	-4.291E-03	-4.241E-01
970	22.00	25.00	19.23	7.198E-06	-7.629E-03	2.015E+00
971	18.00	18.00	19.69	1.057E-05	-1.097E-02	4.453E+00
972	16.00	14.00	20.02	1.395E-05	-1.430E-02	6.892E+00
973	15.00	10.00	19.94	1.395E-05	-1.430E-02	6.892E+00
974	15.00	0.0	19.80	1.395E-05	-1.430E-02	6.892E+00
975	15.00	([a])	19.69	1.395E-05	-1.430E-02	6.892E+00
976	15.00	([a])	19.76	1.395E-05	-1.430E-02	6.892E+00
977	18.00	([a])	19.93	1.395E-05	-1.430E-02	6.892E+00
978	25.00	40.00	20.24	1.395E-05	-1.430E-02	6.892E+00
979	37.00	90.00	20.69	1.395E-05	-1.430E-02	6.892E+00
980	46.00	90.00	21.23	1.395E-05	-1.430E-02	6.892E+00
981	49.00	90.00	21.78	1.395E-05	-1.430E-02	6.892E+00
982	49.00	90.00	22.15	1.395E-05	-1.430E-02	6.892E+00
983	49.00	85.00	22.33	1.395E-05	-1.430E-02	6.892E+00
984	47.00	77.00	22.36	1.395E-05	-1.430E-02	6.892E+00
985	44.00	59.00	22.36	4.650E-06	-4.768E-03	2.297E+00
986	43.00	36.00	22.33	-4.650E-06	4.768E-03	-2.297E+00
987	42.00	13.00	22.15	-1.395E-05	1.430E-02	-6.892E+00
988	40.00	([a])	21.91	-1.395E-05	1.430E-02	-6.892E+00
989	41.00	65.00	21.62	-1.395E-05	1.430E-02	-6.892E+00
990	44.00	65.00	21.32	-1.395E-05	1.430E-02	-6.892E+00
991	45.00	65.00	21.01	-1.395E-05	1.430E-02	-6.892E+00
992	45.00	62.00	20.70	-1.395E-05	1.430E-02	-6.892E+00
993	44.00	56.00	20.48	-1.395E-05	1.430E-02	-6.892E+00
994	42.00	46.00	20.31	-1.395E-05	1.430E-02	-6.892E+00
995	41.00	36.00	20.13	-1.395E-05	1.430E-02	-6.892E+00
996	39.00	20.00	19.86	-1.395E-05	1.430E-02	-6.892E+00

997	38.00	4.00	19.49	-1.395E-05	1.430E-02	-6.892E+00
998	37.00	33.00	19.11	-1.395E-05	1.430E-02	-6.892E+00
999	38.00	39.00	18.71	-1.395E-05	1.430E-02	-6.892E+00
1,000	36.00	40.00	18.30	-1.395E-05	1.430E-02	-6.892E+00
1,001	35.00	40.00	17.86	-1.395E-05	1.430E-02	-6.892E+00
1,002	33.00	39.00	17.39	-1.395E-05	1.430E-02	-6.892E+00
1,003	30.00	36.00	16.86	-1.395E-05	1.430E-02	-6.892E+00
1,004	27.00	33.00	16.31	-1.395E-05	1.430E-02	-6.892E+00
1,005	22.00	24.00	15.75	-1.395E-05	1.430E-02	-6.892E+00
1,006	21.00	([a])	15.24	-1.395E-05	1.430E-02	-6.892E+00
1,007	20.00	([a])	14.73	-1.395E-05	1.430E-02	-6.892E+00
1,008	18.00	([a])	14.23	-1.395E-05	1.430E-02	-6.892E+00
1,009	17.00	28.00	13.73	-1.395E-05	1.430E-02	-6.892E+00
1,010	16.00	5.00	12.79	-1.395E-05	1.430E-02	-6.892E+00
1,011	14.00	([a])	11.11	-1.395E-05	1.430E-02	-6.892E+00
1,012	12.00	([a])	9.43	-1.395E-05	1.430E-02	-6.892E+00
1,013	9.00	([a])	7.75	-1.395E-05	1.430E-02	-6.892E+00
1,014	7.00	([a])	6.07	-1.395E-05	1.430E-02	-6.892E+00
1,015	5.00	([a])	4.39	-4.650E-06	4.768E-03	-2.297E+00
1,016	4.00	([a])	2.71	4.650E-06	-4.768E-03	2.297E+00
1,017	3.00	([a])	1.03	1.395E-05	-1.430E-02	6.892E+00
1,018	2.00	([a])	0.19	1.395E-05	-1.430E-02	6.892E+00
1,019	0	0	0	1.395E-05	-1.430E-02	6.892E+00
1,020	0	0	0	1.395E-05	-1.430E-02	6.892E+00
1,021	0	0	0	1.458E-05	-1.532E-02	5.630E+00
1,022	0	0	0	1.520E-05	-1.634E-02	4.368E+00
1,023	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,024	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,025	2.00	7.00	3.25	1.583E-05	-1.736E-02	3.105E+00
1,026	6.00	15.00	5.47	1.583E-05	-1.736E-02	3.105E+00
1,027	10.00	28.00	6.71	1.583E-05	-1.736E-02	3.105E+00
1,028	11.00	26.00	6.71	1.583E-05	-1.736E-02	3.105E+00
1,029	10.00	10.00	6.71	5.277E-06	-5.787E-03	1.035E+00
1,030	8.00	3.00	6.55	-5.277E-06	5.787E-03	-1.035E+00
1,031	5.00	0	6.01	-1.583E-05	1.736E-02	-3.105E+00
1,032	2.00	0	5.15	-1.583E-05	1.736E-02	-3.105E+00
1,033	0	0	3.90	-1.583E-05	1.736E-02	-3.105E+00
1,034	0	0	2.19	-1.583E-05	1.736E-02	-3.105E+00
1,035	0	0	0	-5.277E-06	5.787E-03	-1.035E+00
1,036	0	0	0	5.277E-06	-5.787E-03	1.035E+00
1,037	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,038	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,039	0	0	0	1.583E-05	-1.736E-02	3.105E+00

1,040	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,041	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,042	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,043	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,044	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,045	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,046	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,047	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,048	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,049	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,050	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,051	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,052	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,053	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,054	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,055	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,056	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,057	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,058	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,059	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,060	0	0	0	1.583E-05	-1.736E-02	3.105E+00
1,061	4.00	5.00	1.95	1.583E-05	-1.736E-02	3.105E+00
1,062	11.00	35.00	3.70	1.583E-05	-1.736E-02	3.105E+00
1,063	21.00	73.00	5.53	1.583E-05	-1.736E-02	3.105E+00
1,064	25.00	86.00	7.22	1.583E-05	-1.736E-02	3.105E+00
1,065	26.00	90.00	8.64	1.583E-05	-1.736E-02	3.105E+00
1,066	25.00	90.00	10.33	1.583E-05	-1.736E-02	3.105E+00
1,067	23.00	83.00	11.18	5.277E-06	-5.787E-03	1.035E+00
1,068	20.00	32.00	10.57	-5.277E-06	5.787E-03	-1.035E+00
1,069	16.00	([a])	9.33	-1.583E-05	1.736E-02	-3.105E+00
1,070	14.00	([a])	7.87	-1.583E-05	1.736E-02	-3.105E+00
1,071	10.00	([a])	6.27	-1.583E-05	1.736E-02	-3.105E+00
1,072	7.00	([a])	4.58	-1.583E-05	1.736E-02	-3.105E+00
1,073	3.00	([a])	3.81	-1.583E-05	1.736E-02	-3.105E+00
1,074	1.00	([a])	2.35	-1.583E-05	1.736E-02	-3.105E+00
1,075	0	0	0	-1.583E-05	1.736E-02	-3.105E+00
1,076	0	0	0	-6.540E-06	7.597E-03	-2.563E+00
1,077	0	0	0	2.749E-06	-2.167E-03	-2.021E+00
1,078	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,079	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,080	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,081	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,082	0	0	0	1.204E-05	-1.193E-02	-1.480E+00

1,083	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,084	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,085	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,086	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,087	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,088	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,089	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,090	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,091	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,092	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,093	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,094	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,095	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,096	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,097	0	0	0	1.204E-05	-1.193E-02	-1.480E+00
1,098	1.00	3.00	1.35	1.204E-05	-1.193E-02	-1.480E+00
1,099	3.00	6.00	3.37	1.204E-05	-1.193E-02	-1.480E+00
1,100	6.00	13.00	6.40	1.204E-05	-1.193E-02	-1.480E+00
1,101	9.00	14.00	8.47	1.204E-05	-1.193E-02	-1.480E+00
1,102	12.00	16.00	9.57	1.204E-05	-1.193E-02	-1.480E+00
1,103	15.00	28.00	10.19	1.204E-05	-1.193E-02	-1.480E+00
1,104	18.00	60.00	10.35	1.204E-05	-1.193E-02	-1.480E+00
1,105	20.00	47.00	10.46	1.204E-05	-1.193E-02	-1.480E+00
1,106	21.00	31.00	10.11	1.204E-05	-1.193E-02	-1.480E+00
1,107	21.00	15.00	9.12	1.204E-05	-1.193E-02	-1.480E+00
1,108	20.00	([a])	7.81	1.133E-05	-1.140E-02	1.667E-01
1,109	20.00	([a])	7.87	1.062E-05	-1.087E-02	1.813E+00
1,110	20.00	([a])	9.57	9.917E-06	-1.035E-02	3.459E+00
1,111	20.00	70.00	9.75	9.917E-06	-1.035E-02	3.459E+00
1,112	21.00	83.00	9.84	9.917E-06	-1.035E-02	3.459E+00
1,113	22.00	84.00	9.96	9.917E-06	-1.035E-02	3.459E+00
1,114	22.00	83.00	10.13	3.306E-06	-3.449E-03	1.153E+00
1,115	18.00	78.00	9.36	-3.306E-06	3.449E-03	-1.153E+00
1,116	14.00	68.00	8.80	-9.917E-06	1.035E-02	-3.459E+00
1,117	8.00	10.00	7.67	-9.917E-06	1.035E-02	-3.459E+00
1,118	4.00	4.00	6.08	-9.917E-06	1.035E-02	-3.459E+00
1,119	1.00	0.0	4.03	-9.917E-06	1.035E-02	-3.459E+00
1,120	0	0	0	-3.306E-06	3.449E-03	-1.153E+00
1,121	0	0	0	3.306E-06	-3.449E-03	1.153E+00
1,122	0	0	0	9.917E-06	-1.035E-02	3.459E+00
1,123	0	0	0	9.917E-06	-1.035E-02	3.459E+00
1,124	0	0	0	9.917E-06	-1.035E-02	3.459E+00
1,125	0	1.00	0	9.917E-06	-1.035E-02	3.459E+00

1,126	1.00	5.00	3.25	9.917E-06	-1.035E-02	3.459E+00
1,127	5.00	18.00	5.47	9.917E-06	-1.035E-02	3.459E+00
1,128	9.00	19.00	6.71	9.917E-06	-1.035E-02	3.459E+00
1,129	12.00	18.00	6.71	9.917E-06	-1.035E-02	3.459E+00
1,130	12.00	15.00	6.71	9.917E-06	-1.035E-02	3.459E+00
1,131	9.00	10.00	6.55	9.917E-06	-1.035E-02	3.459E+00
1,132	5.00	5.00	6.01	9.917E-06	-1.035E-02	3.459E+00
1,133	2.00	2.00	5.15	9.917E-06	-1.035E-02	3.459E+00
1,134	0	0	3.90	9.917E-06	-1.035E-02	3.459E+00
1,135	0	0	2.19	9.917E-06	-1.035E-02	3.459E+00
1,136	0	0	0	6.611E-06	-6.897E-03	2.306E+00
1,137	0	0	0	3.306E-06	-3.449E-03	1.153E+00
1,138	0	0	0	0	0	0
1,139	0	0	0	0	0	0
1,140	0	0	0	0	0	0
1,141	0	0	0	0	0	0
1,142	0	0	0	0	0	0
1,143	0	0	0	0	0	0
1,144	0	0	0	0	0	0
1,145	0	0	0	0	0	0
1,146	0	0	0	0	0	0
1,147	0	0	0	0	0	0
1,148	0	0	0	0	0	0
1,149	0	0	0	0	0	0
1,150	0	0	0	0	0	0
1,151	0	0	0	0	0	0
1,152	0	0	0	0	0	0
1,153	0	0	0	0	0	0
1,154	0	0	0	0	0	0
1,155	0	0	0	0	0	0
1,156	0	0	0	0	0	0
1,157	0	0	0	0	0	0
1,158	0	0	0	0	0	0
1,159	0	0	0	0	0	0
1,160	0	0	0	0	0	0
1,161	0	0	0	0	0	0
1,162	0	0	0	0	0	0
1,163	0	0	0	0	0	0
1,164	0	0	0	0	0	0
1,165	0	0	0	0	0	0
1,166	0	0	0	0	0	0
1,167	0	0	0	0	0	0

[a]Closed throttle motoring.

(c) The following transient duty cycle applies for compression-ignition engines and powertrains:

Record (seconds)	Engine testing		Powertrain testing			
	Normalized revolutions per minute (percent)	Normalized torque (percent)	Vehicle speed (mi/hr)	Road grade coefficients		
				a	*b*	*c*
1	0	0	0	0	0	0
2	0	0	0	1.248E-05	-1.073E-02	1.064E+00
3	0	0	0	1.872E-05	-1.609E-02	1.596E+00
4	0	0	0	1.872E-05	-1.609E-02	1.596E+00
5	0	0	0	1.872E-05	-1.609E-02	1.596E+00
6	0	0	0	1.872E-05	-1.609E-02	1.596E+00
7	0	0	0	1.872E-05	-1.609E-02	1.596E+00
8	0	0	0	1.872E-05	-1.609E-02	1.596E+00
9	0	0	0	1.872E-05	-1.609E-02	1.596E+00
10	0	0	0	1.872E-05	-1.609E-02	1.596E+00
11	0	0	0	1.872E-05	-1.609E-02	1.596E+00
12	0	0	0	1.872E-05	-1.609E-02	1.596E+00
13	0	0	0	1.872E-05	-1.609E-02	1.596E+00
14	0	0	0	1.872E-05	-1.609E-02	1.596E+00
15	0	0	0	1.872E-05	-1.609E-02	1.596E+00
16	0	0	0	1.872E-05	-1.609E-02	1.596E+00
17	0	0	0	1.872E-05	-1.609E-02	1.596E+00
18	0	0	0	1.872E-05	-1.609E-02	1.596E+00
19	0	0	0	1.872E-05	-1.609E-02	1.596E+00
20	0	0	0	1.872E-05	-1.609E-02	1.596E+00
21	0	0	0	1.872E-05	-1.609E-02	1.596E+00
22	0	0	0	1.872E-05	-1.609E-02	1.596E+00
23	0	0	0	1.872E-05	-1.609E-02	1.596E+00
24	0	0	0	1.872E-05	-1.609E-02	1.596E+00
25	0	3.67	0	1.872E-05	-1.609E-02	1.596E+00
26	0	47.69	0	1.872E-05	-1.609E-02	1.596E+00
27	2.78	59.41	0.33	1.872E-05	-1.609E-02	1.596E+00
28	8.12	84.54	1.67	1.872E-05	-1.609E-02	1.596E+00
29	13.95	80.00	2.83	1.872E-05	-1.609E-02	1.596E+00
30	29.90	80.00	4.02	1.872E-05	-1.609E-02	1.596E+00
31	33.87	79.29	5.64	1.872E-05	-1.609E-02	1.596E+00
32	27.86	38.25	7.39	1.872E-05	-1.609E-02	1.596E+00
33	19.63	26.67	8.83	1.872E-05	-1.609E-02	1.596E+00
34	26.79	15.10	9.15	1.872E-05	-1.609E-02	1.596E+00
35	19.85	16.47	9.70	1.872E-05	-1.609E-02	1.596E+00
36	17.51	28.05	11.37	1.872E-05	-1.609E-02	1.596E+00
37	17.86	20.38	13.04	1.872E-05	-1.609E-02	1.596E+00

38	16.37	([a])	14.74	1.872E-05	-1.609E-02	1.596E+00
39	5.85	([a])	16.41	2.033E-05	-1.775E-02	3.890E+00
40	14.13	([a])	16.85	2.194E-05	-1.941E-02	6.184E+00
41	21.10	([a])	16.09	2.356E-05	-2.107E-02	8.477E+00
42	15.63	([a])	15.23	2.356E-05	-2.107E-02	8.477E+00
43	12.67	62.52	14.22	2.356E-05	-2.107E-02	8.477E+00
44	14.86	69.36	13.02	2.356E-05	-2.107E-02	8.477E+00
45	24.79	60.00	12.47	2.356E-05	-2.107E-02	8.477E+00
46	33.06	63.79	13.05	2.356E-05	-2.107E-02	8.477E+00
47	42.29	75.36	14.26	2.356E-05	-2.107E-02	8.477E+00
48	48.90	80.00	15.09	2.356E-05	-2.107E-02	8.477E+00
49	51.52	80.00	15.42	2.356E-05	-2.107E-02	8.477E+00
50	48.24	79.92	15.96	2.356E-05	-2.107E-02	8.477E+00
51	51.79	65.03	16.58	2.356E-05	-2.107E-02	8.477E+00
52	52.37	43.23	17.61	2.356E-05	-2.107E-02	8.477E+00
53	56.14	50.00	18.33	2.356E-05	-2.107E-02	8.477E+00
54	62.35	50.00	18.65	2.356E-05	-2.107E-02	8.477E+00
55	64.29	42.05	19.67	2.356E-05	-2.107E-02	8.477E+00
56	67.69	40.00	20.47	2.356E-05	-2.107E-02	8.477E+00
57	75.20	42.20	20.57	2.356E-05	-2.107E-02	8.477E+00
58	74.88	41.28	20.68	2.356E-05	-2.107E-02	8.477E+00
59	71.92	([a])	21.56	2.356E-05	-2.107E-02	8.477E+00
60	71.88	([a])	23.19	2.356E-05	-2.107E-02	8.477E+00
61	69.64	([a])	23.64	7.852E-06	-7.024E-03	2.826E+00
62	71.24	([a])	22.75	-7.852E-06	7.024E-03	-2.826E+00
63	71.72	30.54	21.81	-2.356E-05	2.107E-02	-8.477E+00
64	76.41	42.12	20.79	-2.356E-05	2.107E-02	-8.477E+00
65	73.02	50.00	19.86	-2.356E-05	2.107E-02	-8.477E+00
66	69.64	50.00	19.18	-2.356E-05	2.107E-02	-8.477E+00
67	72.09	43.16	18.75	-2.356E-05	2.107E-02	-8.477E+00
68	82.23	73.65	18.43	-2.356E-05	2.107E-02	-8.477E+00
69	78.58	([a])	18.61	-2.356E-05	2.107E-02	-8.477E+00
70	75.00	([a])	19.11	-2.356E-05	2.107E-02	-8.477E+00
71	75.00	([a])	18.76	-2.356E-05	2.107E-02	-8.477E+00
72	72.47	([a])	17.68	-2.356E-05	2.107E-02	-8.477E+00
73	62.91	([a])	16.46	-2.356E-05	2.107E-02	-8.477E+00
74	58.93	13.57	15.06	-2.356E-05	2.107E-02	-8.477E+00
75	55.56	29.43	13.41	-2.356E-05	2.107E-02	-8.477E+00
76	57.14	20.00	11.91	-2.356E-05	2.107E-02	-8.477E+00
77	56.68	17.42	11.09	-2.356E-05	2.107E-02	-8.477E+00
78	53.88	10.00	10.90	-2.356E-05	2.107E-02	-8.477E+00
79	50.76	10.00	11.40	-2.356E-05	2.107E-02	-8.477E+00
80	50.00	([a])	12.38	-2.356E-05	2.107E-02	-8.477E+00

81	46.83	([a])	13.02	-2.356E-05	2.107E-02	-8.477E+00
82	35.63	10.00	12.30	-2.356E-05	2.107E-02	-8.477E+00
83	32.48	10.00	10.32	-2.356E-05	2.107E-02	-8.477E+00
84	26.79	10.00	9.70	-2.356E-05	2.107E-02	-8.477E+00
85	24.94	10.00	11.05	-2.356E-05	2.107E-02	-8.477E+00
86	23.21	16.74	11.88	-2.356E-05	2.107E-02	-8.477E+00
87	24.70	3.36	12.21	-2.356E-05	2.107E-02	-8.477E+00
88	25.00	([a])	13.29	-2.356E-05	2.107E-02	-8.477E+00
89	24.47	([a])	13.73	-2.356E-05	2.107E-02	-8.477E+00
90	18.71	([a])	12.77	-2.356E-05	2.107E-02	-8.477E+00
91	10.85	([a])	11.46	-2.356E-05	2.107E-02	-8.477E+00
92	3.40	([a])	9.84	-2.356E-05	2.107E-02	-8.477E+00
93	0	0	7.62	-2.356E-05	2.107E-02	-8.477E+00
94	0	0	3.57	-2.356E-05	2.107E-02	-8.477E+00
95	0	0.91	1.33	-2.356E-05	2.107E-02	-8.477E+00
96	0	7.52	0	-2.356E-05	2.107E-02	-8.477E+00
97	0	0	0	-2.356E-05	2.107E-02	-8.477E+00
98	0	0	0	-2.356E-05	2.107E-02	-8.477E+00
99	0	0	0	-2.356E-05	2.107E-02	-8.477E+00
100	0	0	0	-9.275E-06	8.450E-03	-4.643E+00
101	0	0	0	5.004E-06	-4.171E-03	-8.092E-01
102	0	0	0	1.928E-05	-1.679E-02	3.025E+00
103	0	0	0	1.928E-05	-1.679E-02	3.025E+00
104	0	0	0	1.928E-05	-1.679E-02	3.025E+00
105	0	0	0	1.928E-05	-1.679E-02	3.025E+00
106	0	0	0	1.928E-05	-1.679E-02	3.025E+00
107	0	0	0	1.928E-05	-1.679E-02	3.025E+00
108	0	0	0	1.928E-05	-1.679E-02	3.025E+00
109	0	0	0	1.928E-05	-1.679E-02	3.025E+00
110	0	0	0	1.928E-05	-1.679E-02	3.025E+00
111	0	0	0	1.928E-05	-1.679E-02	3.025E+00
112	0	0	0	1.928E-05	-1.679E-02	3.025E+00
113	0	0	0	1.928E-05	-1.679E-02	3.025E+00
114	0	0	0	1.928E-05	-1.679E-02	3.025E+00
115	0	0	0	1.928E-05	-1.679E-02	3.025E+00
116	0	0	0	1.928E-05	-1.679E-02	3.025E+00
117	0	0	0	1.928E-05	-1.679E-02	3.025E+00
118	0	0	0	1.928E-05	-1.679E-02	3.025E+00
119	0	0	0	1.928E-05	-1.679E-02	3.025E+00
120	0	0	0	1.928E-05	-1.679E-02	3.025E+00
121	0	0	0	1.928E-05	-1.679E-02	3.025E+00
122	0	0	0	1.928E-05	-1.679E-02	3.025E+00
123	0	0	0	1.928E-05	-1.679E-02	3.025E+00

124	0	0	0	1.928E-05	-1.679E-02	3.025E+00
125	0	0	0	1.928E-05	-1.679E-02	3.025E+00
126	0	0	0	1.928E-05	-1.679E-02	3.025E+00
127	0	0	0	1.928E-05	-1.679E-02	3.025E+00
128	0	0	0	1.928E-05	-1.679E-02	3.025E+00
129	1.58	([a])	0	1.928E-05	-1.679E-02	3.025E+00
130	1.43	([a])	0	1.928E-05	-1.679E-02	3.025E+00
131	0	0	0	1.928E-05	-1.679E-02	3.025E+00
132	0	0	0	1.928E-05	-1.679E-02	3.025E+00
133	1.91	9.28	0	1.928E-05	-1.679E-02	3.025E+00
134	2.75	0	0	1.928E-05	-1.679E-02	3.025E+00
135	0	0	0	1.928E-05	-1.679E-02	3.025E+00
136	0	0	0	1.928E-05	-1.679E-02	3.025E+00
137	0	0	0	1.928E-05	-1.679E-02	3.025E+00
138	0	0	0	1.928E-05	-1.679E-02	3.025E+00
139	0	0	0	1.928E-05	-1.679E-02	3.025E+00
140	0	0	0	1.928E-05	-1.679E-02	3.025E+00
141	0	0	0	1.928E-05	-1.679E-02	3.025E+00
142	0	0	0	1.928E-05	-1.679E-02	3.025E+00
143	0	0	0	1.928E-05	-1.679E-02	3.025E+00
144	0	0	0	1.928E-05	-1.679E-02	3.025E+00
145	0	0	0	1.928E-05	-1.679E-02	3.025E+00
146	0	0	0	1.928E-05	-1.679E-02	3.025E+00
147	0	5.51	0	1.928E-05	-1.679E-02	3.025E+00
148	0	11.34	0	1.928E-05	-1.679E-02	3.025E+00
149	0	0	0	1.928E-05	-1.679E-02	3.025E+00
150	0	0	0	1.928E-05	-1.679E-02	3.025E+00
151	0	0	0	1.928E-05	-1.679E-02	3.025E+00
152	0	0	0	1.928E-05	-1.679E-02	3.025E+00
153	0	0	0	1.928E-05	-1.679E-02	3.025E+00
154	0	0	0	1.928E-05	-1.679E-02	3.025E+00
155	0	0	0	1.928E-05	-1.679E-02	3.025E+00
156	0	0	0	1.928E-05	-1.679E-02	3.025E+00
157	0	0	0	1.928E-05	-1.679E-02	3.025E+00
158	0	0.21	0	1.928E-05	-1.679E-02	3.025E+00
159	0	30.00	0	1.928E-05	-1.679E-02	3.025E+00
160	0	26.78	0	1.928E-05	-1.679E-02	3.025E+00
161	0	20.00	0	1.928E-05	-1.679E-02	3.025E+00
162	0	20.00	0	1.928E-05	-1.679E-02	3.025E+00
163	0	4.12	0	1.928E-05	-1.679E-02	3.025E+00
164	0	0	0	1.928E-05	-1.679E-02	3.025E+00
165	0	0	0	1.928E-05	-1.679E-02	3.025E+00
166	0	0	0	1.928E-05	-1.679E-02	3.025E+00

167	0	0	0	1.928E-05	-1.679E-02	3.025E+00
168	0	0	0	1.928E-05	-1.679E-02	3.025E+00
169	0	0	0	1.928E-05	-1.679E-02	3.025E+00
170	0	0	0	1.928E-05	-1.679E-02	3.025E+00
171	0	0	0	1.928E-05	-1.679E-02	3.025E+00
172	0	0	0	1.928E-05	-1.679E-02	3.025E+00
173	0	0	0	1.928E-05	-1.679E-02	3.025E+00
174	0	0	0	1.928E-05	-1.679E-02	3.025E+00
175	0	0	0	1.928E-05	-1.679E-02	3.025E+00
176	0	0	0	1.928E-05	-1.679E-02	3.025E+00
177	0	0	0	1.928E-05	-1.679E-02	3.025E+00
178	0	0	0	1.928E-05	-1.679E-02	3.025E+00
179	0	0	0	1.928E-05	-1.679E-02	3.025E+00
180	0	0	0	1.928E-05	-1.679E-02	3.025E+00
181	0	0	0	1.928E-05	-1.679E-02	3.025E+00
182	0	0	0	1.928E-05	-1.679E-02	3.025E+00
183	0	0	0	1.928E-05	-1.679E-02	3.025E+00
184	0	20.00	0	1.928E-05	-1.679E-02	3.025E+00
185	0	20.00	0	1.928E-05	-1.679E-02	3.025E+00
186	0	11.73	0	1.928E-05	-1.679E-02	3.025E+00
187	0	0	0	1.928E-05	-1.679E-02	3.025E+00
188	0	0	0	1.928E-05	-1.679E-02	3.025E+00
189	0	0	0	1.928E-05	-1.679E-02	3.025E+00
190	0	0	0	1.928E-05	-1.679E-02	3.025E+00
191	0	0	0	1.928E-05	-1.679E-02	3.025E+00
192	0	0	0	1.928E-05	-1.679E-02	3.025E+00
193	0	0	0	1.928E-05	-1.679E-02	3.025E+00
194	0	0	0	1.928E-05	-1.679E-02	3.025E+00
195	0	0	0	1.928E-05	-1.679E-02	3.025E+00
196	0	0	0	1.928E-05	-1.679E-02	3.025E+00
197	0	0	0	1.928E-05	-1.679E-02	3.025E+00
198	0	0	0	1.928E-05	-1.679E-02	3.025E+00
199	0	0	0	1.928E-05	-1.679E-02	3.025E+00
200	0	0	0	1.928E-05	-1.679E-02	3.025E+00
201	0	0	0	1.928E-05	-1.679E-02	3.025E+00
202	0	0	0	1.928E-05	-1.679E-02	3.025E+00
203	0	0	0	1.928E-05	-1.679E-02	3.025E+00
204	0	0	0	1.928E-05	-1.679E-02	3.025E+00
205	0	0	0	1.928E-05	-1.679E-02	3.025E+00
206	0	0	0	1.928E-05	-1.679E-02	3.025E+00
207	0	0	0	1.928E-05	-1.679E-02	3.025E+00
208	0	0	0	1.928E-05	-1.679E-02	3.025E+00
209	0	0	0	1.928E-05	-1.679E-02	3.025E+00

210	0	0	0	1.928E-05	-1.679E-02	3.025E+00
211	0	0	0	1.928E-05	-1.679E-02	3.025E+00
212	0	0	0	1.928E-05	-1.679E-02	3.025E+00
213	0	0	0	1.928E-05	-1.679E-02	3.025E+00
214	0	73.41	0	1.928E-05	-1.679E-02	3.025E+00
215	0	90.00	0	1.928E-05	-1.679E-02	3.025E+00
216	27.95	81.30	0	1.928E-05	-1.679E-02	3.025E+00
217	36.74	90.00	2.80	1.928E-05	-1.679E-02	3.025E+00
218	39.29	90.00	5.59	1.928E-05	-1.679E-02	3.025E+00
219	41.44	90.00	8.39	1.928E-05	-1.679E-02	3.025E+00
220	45.57	82.41	11.19	1.928E-05	-1.679E-02	3.025E+00
221	59.52	80.00	14.30	1.928E-05	-1.679E-02	3.025E+00
222	66.99	90.00	16.03	1.928E-05	-1.679E-02	3.025E+00
223	80.22	90.00	17.30	1.928E-05	-1.679E-02	3.025E+00
224	86.41	93.88	19.72	1.928E-05	-1.679E-02	3.025E+00
225	86.53	50.94	23.18	1.928E-05	-1.679E-02	3.025E+00
226	84.46	17.02	25.27	1.928E-05	-1.679E-02	3.025E+00
227	88.54	28.60	26.91	1.928E-05	-1.679E-02	3.025E+00
228	89.29	39.83	28.89	1.928E-05	-1.679E-02	3.025E+00
229	89.29	30.00	29.43	1.928E-05	-1.679E-02	3.025E+00
230	89.29	26.69	29.50	1.928E-05	-1.679E-02	3.025E+00
231	90.16	20.00	30.49	1.928E-05	-1.679E-02	3.025E+00
232	89.92	20.00	32.02	1.928E-05	-1.679E-02	3.025E+00
233	89.29	36.06	32.91	1.928E-05	-1.679E-02	3.025E+00
234	85.86	40.00	32.55	1.928E-05	-1.679E-02	3.025E+00
235	85.51	30.00	32.26	1.928E-05	-1.679E-02	3.025E+00
236	84.42	32.75	32.65	1.928E-05	-1.679E-02	3.025E+00
237	86.48	35.68	33.50	1.928E-05	-1.679E-02	3.025E+00
238	88.55	30.00	34.96	1.928E-05	-1.679E-02	3.025E+00
239	89.29	44.93	36.44	1.928E-05	-1.679E-02	3.025E+00
240	90.90	50.00	36.95	6.428E-06	-5.597E-03	1.008E+00
241	77.27	([a])	37.02	-6.428E-06	5.597E-03	-1.008E+00
242	56.75	([a])	36.97	-1.928E-05	1.679E-02	-3.025E+00
243	50.00	([a])	36.37	-1.928E-05	1.679E-02	-3.025E+00
244	41.07	([a])	35.56	-1.928E-05	1.679E-02	-3.025E+00
245	37.38	45.18	34.72	-1.928E-05	1.679E-02	-3.025E+00
246	34.21	78.47	33.84	-1.928E-05	1.679E-02	-3.025E+00
247	32.13	80.00	33.40	-1.928E-05	1.679E-02	-3.025E+00
248	27.71	80.00	32.93	-1.928E-05	1.679E-02	-3.025E+00
249	22.64	80.00	31.98	-1.928E-05	1.679E-02	-3.025E+00
250	20.58	60.97	30.98	-1.928E-05	1.679E-02	-3.025E+00
251	16.25	27.34	29.91	-1.928E-05	1.679E-02	-3.025E+00
252	11.46	43.71	28.73	-1.928E-05	1.679E-02	-3.025E+00

253	9.02	68.95	27.34	-1.928E-05	1.679E-02	-3.025E+00
254	3.38	68.95	25.85	-1.928E-05	1.679E-02	-3.025E+00
255	1.32	44.28	24.49	-1.928E-05	1.679E-02	-3.025E+00
256	0	0	23.19	-1.928E-05	1.679E-02	-3.025E+00
257	0	0	21.87	-1.928E-05	1.679E-02	-3.025E+00
258	0	0	17.39	-1.928E-05	1.679E-02	-3.025E+00
259	0	0	12.92	-1.928E-05	1.679E-02	-3.025E+00
260	0	0	8.45	-1.928E-05	1.679E-02	-3.025E+00
261	0	0	3.97	-1.928E-05	1.679E-02	-3.025E+00
262	0	0	0	-1.928E-05	1.679E-02	-3.025E+00
263	0	24.97	0	-1.928E-05	1.679E-02	-3.025E+00
264	0	17.16	0	-1.928E-05	1.679E-02	-3.025E+00
265	0	6.20	0	-6.926E-06	5.240E-03	8.504E-01
266	0	10.00	0	5.431E-06	-6.313E-03	4.726E+00
267	0	10.00	0	1.779E-05	-1.787E-02	8.601E+00
268	0	0	0	1.779E-05	-1.787E-02	8.601E+00
269	0	0	0	1.779E-05	-1.787E-02	8.601E+00
270	0	0	0	1.779E-05	-1.787E-02	8.601E+00
271	0	0	0	1.779E-05	-1.787E-02	8.601E+00
272	0	0	0	1.779E-05	-1.787E-02	8.601E+00
273	0	0	0	1.779E-05	-1.787E-02	8.601E+00
274	0	0	0	1.779E-05	-1.787E-02	8.601E+00
275	0	0	0	1.779E-05	-1.787E-02	8.601E+00
276	0	0	0	1.779E-05	-1.787E-02	8.601E+00
277	0	0	0	1.779E-05	-1.787E-02	8.601E+00
278	0	0	0	1.779E-05	-1.787E-02	8.601E+00
279	0	0	0	1.779E-05	-1.787E-02	8.601E+00
280	0	0	0	1.779E-05	-1.787E-02	8.601E+00
281	0	0	0	1.779E-05	-1.787E-02	8.601E+00
282	0	0	0	1.779E-05	-1.787E-02	8.601E+00
283	0	0	0	1.779E-05	-1.787E-02	8.601E+00
284	0	0	0	1.779E-05	-1.787E-02	8.601E+00
285	0	0	0	1.779E-05	-1.787E-02	8.601E+00
286	0	0	0	1.779E-05	-1.787E-02	8.601E+00
287	0	0	0	1.779E-05	-1.787E-02	8.601E+00
288	0	0	0	1.779E-05	-1.787E-02	8.601E+00
289	0	0	0	1.779E-05	-1.787E-02	8.601E+00
290	0	0	0	1.779E-05	-1.787E-02	8.601E+00
291	0	0	0	1.779E-05	-1.787E-02	8.601E+00
292	0	0	0	1.779E-05	-1.787E-02	8.601E+00
293	0	0	0	1.779E-05	-1.787E-02	8.601E+00
294	0	0	0	1.779E-05	-1.787E-02	8.601E+00
295	0	0	0	1.779E-05	-1.787E-02	8.601E+00

296	0	0	0	1.779E-05	-1.787E-02	8.601E+00
297	0	0	0	1.779E-05	-1.787E-02	8.601E+00
298	0	0	0	1.779E-05	-1.787E-02	8.601E+00
299	0	0	0	1.779E-05	-1.787E-02	8.601E+00
300	0	0	0	1.779E-05	-1.787E-02	8.601E+00
301	0	0	0	1.779E-05	-1.787E-02	8.601E+00
302	0	0	0	1.779E-05	-1.787E-02	8.601E+00
303	0	0	0	1.779E-05	-1.787E-02	8.601E+00
304	0	0	0	1.779E-05	-1.787E-02	8.601E+00
305	0	0	0	1.779E-05	-1.787E-02	8.601E+00
306	0	0	0	1.779E-05	-1.787E-02	8.601E+00
307	0	0	0	1.779E-05	-1.787E-02	8.601E+00
308	0	0	0	1.779E-05	-1.787E-02	8.601E+00
309	0	0	0	1.779E-05	-1.787E-02	8.601E+00
310	0	0	0	1.779E-05	-1.787E-02	8.601E+00
311	0	0	0	1.779E-05	-1.787E-02	8.601E+00
312	0	0	0	1.779E-05	-1.787E-02	8.601E+00
313	0	0	0	1.779E-05	-1.787E-02	8.601E+00
314	0	0	0	1.779E-05	-1.787E-02	8.601E+00
315	0	0	0	1.779E-05	-1.787E-02	8.601E+00
316	0	0	0	1.779E-05	-1.787E-02	8.601E+00
317	0	0	0	1.779E-05	-1.787E-02	8.601E+00
318	0	0	0	1.779E-05	-1.787E-02	8.601E+00
319	0	0	0	1.779E-05	-1.787E-02	8.601E+00
320	0	0	0	1.779E-05	-1.787E-02	8.601E+00
321	0	15.55	0	1.779E-05	-1.787E-02	8.601E+00
322	0	20.00	0	1.779E-05	-1.787E-02	8.601E+00
323	21.59	19.08	1.20	1.779E-05	-1.787E-02	8.601E+00
324	20.54	10.00	2.18	1.779E-05	-1.787E-02	8.601E+00
325	10.32	1.86	2.88	1.779E-05	-1.787E-02	8.601E+00
326	6.13	([a])	3.00	1.779E-05	-1.787E-02	8.601E+00
327	5.36	([a])	2.28	1.779E-05	-1.787E-02	8.601E+00
328	0.64	([a])	0	1.779E-05	-1.787E-02	8.601E+00
329	0	0	0	1.779E-05	-1.787E-02	8.601E+00
330	0	0	0	1.779E-05	-1.787E-02	8.601E+00
331	0	0	0	1.779E-05	-1.787E-02	8.601E+00
332	0	0	0	1.779E-05	-1.787E-02	8.601E+00
333	0	0	0	1.779E-05	-1.787E-02	8.601E+00
334	0	0	0	1.779E-05	-1.787E-02	8.601E+00
335	0	0	0	1.779E-05	-1.787E-02	8.601E+00
336	0	0	0	1.779E-05	-1.787E-02	8.601E+00
337	0	0	0	1.779E-05	-1.787E-02	8.601E+00
338	0	0	0	1.779E-05	-1.787E-02	8.601E+00

339	0	0	0	1.779E-05	-1.787E-02	8.601E+00
340	0	0	0	1.779E-05	-1.787E-02	8.601E+00
341	0	0	0	1.779E-05	-1.787E-02	8.601E+00
342	0	0	0	1.779E-05	-1.787E-02	8.601E+00
343	0	0	0	1.779E-05	-1.787E-02	8.601E+00
344	0	0	0	1.779E-05	-1.787E-02	8.601E+00
345	0	0	0	1.779E-05	-1.787E-02	8.601E+00
346	0	0	0	1.779E-05	-1.787E-02	8.601E+00
347	0	0	0	1.779E-05	-1.787E-02	8.601E+00
348	0	0	0	1.779E-05	-1.787E-02	8.601E+00
349	0	0	0	1.779E-05	-1.787E-02	8.601E+00
350	0	0	0	1.779E-05	-1.787E-02	8.601E+00
351	0	0	0	1.779E-05	-1.787E-02	8.601E+00
352	0	0	0	1.779E-05	-1.787E-02	8.601E+00
353	0	0	0	1.779E-05	-1.787E-02	8.601E+00
354	0	0	0	1.779E-05	-1.787E-02	8.601E+00
355	0	0	0	1.779E-05	-1.787E-02	8.601E+00
356	0	0	0	1.779E-05	-1.787E-02	8.601E+00
357	0	0	0	1.779E-05	-1.787E-02	8.601E+00
358	0	0	0	1.779E-05	-1.787E-02	8.601E+00
359	0	0	0	1.779E-05	-1.787E-02	8.601E+00
360	0	0	0	1.779E-05	-1.787E-02	8.601E+00
361	0	0	0	1.779E-05	-1.787E-02	8.601E+00
362	0	0	0	1.779E-05	-1.787E-02	8.601E+00
363	0	0	0	1.779E-05	-1.787E-02	8.601E+00
364	0	0	0	1.779E-05	-1.787E-02	8.601E+00
365	0	0	0	1.779E-05	-1.787E-02	8.601E+00
366	0	0	0	1.779E-05	-1.787E-02	8.601E+00
367	0	0	0	1.779E-05	-1.787E-02	8.601E+00
368	0	0	0	1.779E-05	-1.787E-02	8.601E+00
369	0	0	0	1.779E-05	-1.787E-02	8.601E+00
370	0	0	0	1.779E-05	-1.787E-02	8.601E+00
371	0	0	0	1.779E-05	-1.787E-02	8.601E+00
372	0	0	0	1.779E-05	-1.787E-02	8.601E+00
373	0	0	0	1.779E-05	-1.787E-02	8.601E+00
374	0	0	0	1.779E-05	-1.787E-02	8.601E+00
375	0	0	0	2.077E-05	-1.947E-02	7.751E+00
376	0	0	0	2.376E-05	-2.108E-02	6.900E+00
377	0	29.59	0	2.674E-05	-2.269E-02	6.050E+00
378	-1.34	87.46	0	2.674E-05	-2.269E-02	6.050E+00
379	7.93	100.00	1.15	2.674E-05	-2.269E-02	6.050E+00
380	41.11	100.00	3.82	2.674E-05	-2.269E-02	6.050E+00
381	68.65	100.00	6.11	2.674E-05	-2.269E-02	6.050E+00

382	71.43	100.00	10.00	2.674E-05	-2.269E-02	6.050E+00
383	73.34	94.64	14.52	2.674E-05	-2.269E-02	6.050E+00
384	76.24	83.07	18.09	2.674E-05	-2.269E-02	6.050E+00
385	78.30	88.51	20.64	2.674E-05	-2.269E-02	6.050E+00
386	82.14	79.83	22.36	2.674E-05	-2.269E-02	6.050E+00
387	82.14	61.66	23.70	2.674E-05	-2.269E-02	6.050E+00
388	84.45	66.77	24.80	2.674E-05	-2.269E-02	6.050E+00
389	91.86	60.00	25.26	2.674E-05	-2.269E-02	6.050E+00
390	94.64	72.76	25.44	2.674E-05	-2.269E-02	6.050E+00
391	97.48	8.43	25.57	2.674E-05	-2.269E-02	6.050E+00
392	99.92	([a])	25.79	2.674E-05	-2.269E-02	6.050E+00
393	73.21	([a])	25.80	2.674E-05	-2.269E-02	6.050E+00
394	70.83	([a])	24.98	2.674E-05	-2.269E-02	6.050E+00
395	63.53	([a])	23.70	2.674E-05	-2.269E-02	6.050E+00
396	61.46	([a])	22.23	2.674E-05	-2.269E-02	6.050E+00
397	69.96	49.17	20.51	2.674E-05	-2.269E-02	6.050E+00
398	73.21	70.00	18.44	2.674E-05	-2.269E-02	6.050E+00
399	72.01	69.46	18.19	2.674E-05	-2.269E-02	6.050E+00
400	82.90	60.00	21.27	2.674E-05	-2.269E-02	6.050E+00
401	87.04	60.00	23.53	2.674E-05	-2.269E-02	6.050E+00
402	88.35	60.00	23.88	2.674E-05	-2.269E-02	6.050E+00
403	89.95	60.00	24.03	2.674E-05	-2.269E-02	6.050E+00
404	92.57	43.17	24.17	2.228E-05	-1.969E-02	5.457E+00
405	92.86	10.04	24.30	1.781E-05	-1.670E-02	4.864E+00
406	71.98	20.00	24.09	1.335E-05	-1.370E-02	4.271E+00
407	74.44	20.00	24.97	1.335E-05	-1.370E-02	4.271E+00
408	72.38	15.29	25.32	4.449E-06	-4.566E-03	1.424E+00
409	71.43	10.00	24.15	-4.449E-06	4.566E-03	-1.424E+00
410	68.63	([a])	23.14	-1.335E-05	1.370E-02	-4.271E+00
411	66.17	([a])	22.38	-1.335E-05	1.370E-02	-4.271E+00
412	63.93	([a])	21.58	-1.335E-05	1.370E-02	-4.271E+00
413	63.02	([a])	20.06	-1.335E-05	1.370E-02	-4.271E+00
414	69.64	([a])	18.29	-1.335E-05	1.370E-02	-4.271E+00
415	71.69	1.45	16.16	-1.335E-05	1.370E-02	-4.271E+00
416	71.91	17.30	13.44	-1.335E-05	1.370E-02	-4.271E+00
417	69.85	11.13	11.00	-1.335E-05	1.370E-02	-4.271E+00
418	70.04	19.55	10.13	-7.827E-06	7.759E-03	-3.711E+00
419	75.32	24.16	11.50	-2.306E-06	1.819E-03	-3.150E+00
420	64.43	80.00	13.65	3.214E-06	-4.121E-03	-2.590E+00
421	70.63	74.83	15.03	3.214E-06	-4.121E-03	-2.590E+00
422	80.44	16.04	17.50	3.214E-06	-4.121E-03	-2.590E+00
423	66.11	([a])	20.79	3.214E-06	-4.121E-03	-2.590E+00
424	60.73	([a])	22.92	3.214E-06	-4.121E-03	-2.590E+00

425	61.19	([a])	23.23	3.214E-06	-4.121E-03	-2.590E+00
426	53.03	([a])	22.42	3.214E-06	-4.121E-03	-2.590E+00
427	56.73	([a])	21.51	3.214E-06	-4.121E-03	-2.590E+00
428	62.50	2.38	20.46	3.214E-06	-4.121E-03	-2.590E+00
429	65.27	17.76	19.25	3.214E-06	-4.121E-03	-2.590E+00
430	64.40	([a])	19.61	3.214E-06	-4.121E-03	-2.590E+00
431	60.06	([a])	21.94	3.214E-06	-4.121E-03	-2.590E+00
432	32.17	([a])	22.99	3.214E-06	-4.121E-03	-2.590E+00
433	18.53	([a])	22.51	3.214E-06	-4.121E-03	-2.590E+00
434	10.26	([a])	21.98	3.214E-06	-4.121E-03	-2.590E+00
435	-1.87	0.0	21.39	3.214E-06	-4.121E-03	-2.590E+00
436	-0.65	0.0	20.73	3.214E-06	-4.121E-03	-2.590E+00
437	7.65	60.00	20.38	3.214E-06	-4.121E-03	-2.590E+00
438	27.28	61.93	20.38	3.214E-06	-4.121E-03	-2.590E+00
439	59.91	63.00	20.78	3.214E-06	-4.121E-03	-2.590E+00
440	76.81	39.85	21.84	3.214E-06	-4.121E-03	-2.590E+00
441	79.76	30.00	23.60	3.214E-06	-4.121E-03	-2.590E+00
442	81.82	30.00	25.31	3.214E-06	-4.121E-03	-2.590E+00
443	87.39	10.40	26.41	3.214E-06	-4.121E-03	-2.590E+00
444	87.26	1.37	27.29	3.214E-06	-4.121E-03	-2.590E+00
445	85.71	10.00	27.97	3.214E-06	-4.121E-03	-2.590E+00
446	85.71	0.96	28.20	3.214E-06	-4.121E-03	-2.590E+00
447	85.71	([a])	28.31	3.214E-06	-4.121E-03	-2.590E+00
448	76.13	28.34	29.22	3.214E-06	-4.121E-03	-2.590E+00
449	78.16	30.76	29.63	3.214E-06	-4.121E-03	-2.590E+00
450	76.93	29.18	29.64	3.214E-06	-4.121E-03	-2.590E+00
451	78.57	20.00	30.67	3.214E-06	-4.121E-03	-2.590E+00
452	77.87	20.00	32.17	3.214E-06	-4.121E-03	-2.590E+00
453	76.79	20.00	33.10	3.214E-06	-4.121E-03	-2.590E+00
454	78.05	20.00	33.30	3.214E-06	-4.121E-03	-2.590E+00
455	78.57	11.32	33.15	3.214E-06	-4.121E-03	-2.590E+00
456	69.50	([a])	32.66	3.214E-06	-4.121E-03	-2.590E+00
457	64.29	([a])	31.98	3.214E-06	-4.121E-03	-2.590E+00
458	63.68	([a])	31.48	3.214E-06	-4.121E-03	-2.590E+00
459	62.50	0.04	31.39	3.214E-06	-4.121E-03	-2.590E+00
460	62.50	([a])	31.30	3.214E-06	-4.121E-03	-2.590E+00
461	66.86	([a])	32.20	3.214E-06	-4.121E-03	-2.590E+00
462	66.13	([a])	33.13	3.214E-06	-4.121E-03	-2.590E+00
463	60.48	([a])	33.13	3.214E-06	-4.121E-03	-2.590E+00
464	58.93	([a])	33.14	3.214E-06	-4.121E-03	-2.590E+00
465	57.35	([a])	33.14	3.214E-06	-4.121E-03	-2.590E+00
466	55.36	([a])	33.15	3.214E-06	-4.121E-03	-2.590E+00
467	49.95	([a])	33.16	3.214E-06	-4.121E-03	-2.590E+00

468	48.21	([a])	33.16	3.214E-06	-4.121E-03	-2.590E+00
469	59.31	([a])	33.17	2.308E-06	-3.167E-03	-2.524E+00
470	67.15	70.00	33.30	1.401E-06	-2.214E-03	-2.458E+00
471	76.79	54.53	33.56	4.942E-07	-1.260E-03	-2.391E+00
472	76.79	24.56	35.59	4.942E-07	-1.260E-03	-2.391E+00
473	79.29	([a])	39.04	4.942E-07	-1.260E-03	-2.391E+00
474	80.36	([a])	41.83	4.942E-07	-1.260E-03	-2.391E+00
475	94.18	([a])	43.06	4.942E-07	-1.260E-03	-2.391E+00
476	66.07	([a])	43.13	4.942E-07	-1.260E-03	-2.391E+00
477	65.48	([a])	43.21	4.942E-07	-1.260E-03	-2.391E+00
478	63.41	10.00	43.29	4.942E-07	-1.260E-03	-2.391E+00
479	68.27	29.38	43.37	4.942E-07	-1.260E-03	-2.391E+00
480	72.87	40.00	44.00	4.942E-07	-1.260E-03	-2.391E+00
481	69.79	30.39	45.13	4.942E-07	-1.260E-03	-2.391E+00
482	66.19	26.46	47.02	4.942E-07	-1.260E-03	-2.391E+00
483	80.36	0.0	49.20	4.942E-07	-1.260E-03	-2.391E+00
484	81.13	0.0	49.92	4.942E-07	-1.260E-03	-2.391E+00
485	82.14	([a])	50.36	4.942E-07	-1.260E-03	-2.391E+00
486	83.48	([a])	51.52	4.942E-07	-1.260E-03	-2.391E+00
487	83.93	([a])	52.11	4.942E-07	-1.260E-03	-2.391E+00
488	84.04	([a])	52.12	4.942E-07	-1.260E-03	-2.391E+00
489	79.43	([a])	52.14	4.942E-07	-1.260E-03	-2.391E+00
490	56.47	([a])	52.16	4.942E-07	-1.260E-03	-2.391E+00
491	55.36	([a])	52.18	4.942E-07	-1.260E-03	-2.391E+00
492	44.23	45.37	52.20	4.942E-07	-1.260E-03	-2.391E+00
493	46.87	86.99	52.22	4.942E-07	-1.260E-03	-2.391E+00
494	57.14	90.00	52.16	4.942E-07	-1.260E-03	-2.391E+00
495	58.03	90.00	52.53	4.942E-07	-1.260E-03	-2.391E+00
496	64.22	93.22	52.98	4.942E-07	-1.260E-03	-2.391E+00
497	70.42	95.21	53.65	4.942E-07	-1.260E-03	-2.391E+00
498	73.21	83.64	54.77	4.942E-07	-1.260E-03	-2.391E+00
499	77.46	80.00	55.14	4.942E-07	-1.260E-03	-2.391E+00
500	83.67	80.00	54.57	4.942E-07	-1.260E-03	-2.391E+00
501	84.71	80.00	53.63	4.942E-07	-1.260E-03	-2.391E+00
502	92.50	80.00	52.70	4.942E-07	-1.260E-03	-2.391E+00
503	90.38	41.89	52.03	4.942E-07	-1.260E-03	-2.391E+00
504	85.25	24.85	51.66	4.942E-07	-1.260E-03	-2.391E+00
505	87.50	50.00	51.42	4.942E-07	-1.260E-03	-2.391E+00
506	89.10	50.00	51.28	4.942E-07	-1.260E-03	-2.391E+00
507	94.83	46.82	51.13	4.942E-07	-1.260E-03	-2.391E+00
508	98.96	([a])	51.53	4.942E-07	-1.260E-03	-2.391E+00
509	87.99	([a])	52.04	1.647E-07	-4.200E-04	-7.972E-01
510	63.35	([a])	51.32	-1.647E-07	4.200E-04	7.972E-01

511	60.06	([a])	49.20	-4.942E-07	1.260E-03	2.391E+00
512	54.43	([a])	46.43	-4.942E-07	1.260E-03	2.391E+00
513	42.88	([a])	43.58	-4.942E-07	1.260E-03	2.391E+00
514	46.71	([a])	40.65	-4.942E-07	1.260E-03	2.391E+00
515	48.21	([a])	37.62	-4.942E-07	1.260E-03	2.391E+00
516	58.28	([a])	34.62	-4.942E-07	1.260E-03	2.391E+00
517	69.64	([a])	31.62	-4.942E-07	1.260E-03	2.391E+00
518	51.44	([a])	28.44	-4.942E-07	1.260E-03	2.391E+00
519	38.02	([a])	25.01	-4.942E-07	1.260E-03	2.391E+00
520	34.65	([a])	21.38	-4.942E-07	1.260E-03	2.391E+00
521	19.97	([a])	17.39	-4.942E-07	1.260E-03	2.391E+00
522	3.14	([a])	12.76	-4.942E-07	1.260E-03	2.391E+00
523	0	0	6.14	-4.942E-07	1.260E-03	2.391E+00
524	-1.30	36.39	0	-4.942E-07	1.260E-03	2.391E+00
525	-0.21	5.75	0	-4.942E-07	1.260E-03	2.391E+00
526	0	0	0	-4.942E-07	1.260E-03	2.391E+00
527	0	0	0	-4.942E-07	1.260E-03	2.391E+00
528	0	0	0	-4.942E-07	1.260E-03	2.391E+00
529	0	0	0	-4.942E-07	1.260E-03	2.391E+00
530	0	0	0	7.439E-06	-5.768E-03	1.455E+00
531	0	0	0	1.537E-05	-1.280E-02	5.195E-01
532	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
533	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
534	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
535	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
536	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
537	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
538	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
539	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
540	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
541	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
542	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
543	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
544	0	([a])	0	2.331E-05	-1.982E-02	-4.165E-01
545	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
546	-0.67	0	0	2.331E-05	-1.982E-02	-4.165E-01
547	-0.50	0	0	2.331E-05	-1.982E-02	-4.165E-01
548	3.57	([a])	0	2.331E-05	-1.982E-02	-4.165E-01
549	0.61	([a])	0	2.331E-05	-1.982E-02	-4.165E-01
550	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
551	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
552	0	2.60	0	2.331E-05	-1.982E-02	-4.165E-01
553	0	20.00	0	2.331E-05	-1.982E-02	-4.165E-01

554	0	20.00	0	2.331E-05	-1.982E-02	-4.165E-01
555	0	7.96	0	2.331E-05	-1.982E-02	-4.165E-01
556	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
557	0	0	0	2.331E-05	-1.982E-02	-4.165E-01
558	0	78.53	0	2.331E-05	-1.982E-02	-4.165E-01
559	1.65	60.00	0	2.331E-05	-1.982E-02	-4.165E-01
560	9.91	63.88	2.80	2.331E-05	-1.982E-02	-4.165E-01
561	14.29	70.00	6.02	2.331E-05	-1.982E-02	-4.165E-01
562	26.83	70.00	8.57	2.331E-05	-1.982E-02	-4.165E-01
563	38.29	70.00	11.07	2.331E-05	-1.982E-02	-4.165E-01
564	50.09	70.00	13.68	2.331E-05	-1.982E-02	-4.165E-01
565	56.60	66.52	16.52	2.331E-05	-1.982E-02	-4.165E-01
566	63.09	59.94	19.38	2.331E-05	-1.982E-02	-4.165E-01
567	65.16	80.00	21.91	2.331E-05	-1.982E-02	-4.165E-01
568	69.53	86.46	24.34	2.331E-05	-1.982E-02	-4.165E-01
569	78.60	90.00	27.02	2.331E-05	-1.982E-02	-4.165E-01
570	80.36	90.00	29.41	2.331E-05	-1.982E-02	-4.165E-01
571	82.35	100.00	31.57	2.331E-05	-1.982E-02	-4.165E-01
572	83.93	100.00	33.52	2.331E-05	-1.982E-02	-4.165E-01
573	84.70	100.00	35.75	2.331E-05	-1.982E-02	-4.165E-01
574	85.71	100.00	38.34	2.331E-05	-1.982E-02	-4.165E-01
575	87.04	100.00	40.83	2.331E-05	-1.982E-02	-4.165E-01
576	97.18	100.00	43.37	2.331E-05	-1.982E-02	-4.165E-01
577	98.21	83.92	44.90	2.331E-05	-1.982E-02	-4.165E-01
578	93.54	([a])	45.32	7.769E-06	-6.608E-03	-1.388E-01
579	78.13	([a])	45.25	-7.769E-06	6.608E-03	1.388E-01
580	80.36	0	44.24	-2.331E-05	1.982E-02	4.165E-01
581	81.59	([a])	42.61	-2.331E-05	1.982E-02	4.165E-01
582	73.07	([a])	40.93	-2.331E-05	1.982E-02	4.165E-01
583	58.92	([a])	39.03	-2.331E-05	1.982E-02	4.165E-01
584	56.86	([a])	36.96	-2.331E-05	1.982E-02	4.165E-01
585	54.22	([a])	34.84	-2.331E-05	1.982E-02	4.165E-01
586	50.94	([a])	32.66	-2.331E-05	1.982E-02	4.165E-01
587	47.74	([a])	30.40	-2.331E-05	1.982E-02	4.165E-01
588	45.02	([a])	28.04	-2.331E-05	1.982E-02	4.165E-01
589	39.56	([a])	25.57	-2.331E-05	1.982E-02	4.165E-01
590	33.55	37.91	22.94	-2.331E-05	1.982E-02	4.165E-01
591	29.89	20.00	20.11	-2.331E-05	1.982E-02	4.165E-01
592	27.82	20.00	18.17	-2.331E-05	1.982E-02	4.165E-01
593	25.76	20.00	17.20	-2.331E-05	1.982E-02	4.165E-01
594	19.76	20.00	16.06	-2.331E-05	1.982E-02	4.165E-01
595	8.31	([a])	14.93	-2.331E-05	1.982E-02	4.165E-01
596	0	0	13.78	-2.331E-05	1.982E-02	4.165E-01

597	0	0	10.72	-2.331E-05	1.982E-02	4.165E-01
598	0	0	6.24	-2.331E-05	1.982E-02	4.165E-01
599	0	0	1.77	-2.331E-05	1.982E-02	4.165E-01
600	0	0	0	-2.331E-05	1.982E-02	4.165E-01
601	0	0	0	-2.331E-05	1.982E-02	4.165E-01
602	0	0	0	-2.331E-05	1.982E-02	4.165E-01
603	0	0	0	-2.331E-05	1.982E-02	4.165E-01
604	0	0	0	-2.331E-05	1.982E-02	4.165E-01
605	0	0	0	-2.331E-05	1.982E-02	4.165E-01
606	2.25	6.30	0	-2.331E-05	1.982E-02	4.165E-01
607	9.20	17.87	0	-1.029E-05	8.762E-03	1.296E+00
608	12.40	20.00	0.75	2.727E-06	-2.302E-03	2.176E+00
609	18.04	20.00	1.90	1.574E-05	-1.337E-02	3.055E+00
610	21.49	22.59	3.81	1.574E-05	-1.337E-02	3.055E+00
611	29.76	17.50	5.91	1.574E-05	-1.337E-02	3.055E+00
612	35.98	([a])	7.92	1.574E-05	-1.337E-02	3.055E+00
613	42.72	([a])	9.86	1.574E-05	-1.337E-02	3.055E+00
614	58.93	7.78	9.37	1.574E-05	-1.337E-02	3.055E+00
615	60.71	10.93	5.32	1.574E-05	-1.337E-02	3.055E+00
616	60.35	32.04	1.45	1.574E-05	-1.337E-02	3.055E+00
617	58.93	40.00	4.28	1.574E-05	-1.337E-02	3.055E+00
618	59.86	40.00	6.78	1.574E-05	-1.337E-02	3.055E+00
619	60.71	40.00	9.12	1.574E-05	-1.337E-02	3.055E+00
620	60.71	48.33	11.69	1.574E-05	-1.337E-02	3.055E+00
621	67.79	99.53	14.17	1.574E-05	-1.337E-02	3.055E+00
622	69.64	100.00	16.35	1.574E-05	-1.337E-02	3.055E+00
623	69.64	100.00	19.18	1.574E-05	-1.337E-02	3.055E+00
624	68.81	100.00	22.35	1.574E-05	-1.337E-02	3.055E+00
625	67.86	100.00	25.17	1.574E-05	-1.337E-02	3.055E+00
626	67.86	100.00	27.60	1.574E-05	-1.337E-02	3.055E+00
627	67.86	100.00	29.72	1.574E-05	-1.337E-02	3.055E+00
628	67.53	100.00	31.71	1.574E-05	-1.337E-02	3.055E+00
629	65.18	97.50	33.60	1.574E-05	-1.337E-02	3.055E+00
630	68.58	90.00	35.39	1.574E-05	-1.337E-02	3.055E+00
631	71.66	90.00	37.08	1.574E-05	-1.337E-02	3.055E+00
632	74.50	90.00	38.83	1.574E-05	-1.337E-02	3.055E+00
633	75.00	98.79	40.28	1.574E-05	-1.337E-02	3.055E+00
634	75.00	100.00	41.29	1.574E-05	-1.337E-02	3.055E+00
635	74.65	100.00	42.31	1.574E-05	-1.337E-02	3.055E+00
636	73.21	100.00	42.90	1.574E-05	-1.337E-02	3.055E+00
637	74.13	94.91	42.94	1.574E-05	-1.337E-02	3.055E+00
638	77.38	90.00	42.83	1.574E-05	-1.337E-02	3.055E+00
639	80.04	90.00	42.74	1.574E-05	-1.337E-02	3.055E+00

640	80.36	99.81	42.65	1.574E-05	-1.337E-02	3.055E+00
641	79.87	100.00	42.56	1.574E-05	-1.337E-02	3.055E+00
642	76.79	100.00	42.88	1.574E-05	-1.337E-02	3.055E+00
643	76.79	95.47	43.29	1.574E-05	-1.337E-02	3.055E+00
644	77.88	90.00	43.30	1.574E-05	-1.337E-02	3.055E+00
645	78.57	90.00	43.37	1.574E-05	-1.337E-02	3.055E+00
646	78.57	80.74	43.79	1.574E-05	-1.337E-02	3.055E+00
647	78.57	79.17	44.07	1.574E-05	-1.337E-02	3.055E+00
648	78.57	77.21	44.01	1.574E-05	-1.337E-02	3.055E+00
649	78.57	100.00	44.41	1.046E-05	-8.994E-03	2.433E+00
650	78.57	94.45	44.85	5.183E-06	-4.623E-03	1.811E+00
651	78.57	90.00	44.83	-9.733E-08	-2.513E-04	1.190E+00
652	78.57	90.00	44.78	-9.733E-08	-2.513E-04	1.190E+00
653	80.36	90.00	45.00	-9.733E-08	-2.513E-04	1.190E+00
654	80.03	90.00	45.80	-9.733E-08	-2.513E-04	1.190E+00
655	79.18	90.00	46.46	-9.733E-08	-2.513E-04	1.190E+00
656	80.36	90.00	46.54	-9.733E-08	-2.513E-04	1.190E+00
657	80.36	90.00	46.12	-9.733E-08	-2.513E-04	1.190E+00
658	81.81	81.86	45.94	-9.733E-08	-2.513E-04	1.190E+00
659	82.14	80.00	45.81	-9.733E-08	-2.513E-04	1.190E+00
660	80.36	81.29	45.45	-9.733E-08	-2.513E-04	1.190E+00
661	79.85	92.86	45.81	-9.733E-08	-2.513E-04	1.190E+00
662	77.78	100.00	46.26	-9.733E-08	-2.513E-04	1.190E+00
663	76.79	100.00	46.32	-9.733E-08	-2.513E-04	1.190E+00
664	76.79	100.00	46.28	-9.733E-08	-2.513E-04	1.190E+00
665	80.05	100.00	46.46	-9.733E-08	-2.513E-04	1.190E+00
666	80.36	99.27	46.92	-9.733E-08	-2.513E-04	1.190E+00
667	80.77	90.00	47.16	-9.733E-08	-2.513E-04	1.190E+00
668	82.84	90.00	47.58	-9.733E-08	-2.513E-04	1.190E+00
669	84.90	90.00	48.04	-9.733E-08	-2.513E-04	1.190E+00
670	89.48	82.97	48.05	-9.733E-08	-2.513E-04	1.190E+00
671	91.07	80.00	48.02	-9.733E-08	-2.513E-04	1.190E+00
672	91.07	70.18	48.00	-9.733E-08	-2.513E-04	1.190E+00
673	91.07	80.00	47.97	-9.733E-08	-2.513E-04	1.190E+00
674	86.91	50.07	47.95	-9.733E-08	-2.513E-04	1.190E+00
675	77.70	([a])	47.95	-9.733E-08	-2.513E-04	1.190E+00
676	76.79	([a])	48.86	-9.733E-08	-2.513E-04	1.190E+00
677	65.29	22.19	49.92	-9.733E-08	-2.513E-04	1.190E+00
678	67.65	39.62	50.26	-9.733E-08	-2.513E-04	1.190E+00
679	67.64	48.80	50.18	-9.733E-08	-2.513E-04	1.190E+00
680	67.06	37.23	49.91	-9.733E-08	-2.513E-04	1.190E+00
681	69.64	34.34	49.90	-9.733E-08	-2.513E-04	1.190E+00
682	71.76	40.00	49.88	-9.733E-08	-2.513E-04	1.190E+00

683	69.21	47.49	49.87	-9.733E-08	-2.513E-04	1.190E+00
684	72.71	50.00	49.86	-9.733E-08	-2.513E-04	1.190E+00
685	73.33	39.36	49.85	-9.733E-08	-2.513E-04	1.190E+00
686	75.00	27.79	49.83	-9.733E-08	-2.513E-04	1.190E+00
687	75.00	16.21	49.82	-9.733E-08	-2.513E-04	1.190E+00
688	75.00	15.36	49.67	-9.733E-08	-2.513E-04	1.190E+00
689	76.24	26.93	49.60	-9.733E-08	-2.513E-04	1.190E+00
690	76.79	30.00	50.23	-9.733E-08	-2.513E-04	1.190E+00
691	76.79	30.08	50.78	-9.733E-08	-2.513E-04	1.190E+00
692	76.49	40.00	50.77	-9.733E-08	-2.513E-04	1.190E+00
693	75.58	40.00	50.76	-9.733E-08	-2.513E-04	1.190E+00
694	76.79	35.20	50.64	-9.733E-08	-2.513E-04	1.190E+00
695	77.93	30.00	50.14	-9.733E-08	-2.513E-04	1.190E+00
696	78.57	22.05	49.74	-9.733E-08	-2.513E-04	1.190E+00
697	76.87	([a])	50.07	-9.733E-08	-2.513E-04	1.190E+00
698	74.80	([a])	50.56	-9.733E-08	-2.513E-04	1.190E+00
699	72.74	([a])	50.73	-2.744E-06	1.973E-03	3.071E-01
700	72.95	([a])	50.76	-5.391E-06	4.198E-03	-5.755E-01
701	76.04	([a])	50.79	-8.038E-06	6.423E-03	-1.458E+00
702	75.46	([a])	50.82	-8.038E-06	6.423E-03	-1.458E+00
703	73.40	([a])	50.85	-8.038E-06	6.423E-03	-1.458E+00
704	71.33	([a])	50.88	-8.038E-06	6.423E-03	-1.458E+00
705	69.27	([a])	50.91	-8.038E-06	6.423E-03	-1.458E+00
706	67.86	6.31	50.94	-8.038E-06	6.423E-03	-1.458E+00
707	70.68	0	50.98	-8.038E-06	6.423E-03	-1.458E+00
708	67.11	27.36	51.00	-8.038E-06	6.423E-03	-1.458E+00
709	64.29	40.00	51.03	-8.038E-06	6.423E-03	-1.458E+00
710	64.29	40.00	51.04	-8.038E-06	6.423E-03	-1.458E+00
711	66.07	38.44	51.05	-8.038E-06	6.423E-03	-1.458E+00
712	66.07	30.00	51.19	-8.038E-06	6.423E-03	-1.458E+00
713	66.07	30.00	51.69	-8.038E-06	6.423E-03	-1.458E+00
714	66.07	36.28	52.35	-8.038E-06	6.423E-03	-1.458E+00
715	64.67	47.86	52.85	-8.038E-06	6.423E-03	-1.458E+00
716	60.92	59.43	53.06	-8.038E-06	6.423E-03	-1.458E+00
717	65.89	50.00	53.07	-8.038E-06	6.423E-03	-1.458E+00
718	64.75	50.00	53.06	-8.038E-06	6.423E-03	-1.458E+00
719	66.07	45.85	53.06	-8.038E-06	6.423E-03	-1.458E+00
720	65.04	57.18	53.05	-8.038E-06	6.423E-03	-1.458E+00
721	68.20	62.70	53.05	-8.038E-06	6.423E-03	-1.458E+00
722	72.81	60.00	53.05	-8.038E-06	6.423E-03	-1.458E+00
723	71.59	60.00	53.04	-8.038E-06	6.423E-03	-1.458E+00
724	74.64	60.00	53.03	-6.308E-06	4.994E-03	-7.637E-01
725	74.50	56.40	53.02	-4.577E-06	3.565E-03	-6.931E-02

726	76.79	50.00	53.24	-2.847E-06	2.136E-03	6.251E-01
727	77.99	50.00	53.73	-2.847E-06	2.136E-03	6.251E-01
728	77.09	50.00	53.98	-2.847E-06	2.136E-03	6.251E-01
729	76.79	40.11	53.98	-2.847E-06	2.136E-03	6.251E-01
730	78.83	61.47	53.98	-2.847E-06	2.136E-03	6.251E-01
731	79.27	63.92	53.98	-2.847E-06	2.136E-03	6.251E-01
732	77.61	50.00	53.97	-2.847E-06	2.136E-03	6.251E-01
733	77.46	50.00	53.95	-2.847E-06	2.136E-03	6.251E-01
734	78.17	42.24	53.95	-2.847E-06	2.136E-03	6.251E-01
735	78.57	49.34	53.94	-2.847E-06	2.136E-03	6.251E-01
736	76.79	50.91	53.94	-2.847E-06	2.136E-03	6.251E-01
737	76.79	67.45	53.94	-2.847E-06	2.136E-03	6.251E-01
738	76.79	81.88	54.15	-2.847E-06	2.136E-03	6.251E-01
739	77.79	70.00	54.65	-2.847E-06	2.136E-03	6.251E-01
740	79.86	77.21	54.92	-2.847E-06	2.136E-03	6.251E-01
741	81.93	88.78	54.90	-2.847E-06	2.136E-03	6.251E-01
742	80.42	89.65	54.89	-2.847E-06	2.136E-03	6.251E-01
743	82.14	80.00	54.97	-2.847E-06	2.136E-03	6.251E-01
744	82.77	80.00	55.44	-2.847E-06	2.136E-03	6.251E-01
745	83.93	80.00	55.82	-2.847E-06	2.136E-03	6.251E-01
746	83.93	80.00	55.80	-2.847E-06	2.136E-03	6.251E-01
747	83.93	80.00	55.79	-2.847E-06	2.136E-03	6.251E-01
748	83.93	80.00	55.78	-2.847E-06	2.136E-03	6.251E-01
749	83.93	81.37	55.76	-5.174E-06	4.059E-03	-2.026E-01
750	84.46	87.05	55.75	-7.501E-06	5.983E-03	-1.030E+00
751	85.71	57.40	55.74	-9.827E-06	7.906E-03	-1.858E+00
752	85.71	42.19	55.42	-9.827E-06	7.906E-03	-1.858E+00
753	85.71	42.33	54.91	-9.827E-06	7.906E-03	-1.858E+00
754	85.71	40.00	55.19	-9.827E-06	7.906E-03	-1.858E+00
755	85.71	38.37	55.64	-9.827E-06	7.906E-03	-1.858E+00
756	85.71	12.83	55.31	-9.827E-06	7.906E-03	-1.858E+00
757	85.71	([a])	55.36	-9.827E-06	7.906E-03	-1.858E+00
758	85.71	([a])	55.75	-9.827E-06	7.906E-03	-1.858E+00
759	85.71	([a])	55.78	-9.827E-06	7.906E-03	-1.858E+00
760	87.27	7.37	55.81	-9.827E-06	7.906E-03	-1.858E+00
761	89.33	19.74	55.85	-9.827E-06	7.906E-03	-1.858E+00
762	91.07	11.83	55.86	-9.827E-06	7.906E-03	-1.858E+00
763	91.07	26.81	55.84	-9.827E-06	7.906E-03	-1.858E+00
764	91.96	49.96	55.81	-9.827E-06	7.906E-03	-1.858E+00
765	92.86	60.00	55.78	-9.827E-06	7.906E-03	-1.858E+00
766	91.40	60.00	55.74	-9.827E-06	7.906E-03	-1.858E+00
767	92.80	60.00	56.19	-9.827E-06	7.906E-03	-1.858E+00
768	92.86	40.00	57.13	-9.827E-06	7.906E-03	-1.858E+00

769	92.86	25.75	57.59	-9.827E-06	7.906E-03	-1.858E+00
770	92.07	([a])	57.55	-9.827E-06	7.906E-03	-1.858E+00
771	90.00	([a])	57.52	-9.827E-06	7.906E-03	-1.858E+00
772	89.29	([a])	57.53	-9.827E-06	7.906E-03	-1.858E+00
773	90.92	44.88	57.58	-9.827E-06	7.906E-03	-1.858E+00
774	91.07	36.40	57.63	-1.014E-05	8.189E-03	-1.873E+00
775	91.07	([a])	57.64	-1.045E-05	8.472E-03	-1.887E+00
776	91.07	([a])	58.11	-1.077E-05	8.756E-03	-1.902E+00
777	90.10	([a])	58.52	-1.077E-05	8.756E-03	-1.902E+00
778	90.54	([a])	58.38	-1.077E-05	8.756E-03	-1.902E+00
779	89.54	([a])	58.24	-1.077E-05	8.756E-03	-1.902E+00
780	87.47	([a])	58.10	-1.077E-05	8.756E-03	-1.902E+00
781	85.71	([a])	57.96	-1.077E-05	8.756E-03	-1.902E+00
782	85.71	10.00	57.81	-1.077E-05	8.756E-03	-1.902E+00
783	85.71	0.23	57.67	-1.077E-05	8.756E-03	-1.902E+00
784	85.71	([a])	57.66	-1.077E-05	8.756E-03	-1.902E+00
785	85.71	([a])	57.89	-1.077E-05	8.756E-03	-1.902E+00
786	84.00	([a])	58.03	-1.077E-05	8.756E-03	-1.902E+00
787	69.64	([a])	57.99	-1.077E-05	8.756E-03	-1.902E+00
788	69.15	([a])	57.96	-1.077E-05	8.756E-03	-1.902E+00
789	63.99	28.96	57.93	-1.077E-05	8.756E-03	-1.902E+00
790	59.98	80.00	57.89	-1.077E-05	8.756E-03	-1.902E+00
791	59.38	87.48	57.85	-1.077E-05	8.756E-03	-1.902E+00
792	63.78	90.00	57.80	-1.077E-05	8.756E-03	-1.902E+00
793	66.19	90.00	57.72	-1.077E-05	8.756E-03	-1.902E+00
794	67.46	92.20	57.65	-1.077E-05	8.756E-03	-1.902E+00
795	66.74	100.00	57.57	-1.077E-05	8.756E-03	-1.902E+00
796	68.81	94.65	57.50	-1.077E-05	8.756E-03	-1.902E+00
797	70.88	83.08	57.80	-1.077E-05	8.756E-03	-1.902E+00
798	71.43	71.51	58.72	-1.077E-05	8.756E-03	-1.902E+00
799	71.44	69.93	59.25	-8.819E-06	7.137E-03	-1.079E+00
800	73.51	58.36	59.19	-6.873E-06	5.518E-03	-2.559E-01
801	75.00	50.00	59.16	-4.927E-06	3.899E-03	5.670E-01
802	75.00	59.58	59.15	-4.927E-06	3.899E-03	5.670E-01
803	75.00	76.36	59.15	-4.927E-06	3.899E-03	5.670E-01
804	75.00	80.00	59.14	-4.927E-06	3.899E-03	5.670E-01
805	75.00	70.49	59.14	-4.927E-06	3.899E-03	5.670E-01
806	73.21	80.00	59.62	-4.927E-06	3.899E-03	5.670E-01
807	72.74	82.66	59.93	-4.927E-06	3.899E-03	5.670E-01
808	71.43	90.00	59.42	-4.927E-06	3.899E-03	5.670E-01
809	69.36	90.00	59.07	-4.927E-06	3.899E-03	5.670E-01
810	66.54	75.24	59.05	-4.927E-06	3.899E-03	5.670E-01
811	69.27	78.96	59.03	-4.927E-06	3.899E-03	5.670E-01

812	73.12	80.00	59.02	-4.927E-06	3.899E-03	5.670E-01
813	71.80	80.00	59.00	-4.927E-06	3.899E-03	5.670E-01
814	73.21	83.68	58.99	-4.927E-06	3.899E-03	5.670E-01
815	74.15	79.50	58.97	-4.927E-06	3.899E-03	5.670E-01
816	75.00	70.00	58.96	-4.927E-06	3.899E-03	5.670E-01
817	75.00	61.60	58.95	-4.927E-06	3.899E-03	5.670E-01
818	75.00	50.03	58.94	-4.927E-06	3.899E-03	5.670E-01
819	76.79	60.00	58.93	-4.927E-06	3.899E-03	5.670E-01
820	76.79	60.00	58.93	-4.927E-06	3.899E-03	5.670E-01
821	76.79	69.39	59.38	-4.927E-06	3.899E-03	5.670E-01
822	79.03	73.73	59.87	-4.927E-06	3.899E-03	5.670E-01
823	78.96	70.00	59.91	-4.927E-06	3.899E-03	5.670E-01
824	78.57	70.00	59.90	-4.927E-06	3.899E-03	5.670E-01
825	83.93	70.99	59.89	-4.927E-06	3.899E-03	5.670E-01
826	84.38	80.00	59.88	-4.927E-06	3.899E-03	5.670E-01
827	84.97	80.00	59.88	-4.927E-06	3.899E-03	5.670E-01
828	84.95	80.00	59.87	-4.927E-06	3.899E-03	5.670E-01
829	84.41	80.00	59.86	-5.382E-06	4.139E-03	6.372E-01
830	83.93	80.00	59.85	-5.838E-06	4.378E-03	7.074E-01
831	83.93	77.89	59.84	-6.294E-06	4.618E-03	7.776E-01
832	83.93	31.99	60.25	-6.294E-06	4.618E-03	7.776E-01
833	83.93	43.57	60.73	-6.294E-06	4.618E-03	7.776E-01
834	83.93	60.28	60.80	-6.294E-06	4.618E-03	7.776E-01
835	83.93	63.29	60.81	-6.294E-06	4.618E-03	7.776E-01
836	83.93	76.57	60.81	-6.294E-06	4.618E-03	7.776E-01
837	83.93	89.86	60.81	-6.294E-06	4.618E-03	7.776E-01
838	84.19	90.00	60.80	-6.294E-06	4.618E-03	7.776E-01
839	87.32	87.00	60.79	-6.294E-06	4.618E-03	7.776E-01
840	91.88	80.00	60.78	-6.294E-06	4.618E-03	7.776E-01
841	92.86	73.85	60.77	-6.294E-06	4.618E-03	7.776E-01
842	92.86	62.28	60.34	-6.294E-06	4.618E-03	7.776E-01
843	92.86	69.29	59.34	-6.294E-06	4.618E-03	7.776E-01
844	94.64	70.00	58.76	-6.294E-06	4.618E-03	7.776E-01
845	94.64	62.70	58.76	-6.294E-06	4.618E-03	7.776E-01
846	94.64	40.00	58.75	-6.294E-06	4.618E-03	7.776E-01
847	93.64	40.00	58.75	-6.294E-06	4.618E-03	7.776E-01
848	92.86	32.85	58.57	-6.294E-06	4.618E-03	7.776E-01
849	92.86	30.00	58.08	-7.448E-06	5.557E-03	8.947E-02
850	92.86	0.30	57.77	-8.602E-06	6.495E-03	-5.987E-01
851	92.53	11.87	57.78	-9.756E-06	7.434E-03	-1.287E+00
852	89.84	13.12	57.80	-9.756E-06	7.434E-03	-1.287E+00
853	87.50	5.01	57.82	-9.756E-06	7.434E-03	-1.287E+00
854	86.32	10.00	57.84	-9.756E-06	7.434E-03	-1.287E+00

855	85.71	([a])	57.86	-9.756E-06	7.434E-03	-1.287E+00
856	85.71	([a])	57.88	-9.756E-06	7.434E-03	-1.287E+00
857	85.71	([a])	57.99	-9.756E-06	7.434E-03	-1.287E+00
858	85.21	([a])	58.19	-9.756E-06	7.434E-03	-1.287E+00
859	83.93	([a])	58.39	-9.756E-06	7.434E-03	-1.287E+00
860	83.93	([a])	58.59	-9.756E-06	7.434E-03	-1.287E+00
861	85.29	5.18	58.79	-9.756E-06	7.434E-03	-1.287E+00
862	87.35	([a])	59.00	-9.756E-06	7.434E-03	-1.287E+00
863	87.50	([a])	57.32	-9.756E-06	7.434E-03	-1.287E+00
864	87.50	([a])	58.15	-9.756E-06	7.434E-03	-1.287E+00
865	86.80	([a])	58.57	-9.756E-06	7.434E-03	-1.287E+00
866	85.71	6.35	58.99	-9.756E-06	7.434E-03	-1.287E+00
867	85.71	12.98	59.41	-3.252E-06	2.478E-03	-4.290E-01
868	85.71	10.00	59.38	3.252E-06	-2.478E-03	4.290E-01
869	85.65	10.00	58.90	9.756E-06	-7.434E-03	1.287E+00
870	82.14	10.00	58.42	9.756E-06	-7.434E-03	1.287E+00
871	82.14	10.00	57.46	9.756E-06	-7.434E-03	1.287E+00
872	83.02	14.89	55.85	9.756E-06	-7.434E-03	1.287E+00
873	83.93	13.54	54.38	9.756E-06	-7.434E-03	1.287E+00
874	81.06	42.12	53.19	9.756E-06	-7.434E-03	1.287E+00
875	78.64	40.40	52.00	9.756E-06	-7.434E-03	1.287E+00
876	76.99	30.00	50.80	9.756E-06	-7.434E-03	1.287E+00
877	78.57	32.75	49.59	9.756E-06	-7.434E-03	1.287E+00
878	77.80	44.32	48.39	9.756E-06	-7.434E-03	1.287E+00
879	75.73	50.00	47.07	9.756E-06	-7.434E-03	1.287E+00
880	73.67	50.00	45.71	9.756E-06	-7.434E-03	1.287E+00
881	73.21	50.00	44.46	9.756E-06	-7.434E-03	1.287E+00
882	73.32	40.00	43.27	9.756E-06	-7.434E-03	1.287E+00
883	74.22	35.64	42.10	9.756E-06	-7.434E-03	1.287E+00
884	71.43	20.00	40.89	9.756E-06	-7.434E-03	1.287E+00
885	75.23	51.95	39.61	9.756E-06	-7.434E-03	1.287E+00
886	77.34	66.21	38.22	9.756E-06	-7.434E-03	1.287E+00
887	75.28	60.00	36.96	9.756E-06	-7.434E-03	1.287E+00
888	73.21	9.96	36.06	9.756E-06	-7.434E-03	1.287E+00
889	70.85	1.61	35.23	9.756E-06	-7.434E-03	1.287E+00
890	67.29	19.56	34.02	9.756E-06	-7.434E-03	1.287E+00
891	65.22	40.00	32.37	9.756E-06	-7.434E-03	1.287E+00
892	63.15	8.35	30.81	9.756E-06	-7.434E-03	1.287E+00
893	61.09	([a])	29.57	9.756E-06	-7.434E-03	1.287E+00
894	42.10	8.95	28.26	9.756E-06	-7.434E-03	1.287E+00
895	31.96	10.00	25.94	9.756E-06	-7.434E-03	1.287E+00
896	29.42	7.38	23.56	9.756E-06	-7.434E-03	1.287E+00
897	26.04	([a])	22.00	9.756E-06	-7.434E-03	1.287E+00

898	14.71	([a])	19.21	9.756E-06	-7.434E-03	1.287E+00
899	1.90	([a])	16.51	9.756E-06	-7.434E-03	1.287E+00
900	0	0	12.12	9.756E-06	-7.434E-03	1.287E+00
901	0	0	7.07	9.756E-06	-7.434E-03	1.287E+00
902	0	0	2.60	9.756E-06	-7.434E-03	1.287E+00
903	0	0	0	9.756E-06	-7.434E-03	1.287E+00
904	0	0	0	1.390E-05	-1.206E-02	3.180E+00
905	0	0	0	1.805E-05	-1.669E-02	5.073E+00
906	0	0	0	2.219E-05	-2.131E-02	6.967E+00
907	0	0	0	2.219E-05	-2.131E-02	6.967E+00
908	0	0	0	2.219E-05	-2.131E-02	6.967E+00
909	0	0	0	2.219E-05	-2.131E-02	6.967E+00
910	0	0	0	2.219E-05	-2.131E-02	6.967E+00
911	0	0	0	2.219E-05	-2.131E-02	6.967E+00
912	0	0	0	2.219E-05	-2.131E-02	6.967E+00
913	0	0	0	2.219E-05	-2.131E-02	6.967E+00
914	0	0	0	2.219E-05	-2.131E-02	6.967E+00
915	0	0	0	2.219E-05	-2.131E-02	6.967E+00
916	0	0	0	2.219E-05	-2.131E-02	6.967E+00
917	0	0	0	2.219E-05	-2.131E-02	6.967E+00
918	0	0	0	2.219E-05	-2.131E-02	6.967E+00
919	0	0	0	2.219E-05	-2.131E-02	6.967E+00
920	0	0	0	2.219E-05	-2.131E-02	6.967E+00
921	0	0	0	2.219E-05	-2.131E-02	6.967E+00
922	0	0	0	2.219E-05	-2.131E-02	6.967E+00
923	0	0	0	2.219E-05	-2.131E-02	6.967E+00
924	0	0	0	2.219E-05	-2.131E-02	6.967E+00
925	0	0	0	2.219E-05	-2.131E-02	6.967E+00
926	0	0	0	2.219E-05	-2.131E-02	6.967E+00
927	0	3.67	0	2.219E-05	-2.131E-02	6.967E+00
928	0	47.69	0	2.219E-05	-2.131E-02	6.967E+00
929	2.78	59.41	0.33	2.219E-05	-2.131E-02	6.967E+00
930	8.12	84.54	1.67	2.219E-05	-2.131E-02	6.967E+00
931	13.95	80.00	2.83	2.219E-05	-2.131E-02	6.967E+00
932	29.90	80.00	4.02	2.219E-05	-2.131E-02	6.967E+00
933	33.87	79.29	5.64	2.219E-05	-2.131E-02	6.967E+00
934	27.86	38.25	7.39	2.219E-05	-2.131E-02	6.967E+00
935	19.63	26.67	8.83	2.219E-05	-2.131E-02	6.967E+00
936	26.79	15.10	9.15	2.219E-05	-2.131E-02	6.967E+00
937	19.85	16.47	9.70	2.219E-05	-2.131E-02	6.967E+00
938	17.51	28.05	11.37	2.219E-05	-2.131E-02	6.967E+00
939	17.86	20.38	13.04	2.219E-05	-2.131E-02	6.967E+00
940	16.37	([a])	14.74	2.219E-05	-2.131E-02	6.967E+00

941	5.85	([a])	16.41	2.219E-05	-2.131E-02	6.967E+00
942	14.13	([a])	16.85	2.219E-05	-2.131E-02	6.967E+00
943	21.10	([a])	16.09	2.219E-05	-2.131E-02	6.967E+00
944	15.63	([a])	15.23	2.219E-05	-2.131E-02	6.967E+00
945	12.67	62.52	14.22	2.219E-05	-2.131E-02	6.967E+00
946	14.86	69.36	13.02	2.219E-05	-2.131E-02	6.967E+00
947	24.79	60.00	12.47	2.219E-05	-2.131E-02	6.967E+00
948	33.06	63.79	13.05	2.219E-05	-2.131E-02	6.967E+00
949	42.29	75.36	14.26	2.219E-05	-2.131E-02	6.967E+00
950	48.90	80.00	15.09	2.219E-05	-2.131E-02	6.967E+00
951	51.52	80.00	15.42	2.219E-05	-2.131E-02	6.967E+00
952	48.24	79.92	15.96	2.219E-05	-2.131E-02	6.967E+00
953	51.79	65.03	16.58	2.219E-05	-2.131E-02	6.967E+00
954	52.37	43.23	17.61	2.219E-05	-2.131E-02	6.967E+00
955	56.14	50.00	18.33	2.219E-05	-2.131E-02	6.967E+00
956	62.35	50.00	18.65	2.219E-05	-2.131E-02	6.967E+00
957	64.29	42.05	19.67	2.219E-05	-2.131E-02	6.967E+00
958	67.69	40.00	20.47	2.219E-05	-2.131E-02	6.967E+00
959	75.20	42.20	20.57	2.219E-05	-2.131E-02	6.967E+00
960	74.88	41.28	20.68	2.219E-05	-2.131E-02	6.967E+00
961	71.92	([a])	21.56	2.219E-05	-2.131E-02	6.967E+00
962	71.88	([a])	23.19	2.219E-05	-2.131E-02	6.967E+00
963	69.64	([a])	23.64	7.398E-06	-7.105E-03	2.322E+00
964	71.24	([a])	22.75	-7.398E-06	7.105E-03	-2.322E+00
965	71.72	30.54	21.81	-2.219E-05	2.131E-02	-6.967E+00
966	76.41	42.12	20.79	-2.219E-05	2.131E-02	-6.967E+00
967	73.02	50.00	19.86	-2.219E-05	2.131E-02	-6.967E+00
968	69.64	50.00	19.18	-2.219E-05	2.131E-02	-6.967E+00
969	72.09	43.16	18.75	-2.219E-05	2.131E-02	-6.967E+00
970	82.23	73.65	18.43	-2.219E-05	2.131E-02	-6.967E+00
971	78.58	([a])	18.61	-2.219E-05	2.131E-02	-6.967E+00
972	75.00	([a])	19.11	-2.219E-05	2.131E-02	-6.967E+00
973	75.00	([a])	18.76	-2.219E-05	2.131E-02	-6.967E+00
974	72.47	([a])	17.68	-2.219E-05	2.131E-02	-6.967E+00
975	62.91	([a])	16.46	-2.219E-05	2.131E-02	-6.967E+00
976	58.93	13.57	15.06	-2.219E-05	2.131E-02	-6.967E+00
977	55.56	29.43	13.41	-2.219E-05	2.131E-02	-6.967E+00
978	57.14	20.00	11.91	-2.219E-05	2.131E-02	-6.967E+00
979	56.68	17.42	11.09	-2.219E-05	2.131E-02	-6.967E+00
980	53.88	10.00	10.90	-2.219E-05	2.131E-02	-6.967E+00
981	50.76	10.00	11.40	-2.219E-05	2.131E-02	-6.967E+00
982	50.00	([a])	12.38	-2.219E-05	2.131E-02	-6.967E+00
983	46.83	([a])	13.02	-2.219E-05	2.131E-02	-6.967E+00

984	35.63	10.00	12.30	-2.219E-05	2.131E-02	-6.967E+00
985	32.48	10.00	10.32	-2.219E-05	2.131E-02	-6.967E+00
986	26.79	10.00	9.70	-2.219E-05	2.131E-02	-6.967E+00
987	24.94	10.00	11.05	-2.219E-05	2.131E-02	-6.967E+00
988	23.21	16.74	11.88	-2.219E-05	2.131E-02	-6.967E+00
989	24.70	3.36	12.21	-2.219E-05	2.131E-02	-6.967E+00
990	25.00	([a])	13.29	-2.219E-05	2.131E-02	-6.967E+00
991	24.47	([a])	13.73	-2.219E-05	2.131E-02	-6.967E+00
992	18.71	([a])	12.77	-2.219E-05	2.131E-02	-6.967E+00
993	10.85	([a])	11.46	-2.219E-05	2.131E-02	-6.967E+00
994	3.40	([a])	9.84	-2.219E-05	2.131E-02	-6.967E+00
995	0	0	7.62	-2.219E-05	2.131E-02	-6.967E+00
996	0	0	3.57	-2.219E-05	2.131E-02	-6.967E+00
997	0	0.91	1.33	-2.219E-05	2.131E-02	-6.967E+00
998	0	7.52	0	-2.219E-05	2.131E-02	-6.967E+00
999	0	0	0	-2.219E-05	2.131E-02	-6.967E+00
1,000	0	0	0	-4.577E-06	5.686E-03	-3.784E+00
1,001	0	0	0	1.304E-05	-9.944E-03	-6.018E-01
1,002	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,003	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,004	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,005	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,006	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,007	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,008	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,009	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,010	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,011	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,012	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,013	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,014	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,015	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,016	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,017	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,018	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,019	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,020	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,021	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,022	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,023	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,024	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,025	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,026	0	0	0	3.066E-05	-2.557E-02	2.581E+00

1,027	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,028	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,029	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,030	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,031	1.58	([a])	0	3.066E-05	-2.557E-02	2.581E+00
1,032	1.43	([a])	0	3.066E-05	-2.557E-02	2.581E+00
1,033	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,034	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,035	1.91	9.28	0	3.066E-05	-2.557E-02	2.581E+00
1,036	2.75	0	0	3.066E-05	-2.557E-02	2.581E+00
1,037	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,038	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,039	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,040	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,041	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,042	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,043	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,044	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,045	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,046	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,047	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,048	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,049	0	5.51	0	3.066E-05	-2.557E-02	2.581E+00
1,050	0	11.34	0	3.066E-05	-2.557E-02	2.581E+00
1,051	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,052	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,053	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,054	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,055	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,056	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,057	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,058	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,059	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,060	0	0.21	0	3.066E-05	-2.557E-02	2.581E+00
1,061	0	30.00	0	3.066E-05	-2.557E-02	2.581E+00
1,062	0	26.78	0	3.066E-05	-2.557E-02	2.581E+00
1,063	0	20.00	0	3.066E-05	-2.557E-02	2.581E+00
1,064	0	20.00	0	3.066E-05	-2.557E-02	2.581E+00
1,065	0	4.12	0	3.066E-05	-2.557E-02	2.581E+00
1,066	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,067	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,068	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,069	0	0	0	3.066E-05	-2.557E-02	2.581E+00

1,070	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,071	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,072	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,073	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,074	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,075	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,076	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,077	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,078	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,079	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,080	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,081	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,082	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,083	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,084	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,085	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,086	0	20.00	0	3.066E-05	-2.557E-02	2.581E+00
1,087	0	20.00	0	3.066E-05	-2.557E-02	2.581E+00
1,088	0	11.73	0	3.066E-05	-2.557E-02	2.581E+00
1,089	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,090	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,091	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,092	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,093	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,094	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,095	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,096	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,097	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,098	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,099	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,100	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,101	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,102	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,103	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,104	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,105	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,106	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,107	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,108	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,109	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,110	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,111	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,112	0	0	0	3.066E-05	-2.557E-02	2.581E+00

1,113	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,114	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,115	0	0	0	3.066E-05	-2.557E-02	2.581E+00
1,116	0	73.41	0	3.066E-05	-2.557E-02	2.581E+00
1,117	0	90.00	0	3.066E-05	-2.557E-02	2.581E+00
1,118	27.95	81.30	2.83	3.066E-05	-2.557E-02	2.581E+00
1,119	36.74	90.00	5.87	3.066E-05	-2.557E-02	2.581E+00
1,120	39.29	90.00	8.67	3.066E-05	-2.557E-02	2.581E+00
1,121	41.44	90.00	11.47	3.066E-05	-2.557E-02	2.581E+00
1,122	45.57	82.41	14.26	3.066E-05	-2.557E-02	2.581E+00
1,123	59.52	80.00	16.91	3.066E-05	-2.557E-02	2.581E+00
1,124	66.99	90.00	18.33	3.066E-05	-2.557E-02	2.581E+00
1,125	80.22	90.00	19.35	3.066E-05	-2.557E-02	2.581E+00
1,126	86.41	93.88	21.55	3.066E-05	-2.557E-02	2.581E+00
1,127	86.53	50.94	24.84	3.066E-05	-2.557E-02	2.581E+00
1,128	84.46	17.02	26.81	3.066E-05	-2.557E-02	2.581E+00
1,129	88.54	28.60	28.36	2.397E-05	-2.025E-02	2.539E+00
1,130	89.29	39.83	30.31	1.729E-05	-1.494E-02	2.498E+00
1,131	89.29	30.00	30.82	1.060E-05	-9.616E-03	2.457E+00
1,132	89.29	26.69	30.86	1.060E-05	-9.616E-03	2.457E+00
1,133	90.16	20.00	31.82	1.060E-05	-9.616E-03	2.457E+00
1,134	89.92	20.00	33.33	1.060E-05	-9.616E-03	2.457E+00
1,135	89.29	36.06	34.20	1.060E-05	-9.616E-03	2.457E+00
1,136	85.86	40.00	33.82	1.060E-05	-9.616E-03	2.457E+00
1,137	85.51	30.00	33.51	1.060E-05	-9.616E-03	2.457E+00
1,138	84.42	32.75	33.87	1.060E-05	-9.616E-03	2.457E+00
1,139	86.48	35.68	34.70	1.060E-05	-9.616E-03	2.457E+00
1,140	88.55	30.00	36.14	1.060E-05	-9.616E-03	2.457E+00
1,141	89.29	44.93	37.60	1.060E-05	-9.616E-03	2.457E+00
1,142	90.90	50.00	38.09	1.060E-05	-9.616E-03	2.457E+00
1,143	77.27	([a])	38.13	3.535E-06	-3.205E-03	8.188E-01
1,144	56.75	([a])	38.05	-3.535E-06	3.205E-03	-8.188E-01
1,145	50.00	([a])	37.47	-1.060E-05	9.616E-03	-2.457E+00
1,146	41.07	([a])	36.69	-1.060E-05	9.616E-03	-2.457E+00
1,147	37.38	45.18	35.89	-1.060E-05	9.616E-03	-2.457E+00
1,148	34.21	78.47	35.06	-1.060E-05	9.616E-03	-2.457E+00
1,149	32.13	80.00	34.63	-1.060E-05	9.616E-03	-2.457E+00
1,150	27.71	80.00	34.13	-1.060E-05	9.616E-03	-2.457E+00
1,151	22.64	80.00	33.15	-1.060E-05	9.616E-03	-2.457E+00
1,152	20.58	60.97	32.12	-1.060E-05	9.616E-03	-2.457E+00
1,153	16.25	27.34	31.02	-1.060E-05	9.616E-03	-2.457E+00
1,154	11.46	43.71	29.82	-1.060E-05	9.616E-03	-2.457E+00
1,155	9.02	68.95	28.41	-1.060E-05	9.616E-03	-2.457E+00

1,156	3.38	68.95	26.91	-1.060E-05	9.616E-03	-2.457E+00
1,157	1.32	44.28	25.53	-1.060E-05	9.616E-03	-2.457E+00
1,158	0	0	24.21	-1.060E-05	9.616E-03	-2.457E+00
1,159	0	0	22.88	-1.060E-05	9.616E-03	-2.457E+00
1,160	0	0	18.40	-1.060E-05	9.616E-03	-2.457E+00
1,161	0	0	13.93	-1.060E-05	9.616E-03	-2.457E+00
1,162	0	0	9.45	-1.060E-05	9.616E-03	-2.457E+00
1,163	0	0	4.98	-1.060E-05	9.616E-03	-2.457E+00
1,164	0	0	0.50	-7.069E-06	6.411E-03	-1.638E+00
1,165	0	24.97	0	-3.535E-06	3.205E-03	-8.188E-01
1,166	0	17.16	0	0	0	0
1,167	0	6.20	0	0	0	0
1,168	0	10.00	0	0	0	0
1,169	0	10.00	0	0	0	0
1,170	0	0	0	0	0	0
1,171	0	0	0	0	0	0
1,172	0	0	0	0	0	0
1,173	0	0	0	0	0	0
1,174	0	0	0	0	0	0
1,175	0	0	0	0	0	0
1,176	0	0	0	0	0	0
1,177	0	0	0	0	0	0
1,178	0	0	0	0	0	0
1,179	0	0	0	0	0	0
1,180	0	0	0	0	0	0
1,181	0	0	0	0	0	0
1,182	0	0	0	0	0	0
1,183	0	0	0	0	0	0
1,184	0	0	0	0	0	0
1,185	0	0	0	0	0	0
1,186	0	0	0	0	0	0
1,187	0	0	0	0	0	0
1,188	0	0	0	0	0	0
1,189	0	0	0	0	0	0
1,190	0	0	0	0	0	0
1,191	0	0	0	0	0	0
1,192	0	0	0	0	0	0
1,193	0	0	0	0	0	0
1,194	0	0	0	0	0	0
1,195	0	0	0	0	0	0
1,196	0	0	0	0	0	0
1,197	0	0	0	0	0	0
1,198	0	0	0	0	0	0

1,199	0	0	0	0	0	0

[a]Closed throttle motoring.

PART 1037—CONTROL OF EMISSIONS FROM NEW HEAVY-DUTY MOTOR VEHICLES

127. The authority citation for part 1037 continues to read as follows:
Authority: 42 U.S.C. 7401 - 7671q.

128. Amend §1037.103 by revising paragraph (c) to read as follows:

§1037.103 Evaporative and refueling emission standards.

* * * * *

(c) Compliance demonstration. You may provide a statement in the application for certification that vehicles above 14,000 pounds GVWR comply with evaporative and refueling emission standards instead of submitting test data if you include an engineering analysis describing how vehicles include design parameters, equipment, operating controls, or other elements of design that adequately demonstrate that vehicles comply with the standards throughout the useful life. We would expect emission control components and systems to exhibit a comparable degree of control relative to vehicles that comply based on testing. For example, vehicles that comply under this paragraph (c) should rely on comparable material specifications to limit fuel permeation, and components should be sized and calibrated to correspond with the appropriate fuel capacities, fuel flow rates, purge strategies, and other vehicle operating characteristics. You may alternatively show that design parameters are comparable to those for vehicles at or below 14,000 pounds GVWR certified under 40 CFR part 86, subpart S.

* * * * *

129. Amend §1037.105 by revising paragraph (h)(1) to read as follows:

§1037.105 CO_2 emission standards for vocational vehicles.

* * * * *

(h) * * *

(1) The following alternative emission standards apply by vehicle type and model year as follows:

Table 5 of §1037.105—Phase 2 Custom Chassis Standards (g/ton-mile)

VEHICLE TYPE[a]	ASSIGNED VEHICLE SERVICE CLASS	MY 2021-2026	MY 2027+
School bus	Medium HDV	291	271
Motor home	Medium HDV	228	226
Coach bus	Heavy HDV	210	205
Other bus	Heavy HDV	300	286
Refuse hauler	Heavy HDV	313	298
Concrete mixer	Heavy HDV	319	316
Mixed-use vehicle	Heavy HDV	319	316
Emergency vehicle	Heavy HDV	324	319

[a]Vehicle types are generally defined in §1037.801. “Other bus” includes any bus that is not a school bus or a coach bus. A “mixed-use vehicle” is one that meets at least one of the criteria specified in §1037.631(a)(1) and at least one of the criteria in §1037.631(a)(2), but not both.

* * * * *

130. Amend §1037.106 by revising paragraphs (b) and (f)(2)(i) to read as follows:

§1037.106 Exhaust emission standards for tractors above 26,000 pounds GVWR.

* * * * *

(b) The CO_2 standards for tractors above 26,000 pounds GVWR in Table 1 of this section apply based on modeling and testing as described in subpart F of this part. The provisions of §1037.241 specify how to comply with these standards.

Table 1 of §1037.106—CO_2 Standards for
Class 7 and Class 8 Tractors by Model Year (g/ton-mile)

SUBCATEGORY[a]	PHASE 1 STANDARDS FOR MODEL YEARS 2014-2016	PHASE 1 STANDARDS FOR MODEL YEARS 2017-2020	PHASE 2 STANDARDS FOR MODEL YEARS 2021-2023	PHASE 2 STANDARDS FOR MODEL YEARS 2024-2026	PHASE 2 STANDARDS FOR MODEL YEAR 2027 AND LATER
Class 7 Low-Roof (all cab styles)	107	104	105.5	99.8	96.2
Class 7 Mid-Roof (all cab styles)	119	115	113.2	107.1	103.4
Class 7 High-Roof (all cab styles)	124	120	113.5	106.6	100.0
Class 8 Low-Roof Day Cab	81	80	80.5	76.2	73.4
Class 8 Low-Roof Sleeper Cab	68	66	72.3	68.0	64.1
Class 8 Mid-Roof Day Cab	88	86	85.4	80.9	78.0
Class 8 Mid-Roof Sleeper Cab	76	73	78.0	73.5	69.6
Class 8 High-Roof Day Cab	92	89	85.6	80.4	75.7
Class 8 High-Roof Sleeper Cab	75	72	75.7	70.7	64.3
Heavy-Haul Tractors	—	—	52.4	50.2	48.3

[a]Sub-category terms are defined in §1037.801.

* * * * *

(f) * * *

(2) * * *

(i) If you certify all your Class 7 tractors to Class 8 standards, you may use these Heavy HDV credits without restriction. This applies equally for hybrid and electric vehicles.

* * * * *

131. Amend §1037.115 by revising paragraph (e) to read as follows:

§1037.115 Other requirements.

* * * * *

(e) Air conditioning leakage. Loss of refrigerant from your air conditioning systems may not exceed a total leakage rate of 11.0 grams per year or a percent leakage rate of 1.50 percent per year, whichever is greater. This applies for all refrigerants. Calculate the total leakage rate in g/year as specified in 40 CFR 86.1867-12(a). Calculate the percent leakage rate as: [total leakage

rate (g/yr)] ÷ [total refrigerant capacity (g)] × 100. Round your percent leakage rate to the nearest one-hundredth of a percent.
(1) This paragraph (e) is intended to address air conditioning systems for which the primary purpose is to cool the driver compartment. This would generally include all cab-complete pickups and vans. This paragraph (e) does not apply for refrigeration units on trailers. Similarly, it does not apply for self-contained air conditioning used to cool passengers or refrigeration units used to cool cargo on vocational vehicles. Air conditioning and refrigeration units may be considered self-contained whether or not they draw electrical power from engines used to propel the vehicles. For purposes of this paragraph (e), a self-contained system is an enclosed unit with its own evaporator and condenser even if it draws power from the engine.
(2) For purposes of this requirement, "refrigerant capacity" is the total mass of refrigerant recommended by the vehicle manufacturer as representing a full charge. Where full charge is specified as a pressure, use good engineering judgment to convert the pressure and system volume to a mass.
(3) If air conditioning systems with capacity above 3000 grams of refrigerant are designed such that a compliance demonstration under 40 CFR 86.1867-12(a) is impossible or impractical, you may ask to use alternative means to demonstrate that your air conditioning system achieves an equivalent level of control.

132. Amend §1037.120 by revising paragraph (b)(1)(i) and (ii) to read as follows:
§1037.120 Emission-related warranty requirements.
* * * * *
(b)(1) * * *
(i) 5 years or 50,000 miles for Light HDV (except tires).
(ii) 5 years or 100,000 miles for Medium HDV and Heavy HDV (except tires).
* * * * *

§1037.135—[Revised]
133. Amend §1037.135 by removing and reserving paragraph (c)(4).

134. Amend §1037.140 by revising paragraphs (g) and (h) to read as follows:
§1037.140 Classifying vehicles and determining vehicle parameters.
* * * * *
(g) The standards and other provisions of this part apply to specific vehicle service classes for tractors and vocational vehicles as follows:

(1) Phase 1 and Phase 2 tractors are divided based on GVWR into Class 7 tractors and Class 8 tractors. Where provisions apply to both tractors and vocational vehicles, Class 7 tractors are considered "Medium HDV" and Class 8 tractors are considered "Heavy HDV". This applies for electric, hybrid, and non-hybrid vehicles.

(2) Phase 1 vocational vehicles are divided based on GVWR. "Light HDV" includes Class 2b through Class 5 vehicles; "Medium HDV includes Class 6 and Class 7 vehicles; and "Heavy HDV includes Class 8 vehicles.

(3) Phase 2 vocational vehicles propelled by engines subject to the spark-ignition standards of 40 CFR part 1036, "Light HDV" includes Class 2b through Class 5 vehicles, and "Medium HDV" includes Class 6 through Class 8 vehicles.

(4) Phase 2 vocational vehicles propelled by engines subject to the compression-ignition

standards in 40 CFR part 1036 are divided as follows:

(i) Class 2b through Class 5 vehicles are considered “Light HDV”.

(ii) Class 6 through 8 vehicles are considered “Heavy HDV” if the installed engine’s primary intended service class is heavy heavy-duty (see 40 CFR 1036.140).

(iii) Class 8 hybrid and electric vehicles are considered “Heavy HDV”, regardless of the engine’s primary intended service class.

(iv) All other Class 6 through Class 8 vehicles are considered “Medium HDV”.

(5) In certain circumstances, you may certify vehicles to standards that apply for a different vehicle service class. For example, see §§1037.105(g) and 1037.106(f). If you optionally certify vehicles to different standards, those vehicles are subject to all the regulatory requirements as if the standards were mandatory.

(h) Use good engineering judgment to identify the intended regulatory subcategory (Urban, Multi-Purpose, or Regional) for each of your vocational vehicle configurations based on the expected use of the vehicles.

135. Amend §1037.150 by revising paragraphs (c), (q)(2), (s), (u), (x) introductory text, (y), (z), and (aa) to read as follows:

§1037.150 Interim provisions.

* * * * *

(c) Small manufacturers. The following provisions apply for small manufacturers:

(1) Small manufacturers are not subject to the greenhouse gas standards of §1037.107 for trailers with a date of manufacture before January 1, 2019.

(2) The greenhouse gas standards of §§1037.105 and 1037.106 are optional for small manufacturers producing vehicles with a date of manufacture before January 1, 2022. In addition, small manufacturers producing vehicles that run on any fuel other than gasoline, E85, or diesel fuel may delay complying with every later standard under this part by one model year.

(3) Qualifying manufacturers must notify the Designated Compliance Officer each model year before introducing excluded vehicles into U.S. commerce. This notification must include a description of the manufacturer’s qualification as a small business under 13 CFR 121.201. Manufacturers must label excluded vehicles with the following statement: “THIS VEHICLE IS EXCLUDED UNDER 40 CFR 1037.150(c).”

(4) Small manufacturers may meet Phase 1 standards instead of Phase 2 standards in the first year Phase 2 standards apply to them if they voluntarily comply with the Phase 1 standards for the full preceding year. Specifically, small manufacturers may certify their model year 2022 vehicles to the Phase 1 greenhouse gas standards of §§1037.105 and 1037.106 if they certify all the vehicles from their annual U.S.-directed production volume to the Phase 1 standards starting on or before January 1, 2021.

(5) See paragraphs (r), (t), (y), and (aa) of this section for additional allowances for small manufacturers.

* * * * *

(q) * * *

(2) For vocational vehicles and tractors subject to Phase 2 standards, create separate vehicle subfamilies if there is a credit multiplier for advanced technology; group those vehicles together in a vehicle subfamily if they use the same multiplier.

* * * * *

(s) Confirmatory testing for $F_{alt-aero}$. If we conduct coastdown testing to verify your $F_{alt-aero}$ value for Phase 2 tractors, we will make our determination using the principles of SEA testing in §1037.305. We will not replace your $F_{alt-aero}$ value if the tractor passes. If your tractor fails, we will generate a replacement value of $F_{alt-aero}$ based on at least one C_dA value and corresponding effective yaw angle, ψ_{eff}, from a minimum of 100 valid runs using the procedures of §1037.528(h). Note that we intend to minimize the differences between our test conditions and those of the manufacturer by testing at similar times of the year where possible and the same location where possible and when appropriate.

* * * * *

(u) Streamlined preliminary approval for trailer devices. Before January 1, 2018, manufacturers of aerodynamic devices for trailers may ask for preliminary EPA approval of compliance data for their devices based on qualifying for designation under the SmartWay program based on measured C_dA values, whether or not that involves testing or other methods specified in §1037.526. Trailer manufacturers may certify based on ΔC_dA values established under this paragraph (u) through model year 2020. Manufacturers must perform testing as specified in subpart F of this part for any vehicles or aerodynamic devices not qualifying for approval under this paragraph (u).

* * * * *

(x) Aerodynamic testing for trailers. Section 1037.526 generally requires you to adjust ΔC_dA values from alternate test methods to be equivalent to measurements with the primary test method. This paragraph (x) describes approximations that we believe are consistent with good engineering judgment; however, you may not use these approximations where we determine that clear and convincing evidence shows that they would significantly overestimate actual improvements in aerodynamic performance.

* * * * *

(y) Transition to Phase 2 standards. The following provisions allow for enhanced generation and use of emission credits from Phase 1 tractors and vocational vehicles for meeting the Phase 2 standards:

(1) For vocational Light HDV and vocational Medium HDV, emission credits you generate in model years 2018 through 2021 may be used through model year 2027, instead of being limited to a five-year credit life as specified in §1037.740(c). For Class 8 vocational vehicles with medium heavy-duty engines, we will approve your request to generate these credits in and use these credits for the Medium HDV averaging set if you show that these vehicles would qualify as Medium HDV under the Phase 2 program as described in §1037.140(g)(4).

(2) You may use the off-cycle provisions of §1037.610 to apply technologies to Phase 1 vehicles as follows:

(i) You may apply an improvement factor of 0.988 for tractors and vocational vehicles with automatic tire inflation systems on all axles.

(ii) For vocational vehicles with automatic engine shutdown systems that conform with §1037.660, you may apply an improvement factor of 0.95.

(iii) For vocational vehicles with stop-start systems that conform with §1037.660, you may apply an improvement factor of 0.92.

(iv) For vocational vehicles with neutral-idle systems conforming with §1037.660, you may apply an improvement factor of 0.98. You may adjust this improvement factor if we approve a partial reduction under §1037.660(a)(2); for example, if your design reduces fuel consumption by half as much as shifting to neutral, you may apply an improvement factor of 0.99.

(3) Small manufacturers may generate emission credits for natural gas-fueled vocational vehicles as follows:

(i) Small manufacturers may certify their vehicles instead of relying on the exemption of paragraph (c) of this section. The provisions of this part apply for such vehicles, except as specified in this paragraph (y)(3).

(ii) Use GEM version 2.0.1 to determine a CO_2 emission level for your vehicle, then multiply this value by the engine's FCL for CO_2 and divide by the engine's applicable CO_2 emission standard.

(4) Phase 1 vocational vehicle credits that small manufacturers generate may be used through model year 2027.

(z) Constraints for vocational regulatory subcategories. The following provisions apply to determinations of vocational regulatory subcategories as described in §1037.140:

(1) Select the Regional regulatory subcategory if you certify the engine based on testing only with the Supplemental Emission Test.

(2) Select the Regional regulatory subcategory for coach buses and motor homes you certify under §1037.105(b).

(3) You may not select the Urban regulatory subcategory for any vehicle with a manual or single-clutch automated manual transmission.

(4) Starting in model year 2024, you must select the Regional regulatory subcategory for any vehicle with a manual transmission.

(5) You may select the Multi-purpose regulatory subcategory for any vocational vehicle, except as specified in paragraphs (z)(1) through (3) of this section.

(6) You may not select the Urban regulatory subcategory for any vehicle with a manual or single-clutch automated manual transmission.

(7) You may select the Urban regulatory subcategory for a hybrid vehicle equipped with regenerative braking, unless it is equipped with a manual transmission.

(8) You may select the Urban regulatory subcategory for any vehicle with a hydrokinetic torque converter paired with an automatic transmission, or a continuously variable automatic transmission, or a dual-clutch transmission with no more than two consecutive forward gears between which it is normal for both clutches to be momentarily disengaged.

(aa) Custom-chassis standards. The following provisions apply uniquely to small manufacturers under the custom-chassis standards of §1037.105(h):

(1) You may use emission credits generated under §1037.105(d), including banked or traded credits from any averaging set. Such credits remain subject to other limitations that apply under subpart H of this part.

(2) You may produce up to 200 drayage tractors in a given model year to the standards described in §1037.105(h) for "other buses". This limit applies with respect to vehicles produced by you and your affiliated companies. Treat these drayage tractors as being in their own averaging set.

136. Amend §1037.201 by revising paragraph (h) to read as follows:

§1037.201 General requirements for obtaining a certificate of conformity.

* * * * *

(h) The certification and testing provisions of 40 CFR part 86, subpart S, apply instead of the provisions of this subpart relative to the evaporative and refueling emission standards specified

in §1037.103, except that §1037.243 describes how to demonstrate compliance with evaporative emission standards. For vehicles that do not use an evaporative canister for controlling diurnal emissions, you may certify with respect to exhaust emissions and use the provisions of §1037.622 to let a different company certify with respect to evaporative emissions.
* * * * *

137. Amend §1037.205 by revising paragraphs (e) and (f) to read as follows:

§1037.205 What must I include in my application?

* * * * *

(e) Describe any test equipment and procedures that you used, including any special or alternate test procedures you used (see §1037.501). Include information describing the procedures you used to determine C_dA values as specified in §§1037.525 through 1037.527. Describe which type of data you are using for engine fuel maps (see 40 CFR 1036.503). If your trailer certification relies on approved data from device manufacturers, identify the device and device manufacturer.

(f) Describe how you operated any emission-data vehicle before testing, including the duty cycle and the number of vehicle operating miles used to stabilize emission-related performance. Explain why you selected the method of service accumulation. Describe any scheduled maintenance you did, and any practices or specifications that should apply for our testing.

* * * * *

138. Amend §1037.225 by revising paragraph (e) to read as follows:

§1037.225 Amending applications for certification.

* * * * *

(e) The amended application applies starting with the date you submit the amended application, as follows:

(1) For vehicle families already covered by a certificate of conformity, you may start producing a new or modified vehicle configuration any time after you send us your amended application and before we make a decision under paragraph (d) of this section. However, if we determine that the affected vehicles do not meet applicable requirements, we will notify you to cease production of the vehicles and may require you to recall the vehicles at no expense to the owner. Choosing to produce vehicles under this paragraph (e) is deemed to be consent to recall all vehicles that we determine do not meet applicable emission standards or other requirements and to remedy the nonconformity at no expense to the owner. If you do not provide information required under paragraph (c) of this section within 30 days after we request it, you must stop producing the new or modified vehicles.

(2) [Reserved]

* * * * *

139. Amend §1037.230 by revising paragraph (a)(2) to read as follows:

§1037.230 Vehicle families, sub-families, and configurations.

(a) * * *

(2) Apply subcategories for tractors (other than vocational tractors) as shown in Table 2 of this section.

(i) For vehicles certified to the optional tractor standards in §1037.670, assign the subcategories as described in §1037.670.

(ii) For vehicles intended for export to Canada, you may assign the subcategories as specified in the Canadian regulations.

(iii) Table 2 follows:

Table 2 of §1037.230— Tractor Subcategories

CLASS 7	CLASS 8	
Low-roof tractors	Low-roof day cabs	Low-roof sleeper cabs
Mid-roof tractors	Mid-roof day cabs	Mid-roof sleeper cabs
High-roof tractors	High-roof day cabs	High-roof sleeper cabs
—	Heavy-haul tractors (starting with Phase 2)	

* * * * *

140. Amend §1037.231 by revising paragraph (b)(7) to read as follows:

§1037.231 Powertrain families.

* * * * *

(b) * * *

(7) Number of available forward gears, and transmission gear ratio for each available forward gear, if applicable. Count forward gears as being available only if the vehicle has the hardware and software to allow operation in those gears.

* * * * *

141. Amend §1037.235 by revising paragraphs (a), (c)(2), and (h) to read as follows:

§1037.235 Testing requirements for certification.

* * * * *

(a) Select emission-data vehicles that represent production vehicles and components for the vehicle family consistent with the specifications in §§1037.205(o), 1037.515, and 1037.520. Where the test results will represent multiple vehicles or components with different emission performance, use good engineering judgment to select worst-case emission data vehicles or components. In the case of powertrain testing under §1037.550, select a test engine, test hybrid components, test axle and test transmission as applicable, by considering the whole range of vehicle models covered by the powertrain family and the mix of duty cycles specified in §1037.510. If the powertrain has more than one transmission calibration, for example economy vs. performance, you may weight the results from the powertrain testing in §1037.550 by the percentage of vehicles in the family by prior model year for each configuration. This can be done, for example, through the use of survey data or based on the previous model year's sales volume. Weight the results of $M_{\text{fuel[cycle]}}$, $\frac{f_{\text{npowertrain}}}{v_{\text{powertrain}}}$, and $W_{\text{[cycle]}}$ from Table 2 of §1037.550 according to the percentage of vehicles in the family that use each transmission calibration.

* * * * *

(c) * * *

(2) If we measure emissions (or other parameters, as applicable) from your vehicle or component, the results of that testing become the official emission results for the vehicle or component. Note that changing the official emission result does not necessarily require a change in the declared modeling input value. These results will only affect your vehicle FEL if the results of our confirmatory testing result in a GEM vehicle emission value that is higher than the

vehicle FEL declared by the manufacturer. Unless we later invalidate these data, we may decide not to consider your data in determining if your vehicle family meets applicable requirements.
* * * * *
(h) You may ask us to use analytically derived GEM inputs for untested configurations (such as untested axle ratios within an axle family) as identified in subpart F of this part based on interpolation of all relevant measured values for related configurations, consistent with good engineering judgment. We may establish specific approval criteria based on prevailing industry practice. If we allow this, we may test any configuration. We may also require you to test any configuration as part of a selective enforcement audit.

142. Amend §1037.243 by revising paragraph (c) to read as follows:
§1037.243 Demonstrating compliance with evaporative emission standards.
* * * * *
(c) Apply deterioration factors to measured emission levels for comparing to the emission standard. Establish an additive deterioration factor based on an engineering analysis that takes into account the expected aging from in-use vehicles.
* * * * *

143. Revise §1037.255 to read as follows:
§1037.255 What decisions may EPA make regarding my certificate of conformity?
(a) If we determine an application is complete and shows that the vehicle family meets all the requirements of this part and the Act, we will issue a certificate of conformity for the vehicle family for that model year. We may make the approval subject to additional conditions.
(b) We may deny an application for certification if we determine that a vehicle family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.
(c) In addition, we may deny an application or suspend or revoke a certificate of conformity if you do any of the following:
(1) Refuse to comply with any testing or reporting requirements.
(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.
(3) Cause any test data to become inaccurate.
(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.
(5) Produce vehicles for importation into the United States at a location where local law prohibits us from carrying out authorized activities.
(6) Fail to supply requested information or amend an application to include all vehicles being produced.
(7) Take any action that otherwise circumvents the intent of the Act or this part.
(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).
(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete after submission.

(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1037.820).

144. Amend §1037.301 by revising paragraph (b) to read as follows:

§1037.301 Overview of measurements related to GEM inputs in a selective enforcement audit.

* * * * *

(b) A selective enforcement audit for this part 1037 consists of performing measurements with production vehicles relative to one or more declared values for GEM inputs, and using those measured values in place of your declared values to run GEM. Except as specified in this subpart, the vehicle is considered passing if the new modeled emission result is at or below the modeled emission result corresponding to the declared GEM inputs. If you report an FEL for the vehicle configuration before the audit, we will instead consider the vehicle passing if the new cycle-weighted emission result is at or below the FEL.

* * * * *

145. Amend §1037.305 by revising the introductory text and paragraph (a) to read as follows:

§1037.305 Audit procedures for tractors—aerodynamic testing.

To perform a selective enforcement audit with respect to drag area for tractors, use the reference method specified in §1037.525; we may instead require you to use the same method you used for certification. The following provisions apply instead of 40 CFR 1068.415 through 1068.425 for a selective enforcement audit with respect to drag area:

(a) Determine whether a tractor meets standards as follows:

(1) We will select a vehicle configuration for testing. Perform a coastdown measurement according to §1037.528 with the vehicle in its production configuration. If the production configuration cannot be connected to a standard trailer, you may ask us to approve trailer specifications different than §1037.501(g)(1) based on good engineering judgment. Instead of the process described in §1037.528(h)(12), determine your test result as described in this paragraph (a). You must have an equal number of runs in each direction.

(2) Measure a yaw curve for your test vehicle using your alternate method according to §1037.525(b)(3). You do not need to test at the coastdown effective yaw angle. You may use a previously established yaw curve from your certification testing if it is available.

(3) Using the yaw curve, perform a regression using values of drag area, C_dA_{alt}, and yaw angle, ψ_{alt}, to determine the air-direction correction coefficients, a_0, a_1, a_2, a_3, and a_4, for the following equation:

$$C_dA_{alt}(\psi) = a_0 + a_1 \cdot \psi_{alt} + a_2 \cdot \psi_{alt}^2 + a_3 \cdot \psi_{alt}^3 + a_4 \cdot \psi_{alt}^4$$

Eq. 1037.305-1

(4) Adjust the drag area value from each coastdown run, C_dA_{run}, from the yaw angle of each run, ψ_{run}, to ±4.5° to represent a wind-averaged drag area value, C_dA_{wa} by applying Eq. 1037.305-1 as follows:

$$C_dA_{wa\text{-}run} = C_dA_{run} \cdot \left[\frac{C_dA_{alt,4.5°} + C_dA_{alt,-4.5°}}{C_dA_{alt,\psi run} + C_dA_{alt,-\psi run}} \right]$$

Eq. 1037.305-2

(5) Perform additional coastdown measurements until you reach a pass or fail decision under this paragraph (a). The minimum number of runs to pass is 24. The minimum number of runs to fail is 100.

(6) Calculate statistical values to characterize cumulative test results at least once per day based on an equal number of coastdown runs in each direction. Determine the wind-averaged drag area value for the test C_dA_{wa} by averaging all $C_dA_{wa\text{-}run}$ values for all days of testing. Determine the upper and lower bounds of the drag area value, $C_dA_{wa\text{-}bounded}$, expressed to two decimal places, using a confidence interval as follows:

$$C_dA_{\text{wa-bounded}} = C_dA_{\text{wa}} \pm \left(\frac{1.5\cdot\sigma}{\sqrt{n}} + 0.03\right)$$

Eq. 1037.305-3

Where:

$C_dA_{wa\text{-}bounded}$ = the upper bound, $C_dA_{wa\text{-}upper}$, and lower bound, $C_dA_{wa\text{-}lower}$, of the drag area value, where $C_dA_{wa\text{-}upper}$ is the larger number.

C_dA_{wa} = the average of all $C_dA_{wa\text{-}run}$ values.

σ = the standard deviation of all C_dA_{run} values (see 40 CFR 1065.602(c)).

n = the total number of coastdown runs.

(7) Determine compliance based on the values of $C_dA_{wa\text{-}upper}$ and $C_dA_{wa\text{-}lower}$ relative to the adjusted bin boundary. For purposes of this section, the upper limit of a bin is expressed as the specified value plus 0.05 to account for rounding. For example, for a bin including values of 5.5-5.9 m^2, being above the upper limit means exceeding 5.95 m^2. The vehicle passes or fails relative to the adjusted bin boundary based on one of the following criteria:

(i) The vehicle passes if $C_dA_{wa\text{-}upper}$ is less than or equal to the upper limit of the bin to which you certified the vehicle.

(ii) The vehicle fails if $C_dA_{wa\text{-}lower}$ is greater than the upper limit of the bin to which you certified the vehicle.

(iii) The vehicle passes if you perform 100 coastdown runs and $C_dA_{wa\text{-}upper}$ is greater than and $C_dA_{wa\text{-}lower}$ is lower than the upper limit of the bin to which you certified the vehicle.

(iv) The vehicle fails if you choose to stop testing before reaching a final determination under this paragraph (a)(7).

(v) You may continue testing beyond the stopping point specified in this paragraph (a)(7). We may consider the additional data in making pass/fail determinations.

* * * * *

146. Revise §1037.320 to read as follows:

§1037.320 Audit procedures for axles and transmissions.

Selective enforcement audit provisions apply for axles and transmissions relative to the efficiency demonstrations of §§1037.560 and 1037.565 as specified in this section. The following provisions apply instead of 40 CFR 1068.415 through 1068.445 for the selective enforcement audit.

(a) A selective enforcement audit for axles or transmissions would consist of performing measurements with a production axle or transmission to determine mean power loss values as declared for GEM simulations, and running GEM over one or more applicable duty cycles based on those measured values. The axle or transmission is considered passing for a given configuration if the new modeled emission result for every applicable duty cycle is at or below the modeled emission result corresponding to the declared GEM inputs.

(b) Run GEM for each applicable vehicle configuration identified in 40 CFR 1036.540 using the applicable default engine map defined in Appendix III of 40 CFR part 1036, and the default torque curve given in Table 1 of this section for the vehicle class as defined in §1037.140(g). For

axle testing, this may require omitting several vehicle configurations based on selecting axle ratios that correspond to the tested axle. For transmission testing, use the test transmission's gear ratios in place of the gear ratios defined in 40 CFR 1036.540. The GEM result for each vehicle configuration counts as a separate test for determining whether the family passes the audit.
(c) If the initial axle or transmission passes, the family passes and no further testing is required. If the initial axle or transmission does not pass, select two additional production axles or transmissions, as applicable, to perform additional tests. Note that these could be different axle and transmission configurations within the family. These become official test results for the family. Use good engineering judgment to use the results of these tests to update the declared maps for the axle or transmission family. For example, if you fail the audit test for any of the axles or transmissions tested, the audit result becomes the declared map. This may also require revising any analytically derived maps.

Table 1 to §1037.320—Default Torque Curves for Vehicle Class

Light HDV		**Medium HDV**		**Heavy HDV**		**Light HDV and Medium HDV Spark-Ignition**	
Engine Speed (r/min)	Engine Torque (N·m)	Engine Speed (r/min)	Engine Torque (N·m)	Engine Speed (r/min)	Engine Torque (N·m)	Engine Speed (r/min)	Engine Torque (N·m)
750	470	600	850	600	1200	600	433
907	579	750	890	750	1320	700	436
1055	721	850	1000	850	1490	800	445
1208	850	950	1200	950	1700	900	473
1358	876	1050	1440	1050	1950	1000	492
1507	866	1100	1520	1100	2090	1100	515
1660	870	1150	1570	1200	2100	1200	526
1809	868	1250	1590	1250	2100	1300	541
1954	869	1300	1590	1300	2093	1400	542
2105	878	1450	1590	1400	2092	1500	542
2258	850	1500	1590	1500	2085	1600	542
2405	800	1600	1540	1520	2075	1700	547
2556	734	1700	1470	1600	2010	1800	550
2600	0	1800	1385	1700	1910	1900	551
		1900	1300	1800	1801	2000	554
		2000	1220	1900	1640	2100	553
		2100	1040	2000	1350	2200	558
		2250	590	2100	910	2300	558
		2400	0	2250	0	2400	566
						2500	571
						2600	572
						2700	581
						2800	586
						2900	587
						3000	590
						3100	591

						3200	589
						3300	585
						3400	584
						3500	582
						3600	573
						3700	562
						3800	555
						3900	544
						4000	534
						4100	517
						4200	473
						4291	442
						4500	150

147. Amend §1037.501 by adding paragraph (i) to read as follows:

§1037.501 General testing and modeling provisions.

* * * * *

(i) Note that declared GEM inputs for fuel maps and aerodynamic drag area typically includes compliance margins to account for testing variability; for other measured GEM inputs, the declared values are typically the measured values without adjustment.

148. Amend §1037.510 by revising paragraphs (a)(2), (c)(3), (d), and (e) to read as follows:

§1037.510 Duty-cycle exhaust testing.

* * * * *

(a) * * *

(2) Perform cycle-average engine fuel mapping as described in 40 CFR 1036.540. For powertrain testing under §§1037.550 or 1037.555, perform testing as described in this paragraph (a)(2) to generate GEM inputs for each simulated vehicle configuration, and test runs representing different idle conditions. Perform testing as follows:

(i) Transient cycle. The transient cycle is specified in Appendix I of this part.

(ii) Highway cruise cycles. The grade portion of the route corresponding to the 55 mi/hr and 65 mi/hr highway cruise cycles is specified in Appendix IV of this part. Maintain vehicle speed between –1.0 mi/hr and 3.0 mi/hr of the speed setpoint; this speed tolerance applies instead of the approach specified in 40 CFR 1066.425(b)(1) and (2).

(iii) Drive idle. Perform testing at a loaded idle condition for Phase 2 vocational vehicles. For engines with an adjustable warm idle speed setpoint, test at the minimum warm idle speed and the maximum warm idle speed; otherwise simply test at the engine's warm idle speed. Warm up the powertrain using the vehicle settings for the Test 1 vehicle configuration as defined in Table 2 or Table 3 of 40 CFR 1036.540 by operating it at 65 mi/hr for 600 seconds. Linearly ramp the powertrain down to zero vehicle speed in 20 seconds. Set the engine to operate at idle speed for 90 seconds, with the brake applied and the transmission in drive (or clutch depressed for manual transmission), and sample emissions to determine mean emission values (in g/s) over the last 30 seconds of idling.

(iv) Parked idle. Perform testing at an unloaded idle condition for Phase 2 vocational vehicles. For engines with an adjustable warm idle speed setpoint, test at the minimum warm idle speed and the maximum warm idle speed; otherwise simply test at the engine's warm idle speed. Warm up the powertrain using the vehicle settings for the Test 1 vehicle configuration by operating it at 65 mi/hr for 600 seconds. Linearly ramp the powertrain down to zero vehicle speed in 20 seconds. Set the engine to operate at idle speed for 780 seconds, with the transmission in park (or the transmission in neutral with the parking brake applied for manual transmissions), and sample emissions to determine mean emission values (in g/s) over the last 600 seconds of idling.

* * * * *

(c) * * *

(3) Table 1 follows:

Table 1 of §1037.510—Weighting Factors for Duty Cycles

	DISTANCE-WEIGHTED			TIME-WEIGHTED[a]			AVERAGE SPEED DURING NON-IDLE CYCLES (MI/HR)[b]
	Transient	55 mi/hr Cruise	65 mi/hr Cruise	Drive Idle	Parked Idle	Non-idle	
Day Cabs	19 %	17 %	64 %	—	—	—	—
Sleeper Cabs	5 %	9 %	86 %	—	—	—	—
Heavy-haul tractors	19 %	17 %	64 %	—	—	—	—
Vocational—Regional	20 %	24 %	56 %	0 %	25 %	75 %	38.41
Vocational—Multi-Purpose (2b-7)	54 %	29 %	17 %	17 %	25 %	58 %	23.18
Vocational—Multi-Purpose (8)	54 %	23 %	23 %	17 %	25 %	58 %	23.27
Vocational—Urban (2b-7)	92 %	8 %	0 %	15 %	25 %	60 %	16.25
Vocational—Urban (8)	90 %	10 %	0 %	15 %	25 %	60 %	16.51
Vocational with conventional powertrain (Phase 1 only)	42 %	21 %	37 %	—	—	—	—
Vocational Hybrid Vehicles (Phase 1 only)	75 %	9 %	16 %	—	—	—	—

[a]Note that these drive idle and non-idle weighting factors do not reflect additional drive idle that occurs during the transient cycle. The transient cycle does not include any parked idle.

[b]These values apply even for vehicles not following the specified speed traces.

(d) For transient testing, compare actual second-by-second vehicle speed with the speed specified in the test cycle and ensure any differences are consistent with the criteria as specified in 40 CFR 1066.425(b) and (c). If the speeds do not conform to these criteria, the test is not valid and must be repeated.

(e) Run test cycles as specified in 40 CFR part 1066. For testing vehicles equipped with cruise control over the highway cruise cycles, you may use the vehicle's cruise control to control the vehicle speed. For vehicles equipped with adjustable vehicle speed limiters, test the vehicle with the vehicle speed limiter at its highest setting.

* * * * *

149. Amend §1037.515 by revising paragraphs (c) and (d)(2) to read as follows:

§1037.515 Determining CO_2 emissions to show compliance for trailers.

* * * * *

(c) Drag area. You may use ΔC_dA values approved under §1037.211 for device manufacturers if your trailers are properly equipped with those devices. Determine ΔC_dA values for other trailers based on testing. Measure C_dA and determine ΔC_dA values as described in §1037.526(a). You may use ΔC_dA values from one trailer configuration to represent any number of additional trailers based on worst-case testing. This means that you may apply ΔC_dA values from your measurements to any trailer models of the same category with drag area at or below that of the tested configuration. For trailers in the short dry box vans and short refrigerated box vans that are not 28 feet long, apply the ΔC_dA value established for a comparable 28-foot trailer model; you may use the same devices designed for 28-foot trailers or you may adapt those devices as appropriate for the different trailer length, consistent with good engineering judgment. For example, 48-foot trailers may use longer side skirts than the skirts that were tested with a 28-foot trailer. Trailer and device manufacturers may seek preliminary approval for these adaptations. Determine bin levels based on ΔC_dA test results as described in the following table:

Table 2 of §1037.515—Bin Determinations for Trailers Based on Aerodynamic Test Results (ΔC_dA in m^2)

IF A TRAILER'S MEASURED ΔC_DA IS …	DESIGNATE THE TRAILER AS …	AND USE THE FOLLOWING VALUE FOR ΔC_DA
≤ 0.09	Bin I	0.0
0.10 – 0.39	Bin II	0.1
0.40 – 0.69	Bin III	0.4
0.70 – 0.99	Bin IV	0.7
1.00 – 1.39	Bin V	1.0
1.40 – 1.79	Bin VI	1.4
≥ 1.80	Bin VII	1.8

(d) * * *

(2) Apply weight reductions for other components made with light-weight materials as shown in the following table:

Table 3 of §1037.515—Weight Reductions for Trailers (pounds)

COMPONENT	MATERIAL	WEIGHT REDUCTION (POUNDS)
Structure for Suspension Assembly[a]	Aluminum	280
Hub and Drum (per axle)	Aluminum	80
Floor[b]	Aluminum	375
Floor[b]	Composite (wood and plastic)	245
Floor Crossmembers[b]	Aluminum	250
Landing Gear	Aluminum	50
Rear Door	Aluminum	187
Rear Door Surround	Aluminum	150
Roof Bows	Aluminum	100
Side Posts	Aluminum	300
Slider Box	Aluminum	150
Upper Coupler Assembly	Aluminum	430

[a]For tandem-axle suspension sub-frames made of aluminum, apply a weight reduction of 280 pounds. Use good engineering judgment to estimate a weight reduction for using aluminum sub-frames with other axle configurations.

[b]Calculate a smaller weight reduction for short trailers by multiplying the indicated values by 0.528 (28/53).

* * * * *

150. Revise §1037.520 to read as follows:

§1037.520 Modeling CO_2 emissions to show compliance for vocational vehicles and tractors. This section describes how to use the Greenhouse gas Emissions Model (GEM) (incorporated by reference in §1037.810) to show compliance with the CO_2 standards of §§1037.105 and 1037.106 for vocational vehicles and tractors. Use GEM version 2.0.1 to demonstrate compliance with Phase 1 standards; use GEM Phase 2, Version 3.5.1 to demonstrate compliance with Phase 2 standards. Use good engineering judgment when demonstrating compliance using GEM. See §1037.515 for calculation procedures for demonstrating compliance with trailer standards.

(a) General modeling provisions. To run GEM, enter all applicable inputs as specified by the model.

(1) GEM inputs apply for Phase 1 standards as follows:

(i) Model year and regulatory subcategory (see §1037.230).

(ii) Coefficient of aerodynamic drag or drag area, as described in paragraph (b) of this section (tractors only).

(iii) Steer and drive tire rolling resistance, as described in paragraph (c) of this section.

(iv) Vehicle speed limit, as described in paragraph (d) of this section (tractors only).

(v) Vehicle weight reduction, as described in paragraph (e) of this section (tractors only for Phase 1).

(vi) Automatic engine shutdown systems, as described in §1037.660 (only for Class 8 sleeper cabs). Enter a GEM input value of 5.0 g/ton-mile, or an adjusted value as specified in §1037.660.

(2) For Phase 2 vehicles, the GEM inputs described in paragraphs (a)(1)(i) through (v) of this section continue to apply. Note that the provisions related to vehicle speed limiters and automatic engine shutdown systems are available for vocational vehicles in Phase 2. The rest

of this section describes additional GEM inputs for demonstrating compliance with Phase 2 standards. Simplified versions of GEM apply for limited circumstances as follows:

(i) You may use default engine fuel maps for glider kits as described in §1037.635.

(ii) If you certify vehicles to the custom-chassis standards specified in §1037.105(h), run GEM by identifying the vehicle type and entering "NA" instead of what would otherwise apply for, tire revolutions per mile, engine information, transmission information, drive axle ratio, axle efficiency, and aerodynamic improvement as specified in paragraphs (c)(1), (f), (g)(1), (g)(3), (i), and (m) of this section, respectively. Incorporate other GEM inputs as specified in this section.

(b) Coefficient of aerodynamic drag and drag area for tractors. Determine the appropriate drag area, C_dA, for tractors as described in this paragraph (b). Use the recommended method or an alternate method to establish a value for C_dA, expressed in m^2 to one decimal place, as specified in §1037.525. Where we allow you to group multiple configurations together, measure C_dA of the worst-case configuration.

(1) Except as specified in paragraph (b)(2) of this section, determine the Phase 1 bin level for your vehicle based on measured C_dA values as shown in the following tables:

Table 1 to §1037.520(b)(1)— C_d inputs for Phase 1 High-Roof Tractors

TRACTOR TYPE	BIN LEVEL	IF YOUR MEASURED C_DA (M^2) IS . . .	THEN YOUR C_D INPUT IS . . .
High-Roof Day Cabs	Bin I	≥ 8.0	0.79
	Bin II	7.1-7.9	0.72
	Bin III	6.2-7.0	0.63
	Bin IV	5.6-6.1	0.56
	Bin V	≤ 5.5	0.51
High-Roof Sleeper Cabs	Bin I	≥ 7.6	0.75
	Bin II	6.8-7.5	0.68
	Bin III	6.3-6.7	0.60
	Bin IV	5.6-6.2	0.52
	Bin V	≤5.5	0.47

Table 2 to §1037.520(b)(1)— C_d inputs for Phase 1 Low-Roof and Mid-Roof Tractors

TRACTOR TYPE	BIN LEVEL	IF YOUR MEASURED C_DA (M^2) IS . . .	THEN YOUR C_D INPUT IS . . .
Low-Roof Day and Sleeper Cabs	Bin I	≥ 5.1	0.77
	Bin II	≤ 5.0	0.71
Mid-Roof Day and Sleeper Cabs	Bin I	≥ 5.6	0.87
	Bin II	≤ 5.5	0.82

(2) For Phase 1 low- and mid-roof tractors, you may instead determine your drag area bin based on the drag area bin of an equivalent high-roof tractor. If the high-roof tractor is in Bin I or Bin II, then you may assume your equivalent low- and mid-roof tractors are in Bin I. If the high-roof tractor is in Bin III, Bin IV, or Bin V, then you may assume your equivalent low- and mid-roof tractors are in Bin II.

(3) For Phase 2 tractors other than heavy-haul tractors, determine bin levels and C_dA inputs

as follows:

(i) Determine bin levels for high-roof tractors based on aerodynamic test results as specified in §1037.525 and summarized in the following table:

Table 3 to §1037.520(b)(3)(i)—Bin determinations for Phase 2 High-Roof Tractors Based on Aerodynamic Test Results (C_dA in m^2)

TRACTOR TYPE	BIN I	BIN II	BIN III	BIN IV	BIN V	BIN VI	BIN VII
Day Cabs	≥ 7.2	6.6-7.1	6.0-6.5	5.5-5.9	5.0-5.4	4.5-4.9	≤ 4.4
Sleeper Cabs	≥ 6.9	6.3-6.8	5.7-6.2	5.2-5.6	4.7-5.1	4.2-4.6	≤ 4.1

(ii) For low- and mid-roof tractors, you may either use the same bin level that applies for an equivalent high-roof tractor as shown in Table 3 of this section, or you may determine your bin level based on aerodynamic test results as described in Table 4 of this section.

Table 4 to §1037.520(b)(3)(ii)—Bin determinations for Phase 2 Low-Roof and Mid-Roof Tractors Based on Aerodynamic Test Results (C_dA in m^2)

TRACTOR TYPE	BIN I	BIN II	BIN III	BIN IV	BIN V	BIN VI	BIN VII
Low-Roof Cabs	≥ 5.4	4.9-5.3	4.5-4.8	4.1-4.4	3.8-4.0	3.5-3.7	≤ 3.4
Mid-Roof Cabs	≥ 5.9	5.5-5.8	5.1-5.4	4.7-5.0	4.4-4.6	4.1-4.3	≤ 4.0

(iii) Determine the C_dA input according to the tractor's bin level as described in the following table:

Table 5 to §1037.520(b)(3)(iii)—Phase 2 C_dA Tractor Inputs Based on Bin Level

TRACTOR TYPE	BIN I	BIN II	BIN III	BIN IV	BIN V	BIN VI	BIN VII
High-Roof Day Cabs	7.45	6.85	6.25	5.70	5.20	4.70	4.20
High-Roof Sleeper Cabs	7.15	6.55	5.95	5.40	4.90	4.40	3.90
Low-Roof Cabs	6.00	5.60	5.15	4.75	4.40	4.10	3.80
Mid-Roof Cabs	7.00	6.65	6.25	5.85	5.50	5.20	4.90

(4) Note that, starting in model year 2027, GEM internally reduces C_dA for high-roof tractors by 0.3 m^2 to simulate adding a rear fairing to the standard trailer.

(c) Tire revolutions per mile and rolling resistance. You must have a tire revolutions per mile (TRPM) and a tire rolling resistance level (TRRL) for each tire configuration. For purposes of this section, you may consider tires with the same SKU number to be the same configuration. Determine TRRL input values separately for drive and steer tires; determine TRPM only for drive tires.

(1) Use good engineering judgment to determine a tire's revolutions per mile to the nearest whole number as specified in SAE J1025 (incorporated by reference in §1037.810). Note that for tire sizes that you do not test, we will treat your analytically derived revolutions per mile the same as test results, and we may perform our own testing to verify your values. We may require you to test a sample of additional tire sizes that we select.

(2) Measure tire rolling resistance in kg per metric ton as specified in ISO 28580 (incorporated by reference in §1037.810), except as specified in this paragraph (c). Use good engineering judgment to ensure that your test results are not biased low. You may ask us to identify a reference test laboratory to which you may correlate your test results. Prior to beginning the test procedure in Section 7 of ISO 28580 for a new bias-ply tire, perform a break-in procedure by running the tire at the specified test speed, load, and pressure for 60±2

minutes.

(3) For each tire design tested, measure rolling resistance of at least three different tires of that specific design and size. Perform the test at least once for each tire. Calculate the arithmetic mean of these results to the nearest 0.1 kg/tonne and use this value or any higher value as your GEM input for TRRL. You must test at least one tire size for each tire model, and may use engineering analysis to determine the rolling resistance of other tire sizes of that model. Note that for tire sizes that you do not test, we will treat your analytically derived rolling resistances the same as test results, and we may perform our own testing to verify your values. We may require you to test a small sub-sample of untested tire sizes that we select.

(4) If you obtain your test results from the tire manufacturer or another third party, you must obtain a signed statement from the party supplying those test results to verify that tests were conducted according to the requirements of this part. Such statements are deemed to be submissions to EPA.

(5) For tires marketed as light truck tires that have load ranges C, D, or E, use as the GEM input TRRL multiplied by 0.87.

(6) For vehicles with at least three drive axles or for vehicles with more than three axles total, use good engineering judgment to combine tire rolling resistance into three values (steer, drive 1, and drive 2) for use in GEM. This may require performing a weighted average of tire rolling resistance from multiple axles based on the typical load on each axle. For liftable axles, calculate load- and time-weighted values to represent the load and the amount of time these tires are in contact with the ground during typical in-use operation.

(7) For vehicles with a single rear axle, enter “NA” as the TRRL value for drive axle 2.

(d) Vehicle speed limit. If the vehicles will be equipped with a vehicle speed limiter, input the maximum vehicle speed to which the vehicle will be limited (in miles per hour rounded to the nearest 0.1 mile per hour) as specified in §1037.640. Use good engineering judgment to ensure the limiter is tamper resistant. We may require you to obtain preliminary approval for your designs.

(e) Vehicle weight reduction. Develop a weight-reduction as a GEM input as described in this paragraph (e). Enter the sum of weight reductions as described in this paragraph (e), or enter zero if there is no weight reduction. For purposes of this paragraph (e), high-strength steel is steel with tensile strength at or above 350 MPa.

(1) Vehicle weight reduction inputs for wheels are specified relative to dual-wide tires with conventional steel wheels. For purposes of this paragraph (e)(1), an aluminum alloy qualifies as light-weight if a dual-wide drive wheel made from this material weighs at least 21 pounds less than a comparable conventional steel wheel. The inputs are listed in Table 6 of this section. For example, a tractor or vocational vehicle with aluminum steer wheels and eight (4×2) dual-wide aluminum drive wheels would have an input of 210 pounds (2×21 + 8×21).

Table 6 to §1037.520(e)(1)—Wheel-Related Weight Reductions

WEIGHT-REDUCTION TECHNOLOGY		WEIGHT REDUCTION—PHASE 1 (LB PER WHEEL)	WEIGHT REDUCTION—PHASE 2 (LB PER WHEEL)
Wide-Base Single Drive Tire with . . .[a]	Steel Wheel	84	84
	Aluminum Wheel	139	147
	Light-Weight Aluminum Alloy Wheel	147	147
Wide-Base Single Trailer Tire with . . .[a]	Steel Wheel	—	84
	Aluminum or Aluminum Alloy Wheel	—	131
Steer Tire, Dual-wide Drive Tire, or Dual-wide Trailer Tire with . . .	High-Strength Steel Wheel	8	8
	Aluminum Wheel	21	25
	Light-Weight Aluminum Alloy Wheel	30	25

[a]The weight reduction for wide-base tires accounts for reduced tire weight relative to dual-wide tires.

(2) Weight reduction inputs for tractor components other than wheels are specified in the following table:

Table 7 to §1037.520(e)(2)—Nonwheel-Related Weight Reductions from Alternative Materials for Tractors (pounds)

WEIGHT REDUCTION TECHNOLOGIES	ALUMINUM	HIGH-STRENGTH STEEL	THERMOPLASTIC
Door	20	6	
Roof	60	18	
Cab rear wall	49	16	
Cab floor	56	18	
Hood Support Structure System	15	3	
Hood and Front Fender			65
Day Cab Roof Fairing			18
Sleeper Cab Roof Fairing	75	20	40
Aerodynamic Side Extender			10
Fairing Support Structure System	35	6	
Instrument Panel Support Structure	5	1	
Brake Drums – Drive (set of 4)	140	74	
Brake Drums – Non Drive (set of 2)	60	42	
Frame Rails	440	87	
Crossmember – Cab	15	5	
Crossmember – Suspension	25	6	
Crossmember – Non Suspension (set of 3)	15	5	
Fifth Wheel	100	25	
Radiator Support	20	6	
Fuel Tank Support Structure	40	12	
Steps	35	6	
Bumper	33	10	
Shackles	10	3	
Front Axle	60	15	
Suspension Brackets, Hangers	100	30	
Transmission Case	50	12	
Clutch Housing	40	10	
Fairing Support Structure System	35	6	
Drive Axle Hubs (set of 4)	80	20	
Non Drive Hubs (2)	40	5	
Two-piece driveshaft	20	5	
Transmission/Clutch Shift Levers	20	4	

(3) Weight-reduction inputs for vocational-vehicle components other than wheels are specified in the following table:

Table 8 to §1037.520(e)(3)—Nonwheel-Related Weight Reductions from Alternative Materials for Phase 2 Vocational Vehicles (pounds)[a]

COMPONENT	MATERIAL	VEHICLE TYPE		
		Light HDV	Medium HDV[b]	Heavy HDV
Axle Hubs - Non-Drive	Aluminum	40		40
Axle Hubs - Non-Drive	High Strength Steel	5		5
Axle - Non-Drive	Aluminum	60		60
Axle - Non-Drive	High Strength Steel	15		15
Brake Drums - Non-Drive	Aluminum	60		60
Brake Drums - Non-Drive	High Strength Steel	42		42
Axle Hubs – Drive	Aluminum	40		80
Axle Hubs – Drive	High Strength Steel	10		20
Brake Drums - Drive	Aluminum	70		140
Brake Drums - Drive	High Strength Steel	37		74
Suspension Brackets, Hangers	Aluminum	67		100
Suspension Brackets, Hangers	High Strength Steel	20		30
Crossmember – Cab	Aluminum	10	15	15
Crossmember – Cab	High Strength Steel	2	5	5
Crossmember - Non-Suspension	Aluminum	15	15	15
Crossmember - Non-Suspension	High Strength Steel	5	5	5
Crossmember -Suspension	Aluminum	15	25	25
Crossmember -Suspension	High Strength Steel	6	6	6
Driveshaft	Aluminum	12	40	50
Driveshaft	High Strength Steel	5	10	12
Frame Rails	Aluminum	120	300	440
Frame Rails	High Strength Steel	40	40	87

[a]Weight-reduction values apply per vehicle unless otherwise noted.
[b]For Medium HDV with 6×4 or 6×2 axle configurations, use the values for Heavy HDV.

(4) Apply vehicle weight inputs for changing technology configurations as follows:

(i) For Class 8 tractors or for Class 8 vocational vehicles with a permanent 6×2 axle configuration, apply a weight reduction input of 300 pounds. This does not apply for coach buses certified to custom-chassis standards under §1037.105(h).

(ii) For Class 8 tractors with 4×2 axle configuration, apply a weight reduction input of 400 pounds.

(iii) For tractors with installed engines with displacement below 14.0 liters, apply a weight reduction of 300 pounds.

(iv) For tractors with single-piece driveshafts with a total length greater than 86 inches, apply a weight reduction of 43 pounds for steel driveshafts and 63 pounds for aluminum driveshafts.

(5) You may ask to apply the off-cycle technology provisions of §1037.610 for weight reductions not covered by this paragraph (e).

(f) Engine characteristics. Enter information from the engine manufacturer to describe the installed engine and its operating parameters as described in 40 CFR 1036.503. The fuel-mapping information must apply for the vehicle's GVWR; for example, if you install a medium heavy-duty engine in a Class 8 vehicle, the engine must have additional fuel-mapping information for the heavier vehicle. Note that you do not need fuel consumption at idle for tractors.

(g) Vehicle characteristics. Enter the following information to describe the vehicle and its operating parameters:

(1) Transmission make, model, and type. Also identify the gear ratio for every available forward gear to two decimal places, the input torque limit for each of the forward gears, and, if applicable, the lowest gear involving a locked torque converter. Count forward gears as being available only if the vehicle has the hardware and software to allow operation in those gears. For vehicles with a manual transmission, GEM applies a 2 % emission increase relative to automated manual transmissions. If your vehicle has a dual-clutch transmission, use good engineering judgment to determine if it can be accurately represented in GEM as an automated manual transmission. We may require you to perform a powertrain test with dual-clutch transmissions to show that they can be properly simulated as an automated manual transmission.

(2) Drive axle make, model, and configuration. Select a drive axle configuration to represent your vehicle for modeling.

(i) 4×2: One drive axle and one non-drive axle. This includes vehicles with two drive axles where one of the drive axles is disconnectable and that disconnectable drive axle is designed to be connected only when the vehicle is driven off-road or in slippery conditions if at least one of the following is true:

(A) The input and output of the disconnectable axle is mechanically disconnected from the drive shaft and the wheels when the axle is in 4×2 configuration.

(B) You provide power loss data generated according to §1037.560 for the combination of both drive axles, where the disconnectable drive axle is in the disconnected configuration.

(ii) 6×2: One drive axle and two non-drive axles.

(iii) 6×4: Two or more drive axles, or more than three total axles. Note that this includes, for example, a vehicle with two drive axles out of four total axles (otherwise known as an 8×4 configuration).

(iv) 6×4D: One non-drive axle and two drive axles where one of the two drive axles is automatically disconnectable such that the axle can switch between 6×2 and 6×4 configurations. You may select this configuration only if at least one of the following is true:

(A) The input and output of the disconnectable axle is mechanically disconnected from the drive shaft and the wheels when the axle is in the 6×2 configuration.

(B) You provide power loss data generated according to §1037.560 for the combination of both drive axles, where the disconnectable drive axle is in the disconnected configuration.

(3) Drive axle ratio, k_a. If a vehicle is designed with two or more user-selectable axle ratios,

use the drive axle ratio that is expected to be engaged for the greatest driving distance. If the vehicle does not have a drive axle, such as a hybrid vehicle with direct electric drive, let $k_a = 1$.

(4) GEM inputs associated with powertrain testing include powertrain family, transmission calibration identifier, test data from §1037.550, and the powertrain test configuration (dynamometer connected to transmission output or wheel hub). You do not need to identify or provide inputs for transmission gear ratios, fuel map data, or engine torque curves, which would otherwise be required under paragraph (f) of this section.

(h) Idle speed and idle-reduction technologies. The following provisions apply for engine idling:

(1) For engines with no adjustable warm idle speed, input vehicle idle speed as the manufacturer's declared warm idle speed. For engines with adjustable warm idle speed, input your vehicle idle speed as follows:

If your vehicle is a...	And your engine is subject to...	Your default vehicle idle speed is...[a]
(i) Heavy HDV	compression-ignition or spark-ignition standards	600 r/min.
(ii) Medium HDV tractor	compression-ignition standards	700 r/min.
(iii) Light HDV or Medium HDV vocational vehicle	compression-ignition standards	750 r/min.
(iv) Light HDV or Medium HDV	spark-ignition standards	600 r/min.

[a]If the default idle speed is above or below the engine manufacturer's whole range of declared warm idle speeds, use the manufacturer's maximum or minimum declared warm idle speed, respectively, instead of the default value.

(2) Identify whether your vehicle has qualifying idle-reduction technologies, subject to the qualifying criteria in §1037.660, as follows:

(i) Stop-start technology and automatic engine shutdown systems apply for vocational vehicles. See paragraph (j) of this section for automatic engine shutdown systems for tractors.

(ii) Neutral idle applies for tractors and vocational vehicles.

(i) Axle, transmission, and torque converter characterization. You may characterize the axle, transmission, and torque converter using axle efficiency maps as described in §1037.560, transmission efficiency maps as described in §1037.565, and torque converter capacity factors and torque ratios as described in §1037.570 to replace the default values in GEM. If you obtain your test results from the axle manufacturer, transmission manufacturer, torque converter manufacturer or another third party, you must obtain a signed statement from the party supplying those test results to verify that tests were conducted according to the requirements of this part. Such statements are deemed to be submissions to EPA.

(j) Additional reduction technologies. Enter input values in GEM as follows to characterize the percentage CO_2 emission reduction corresponding to certain technologies and vehicle configurations, or enter 0:

(1) Intelligent controls. Enter 2 for tractors with predictive cruise control. This includes any cruise control system that incorporates satellite-based global-positioning data for controlling

operator demand. For other tractors, enter 1.5 if they have neutral coasting, unless good engineering judgment indicates that a lower percentage should apply.

(2) Accessory load. Enter the following values related to accessory loads; if more than one item applies, enter the sum of those values:

(i) If vocational vehicles have electrically powered pumps for steering, enter 0.5 for vocational vehicles certified with the Regional duty cycle, and enter 1 for other vocational vehicles.

(ii) If tractors have electrically powered pumps for both steering and engine cooling, enter 1.

(iii) If vehicles have a high-efficiency air conditioning compressor, enter 0.5 for tractors and vocational Heavy HDV, and enter 1 for other vocational vehicles. This includes all electrically powered compressors. It also include mechanically powered compressors if the coefficient of performance improves by 10 percent or greater over the baseline design, consistent with the provisions for improved evaporators and condensers in 40 CFR 86.1868-12(h)(5).

(3) Tire-pressure systems. Enter 1.2 for vehicles with automatic tire inflation systems on all axles (1.1 for Multi-Purpose and Urban vocational vehicles). Enter 1.0 for vehicles with tire pressure monitoring systems on all axles (0.9 for Multi-Purpose and Urban vocational vehicles). If vehicles use a mix of the two systems, treat them as having only tire pressure monitoring systems.

(4) Extended-idle reduction. Enter values as shown in the following table for sleeper cabs equipped with idle-reduction technology meeting the requirements of §1037.660 that are designed to automatically shut off the main engine after 300 seconds or less:

Table 9 to §1037.520(j)(4)—GEM Input Values For AES Systems

Technology	GEM Input Values	
	Adjustable	Tamper-resistant
Standard AES system	1	4
With diesel APU	3	4
With battery APU	5	6
With automatic stop-start	3	3
With fuel-operated heater (FOH)	2	3
With diesel APU and FOH	4	5
With battery APU and FOH	5	6
With stop-start and FOH	4	5

(5) Other. Additional GEM inputs may apply as follows:

(i) Enter 0.9 and 1.7, respectively, for school buses and coach buses that have at least seven available forward gears.

(ii) If we approve off-cycle technology under §1037.610 in the form of an improvement factor, enter the improvement factor expressed as a percentage reduction in CO_2 emissions. (Note: In the case of approved off-cycle technologies whose benefit is quantified as a g/ton-mile credit, apply the credit to the GEM result, not as a GEM input value.)

(k) Vehicles with hybrid power take-off. For vocational vehicles, determine the delta PTO emission result of your engine and hybrid power take-off system as described in §1037.540.

(l) [Reserved]

(m) Aerodynamic improvements for vocational vehicles. For vocational vehicles certified using the Regional duty cycle, enter ΔC_dA values to account for using aerodynamic devices as follows:

(1) Enter 0.2 for vocational vehicles with an installed rear fairing if the vehicle is at least 7 m long with a minimum frontal area of 8 m^2.

(2) For vehicles at least 11 m long with a minimum frontal area of 9 m^2, enter 0.5 if the vehicle has both skirts and a front fairing, and enter 0.3 if it has only one of those devices.

(3) You may determine input values for these or other technologies based on aerodynamic measurements as described in §1037.527.

(n) Alternate fuels. For fuels other than those identified in GEM, perform the simulation by identifying the vehicle as being diesel-fueled if the engine is subject to the compression-ignition standard, or as being gasoline-fueled if the engine is subject to the spark-ignition standards. Correct the engine or powertrain fuel map for mass-specific net energy content as described in 40 CFR 1036.535(b).

151. Revise §1037.525 to read as follows:

§1037.525 Aerodynamic measurements for tractors.

This section describes a methodology for quantifying aerodynamic drag for use in determining input values for tractors as described in §1037.520. This coastdown testing is the reference method for aerodynamic measurements.

(a) General provisions. The GEM input for a tractor's aerodynamic performance is a C_d value for Phase 1 and a C_dA value for Phase 2. The input value is measured or calculated for a tractor in a specific test configuration with a trailer, such as a high-roof tractor with a box van meeting the requirements for the standard trailer.

(1) Aerodynamic measurements may involve any of several different procedures. Measuring with different procedures introduces variability, so we identify the coastdown method in §1037.528 as the primary (or reference) procedure. You may use other procedures with our advance approval as described in paragraph (d) of this section, but we require that you adjust your test results from other test methods to correlate with coastdown test results. All adjustments must be consistent with good engineering judgment. Submit information describing how you quantify aerodynamic drag from coastdown testing, whether or not you use an alternate method.

(2) Test high-roof tractors with a standard trailer as described in §1037.501(g)(1). Note that the standard trailer for Phase 1 tractors is different from that of later model years. Note also that GEM may model a different configuration than the test configuration, but accounts for this internally. Test low-roof and mid-roof tractors without a trailer; however, you may test low-roof and mid-roof tractors with a trailer to evaluate off-cycle technologies.

(b) Adjustments to correlate with coastdown testing. Adjust aerodynamic drag values from alternate methods to be equivalent to the corresponding values from coastdown measurements as follows:

(1) Determine the functional relationship between your alternate method and coastdown testing. Specify this functional relationship as $F_{alt\text{-}aero}$ for a given alternate drag measurement method. The effective yaw angle, ψ_{eff}, is assumed to be zero degrees for Phase 1. For Phase 2, determine ψ_{eff} from coastdown test results using the following equation:

$$F_{alt\text{-}aero} = \frac{C_dA_{coastdown}(\psi_{eff})}{C_dA_{alt}(\psi_{eff})}$$

Eq. 1037.525-1

Where:

$C_dA_{coastdown}(\psi_{eff})$ = the average drag area measured during coastdown at an effective yaw angle, ψ_{eff}.

$C_dA_{alt}(\psi_{eff})$ = the average drag area calculated from an alternate drag measurement method at an effective yaw angle, ψ_{eff}.

(2) Unless good engineering judgment dictates otherwise, assume that coastdown drag is proportional to drag measured using alternate methods and apply a constant adjustment factor, $F_{alt\text{-}aero}$, for a given alternate drag measurement method of similar vehicles.

(3) Determine $F_{alt\text{-}aero}$ by performing coastdown testing and applying your alternate method on the same vehicles. Consider all applicable test data including data collected during selective enforcement audits. Unless we approve another vehicle, one vehicle must be a Class 8 high-roof sleeper cab with a full aerodynamics package pulling a standard trailer. Where you have more than one tractor model meeting these criteria, use the tractor model with the highest projected sales. If you do not have such a tractor model, you may use your most comparable tractor model with our prior approval. In the case of alternate methods other than those specified in this subpart, good engineering judgment may require you to determine your adjustment factor based on results from more than the specified minimum number of vehicles.

(4) Measure the drag area using your alternate method for a Phase 2 tractor used to determine $F_{alt\text{-}aero}$ with testing at yaw angles of 0°, ±1°, ±3°, ±4.5°, ±6°, and ±9° (you may include additional angles), using direction conventions described in Figure 2 of SAE J1252 (incorporated by reference in §1037.810). Also, determine the drag area at the coastdown effective yaw angle, $C_dA_{alt}(\psi_{eff})$, by taking the average drag area at ψ_{eff} and $-\psi_{eff}$ for your vehicle using the same alternate method.

(5) For Phase 2 testing, determine separate values of $F_{alt\text{-}aero}$ for at least one high-roof day cab and one high-roof sleeper cab for model year 2021, for at least two high-roof day cabs and two high-roof sleeper cabs for model year 2024, and for at least three high-roof day cabs and three high-roof sleeper cabs for model year 2027. These test requirements are cumulative; for example, you may meet these requirements by testing two vehicles to support model year 2021 certification and four additional vehicles to support model year 2023 certification. For any untested tractor models, apply the value of $F_{alt\text{-}aero}$ from the tested tractor model that best represents the aerodynamic characteristics of the untested tractor model, consistent with good engineering judgment. Testing under this paragraph (b)(5) continues to be valid for later model years until you change the tractor model in a way that causes the test results to no longer represent production vehicles. You must also determine unique values of $F_{alt\text{-}aero}$ for low-roof and mid-roof tractors if you determine C_dA values based on low or mid-roof tractor testing as shown in Table 4 of §1037.520. For Phase 1 testing, if good engineering judgment allows it, you may calculate a single, constant value of $F_{alt\text{-}aero}$ for your whole product line by dividing the coastdown drag area, $C_dA_{coastdown}$, by drag area from your alternate method, C_dA_{alt}.

(6) Determine $F_{alt\text{-}aero}$ to at least three decimal places. For example, if your coastdown testing results in a drag area of 6.430, but your wind tunnel method results in a drag area of 6.200, $F_{alt\text{-}aero}$ would be 1.037 (or a higher value you declare).

(7) If a tractor and trailer cannot be configured to meet the gap requirements specified in §1037.501(g)(1)(ii), test with the trailer positioned as close as possible to the specified gap dimension and use good engineering judgment to correct the results to be equivalent to a test

configuration meeting the specified gap dimension. For example, we may allow you to correct your test output using an approved alternate method or substitute a test vehicle that is capable of meeting the required specifications and is otherwise aerodynamically equivalent. This allowance applies for certification, confirmatory testing, SEA, and all other testing to demonstrate compliance with standards.

(8) You may ask us for preliminary approval of your coastdown testing under §1037.210. We may witness the testing.

(c) Yaw sweep corrections. Aerodynamic features can have a different effectiveness for reducing wind-averaged drag than is predicted by zero-yaw drag. The following procedures describe how to determine a tractor's C_dA values to account for wind-averaged drag as specified in §1037.520:

(1) Apply the following method for all Phase 2 testing with an alternate method:

(i) Calculate the wind-averaged drag area from the alternate method, $C_dA_{\text{wa-alt}}$, using an average of measurements at –4.5 and +4.5 degrees.

(ii) Determine your wind-averaged drag area, C_dA_{wa}, rounded to one decimal place, using the following equation:

$$C_dA_{\text{wa}} = C_dA_{\text{wa-alt}} \cdot F_{\text{alt-aero}}$$

Eq. 1037.525-2

(2) Apply the following method for Phase 2 coastdown testing other than coastdown testing used to establish $F_{\text{alt-aero}}$:

(i) Determine your drag area at the effective yaw angle from coastdown, $C_dA_{\text{coastdown}}(\psi_{\text{eff}})$.

(ii) Use an alternate method to calculate the ratio of the wind-averaged drag area, $C_dA_{\text{wa-alt}}$ (using an average of measurements at –4.5 and +4.5 degrees) to the drag area at the effective yaw angle, $C_dA_{\text{alt}}(\psi_{\text{eff}})$.

(iii) Determine your wind-averaged drag area, C_dA_{wa}, rounded to one decimal place, using the following equation:

$$C_dA_{\text{wa}} = C_dA_{\text{coastdown}}(\psi_{\text{eff}}) \cdot \frac{C_dA_{\text{wa-alt}}}{C_dA_{\text{alt}}(\psi_{\text{eff}})}$$

Eq. 1037.525-3

(3) Different approximations apply for Phase 1. For Phase 1 testing, you may correct your zero-yaw drag area as follows if the ratio of the zero-yaw drag area divided by yaw-sweep drag area for your vehicle is greater than 0.8065 (which represents the ratio expected for a typical Class 8 high-roof sleeper cab):

(i) Determine the zero-yaw drag area, $C_dA_{\text{zero-yaw}}$, and the yaw-sweep drag area for your vehicle using the same alternate method as specified in this subpart. Measure the drag area for 0°, –6°, and +6°. Use the arithmetic mean of the –6° and +6° drag areas as the ±6° drag area, $C_dA_{\pm 6}$.

(ii) Calculate your yaw-sweep correction factor, CF_{ys}, using the following equation:

$$CF_{\text{ys}} = \frac{C_dA_{\pm 6} \cdot 0.8065}{C_dA_{\text{zero-yaw}}}$$

Eq. 1037.525-4

(iii) Calculate your corrected drag area for determining the aerodynamic bin by multiplying the measured zero-yaw drag area by CF_{ys}, as determined using Eq. 1037.525-4, as applicable. You may apply the correction factor to drag areas measured using other procedures. For example, apply CF_{ys} to drag areas measured using the coastdown method. If you use an alternate method, apply an alternate correction, $F_{alt\text{-}aero}$, and calculate the final drag area using the following equation:

$$C_dA = F_{alt\text{-}aero} \cdot CF_{ys} \cdot C_dA_{zero\text{-}alt}$$

Eq. 1037.525-5

(iv) You may ask us to apply CF_{ys} to similar vehicles incorporating the same design features.

(v) As an alternative, you may calculate the wind-averaged drag area according to SAE J1252 (incorporated by reference in §1037.810) and substitute this value into Eq. 1037.525-4 for the ±6° drag area.

(d) Approval of alternate methods. You must obtain preliminary approval before using any method other than coastdown testing to quantify aerodynamic drag. We will approve your request if you show that your procedures produce data that are the same as or better than coastdown testing with respect to repeatability and unbiased correlation. Note that the correlation is not considered to be biased if there is a bias before correction, but you remove the bias using $F_{alt\text{-}aero}$. Send your request for approval to the Designated Compliance Officer. Keep records of the information specified in this paragraph (d). Unless we specify otherwise, include this information with your request. You must provide any information we require to evaluate whether you may apply the provisions of this section. Include additional information related to your alternate method as described in §§1037.530 through 1037.534. If you use a method other than those specified in this subpart, include all the following information, as applicable:

(1) Official name/title of the procedure.

(2) Description of the procedure.

(3) Cited sources for any standardized procedures that the method is based on.

(4) Description and rationale for any modifications/deviations from the standardized procedures.

(5) Data comparing the procedure to the coastdown reference procedure.

(6) Additional information specified for the alternate methods described in §§1037.530 through 1037.534 as applicable to this method (*e.g.*, source location/address, background/history).

152. Amend §1037.528 by revising the introductory text and paragraphs (a), (c) introductory text, (e) introductory text, (g)(3) introductory text, (h)(3)(i), (h)(6), and (h)(12)(v) to read as follows:

§1037.528 Coastdown procedures for calculating drag area (C_dA).

The coastdown procedures in this section describe how to calculate drag area, C_dA, for Phase 2 tractors, trailers, and vocational vehicles, subject to the provisions of §§1037.525 through 1037.527. These procedures are considered the reference method for tractors, but an alternate method for trailers. Follow the provisions of Sections 1 through 9 of SAE J2263 (incorporated by reference in §1037.810), with the clarifications and exceptions described in this section. Several of these exceptions are from SAE J1263 (incorporated by reference in §1037.810). The coastdown procedures in 40 CFR 1066.310 apply instead of the provisions of this section for Phase 1 tractors.

(a) The terms and variables identified in this section have the meaning given in SAE J1263 and SAE J2263 unless specified otherwise.

* * * * *

(c) The test condition specifications described in Sections 7.1 through 7.4 of SAE J1263 apply, with certain exceptions and additional provisions as described in this paragraph (c). These conditions apply to each run separately.

* * * * *

(e) Measure wind speed, wind direction, air temperature, and air pressure at a recording frequency of 10 Hz, in conjunction with time-of-day data. Use at least one stationary anemometer and suitable data loggers meeting SAE J1263 specifications, subject to the following additional specifications for the anemometer placed along the test surface:

* * * * *

(g) * * *

(3) Correct measured air direction from all the high-speed segments using the wind speed and wind direction measurements described in paragraph (e) of this section as follows:

* * * * *

(h) * * *

(3) * * *

(i) Calculate the mean vehicle speed to represent the start point of each speed range as the arithmetic average of measured speeds throughout the continuous time interval that begins when measured vehicle speed is less than 2.00 mi/hr above the nominal starting speed point and ends when measured vehicle speed reaches 2.00 mi/hr below the nominal starting speed point, expressed to at least two decimal places. Calculate the timestamp corresponding to the starting point of each speed range as the average timestamp of the interval.

* * * * *

(6) For tractor testing, calculate the tire rolling resistance force at high and low speeds for steer, drive, and trailer axle positions, $F_{\mathrm{TRR[speed,axle]}}$, and determine ΔF_{TRR}, the rolling resistance difference between 65 mi/hr and 15 mi/hr, for each tire as follows:

(i) Conduct a stepwise coastdown tire rolling resistance test with three tires for each tire model installed on the vehicle using SAE J2452 (incorporated by reference in §1037.810) for the following test points (which replace the test points in Table 3 of SAE J2452):

Table 1 of §1037.528—Stepwise Coastdown Test Points for Determining Tire Rolling Resistance as a Function of Speed

Step #	**Load (% of Max)**	**Inflation pressure (% of max)**
1	20	100
2	55	70
3	85	120
4	85	100
5	100	95

(ii) Calculate $F_{\mathrm{TRR[speed,axle]}}$ using the following equation:

$$F_{\mathrm{TRR[speed,axle]}} = n_{\mathrm{t,[axle]}} \cdot p_{\mathrm{[axle]}}^{\alpha} \cdot \left(\frac{L_{\mathrm{[axle]}}}{n_{\mathrm{t,[axle]}}} \right)^{\beta_{\mathrm{[axle]}}} \cdot \left(a_{\mathrm{[axle]}} + b_{\mathrm{[axle]}} \cdot \overline{v}_{\mathrm{seg[speed]}} + c_{\mathrm{[axle]}} \cdot \overline{v}_{\mathrm{seg[speed]}}^{2} \right)$$

Eq. 1037.528-11

Where:

$n_{t,[axle]}$ = number of tires at the axle position.
$p_{[axle]}$ = the inflation pressure set and measured on the tires at the axle position at the beginning of the coastdown test.
$L_{[axle]}$ = the load over the axle at the axle position on the coastdown test vehicle.
$\alpha_{[axle]}$, $\beta_{[axle]}$, $a_{[axle]}$, $b_{[axle]}$, and $c_{[axle]}$ = regression coefficients from SAE J2452 that are specific to axle position.

Example:

$n_{t,steer} = 2$
$p_{steer} = 758.4$ kPa
$L_{steer} = 51421.2$ N
$\alpha_{steer} = -0.2435$
$\beta_{steer} = 0.9576$
$a_{steer} = 0.0434$
$b_{steer} = 5.4 \cdot 10^{-5}$
$c_{steer} = 5.53 \cdot 10^{-7}$
$n_{t,drive} = 8$
$p_{drive} = 689.5$ kPa
$L_{drive} = 55958.4$ N
$\alpha_{drive} = -0.3146$
$\beta_{drive} = 0.9914$
$a_{drive} = 0.0504$
$b_{drive} = 1.11 \cdot 10^{-4}$
$c_{drive} = 2.86 \cdot 10^{-7}$
$n_{t,trailer} = 8$
$p_{trailer} = 689.5$ kPa
$L_{trailer} = 45727.5$ N
$\alpha_{trailer} = -0.3982$
$\beta_{trailer} = 0.9756$
$a_{trailer} = 0.0656$
$b_{trailer} = 1.51 \cdot 10^{-4}$
$c_{trailer} = 2.94 \cdot 10^{-7}$
$\overline{v}_{seghi} = 28.86$ m/s = 103.896 km/hr
$\overline{v}_{seglo} = 5.84$ m/s = 21.024 km/hr

$$F_{TRRhi,steer} = 2 \cdot 758.4^{-0.2435} \cdot \left(\frac{51421.2}{2}\right)^{0.9576} \cdot \left(0.0434 + 5.4 \cdot 10^{5} \cdot 103.896 + 5.53 \cdot 10^{-7} \cdot 103.896^{2}\right)$$

$F_{TRRhi,steer} = 365.6$ N
$F_{TRRhi,drive} = 431.4$ N
$F_{TRRhi,trailer} = 231.7$ N
$F_{TRRlo,steer} = 297.8$ N
$F_{TRRlo,drive} = 350.7$ N
$F_{TRRlo,trailer} = 189.0$ N

(iii) Calculate $F_{TRR[speed]}$ by summing the tire rolling resistance calculations at a given speed for each axle position:

$$F_{TRR[speed]} = F_{TRR,[speed]steer} + F_{TRR,[speed]drive} + F_{TRR,[speed]trailer}$$

Eq. 1037.528-12

Example:

F_{TRRhi} = 365.6 + 431.4 + 231.7 = 1028.7 N

F_{TRRlo} = 297.8 + 350.7 + 189.0 = 837.5 N

(iv) Adjust $F_{TRR[speed]}$ to the ambient temperature during the coastdown segment as follows:

$$F_{\text{TRRadj[speed]}} = F_{\text{TRR,[speed]}}\left[1+0.006\cdot(24-\overline{T}_{seg[speed]})\right]$$

Eq. 1037.528-13

Where:

$\overline{T}_{seg[speed]}$ = the average ambient temperature during the coastdown segment, in °C.

Example:

F_{TRRhi} = 1028.7 N

F_{TRRlo} = 837.5 N

$\overline{T}_{seghi}$ = 25.5 °C

$\overline{T}_{seglo}$ = 25.1 °C

$$F_{\text{TRRhi,adj}} = 1028.7\cdot\left[1+0.006\cdot(24-25.5)\right] = 1019.4 \text{ N}$$

$$F_{\text{TRRlo,adj}} = 837.5\cdot\left[1+0.006\cdot(24-25.1)\right] = 832.0 \text{ N}$$

(v) Determine the difference in rolling resistance between 65 mph and 15 mph, ΔF_{TRR}, for each tire. Use good engineering judgment to consider the multiple results. For example, you may ignore the test results for the tires with the highest and lowest differences and use the result from the remaining tire. Determine ΔF_{TRR} as follows:

$$\Delta F_{\text{TRR}} = F_{\text{TRRhi,adj}} - F_{\text{TRRlo,adj}}$$

Eq. 1037.528-14

Example:

ΔF_{TRR} = 1019.4 – 832.0 = 187.4 N

*   *   *   *   *

(12)   *   *   *

(v) For the same set of points, recalculate the mean C_dA. This is the final result of the coastdown test, $C_dA_{coastdown}(\psi_{eff})$.

*   *   *   *   *

153. Amend §1037.530 by revising paragraph (d)(7) to read as follows:

§1037.530 Wind-tunnel procedures for calculating drag area (C_dA).

*   *   *   *   *

(d) *   *   *

(7) Fan section description: fan type, diameter, power, maximum angular speed, maximum speed, support type, mechanical drive, and sectional total weight.

*   *   *   *   *

154. Amend §1037.532 by revising paragraph (a) to read as follows:

§1037.532 Using computational fluid dynamics to calculate drag area (C_dA).

*   *   *   *   *

(a) For Phase 2 vehicles, use SAE J2966 (incorporated by reference in §1037.810), with the following clarifications and exceptions:

(1) Vehicles are subject to the requirement to meet standards based on the average of testing at yaw angles of +4.5° and –4.5°; however, you may submit your application for certification with CFD results based on only one of those yaw angles.

(2) For CFD code with a Navier-Stokes based solver, follow the additional steps in paragraph (d) of this section. For Lattice-Boltzmann based CFD code, follow the additional steps in paragraph (e) of this section.

(3) Simulate a Reynolds number of 5.1 million (based on a 102-inch trailer width) and an air speed of 65 mi/hr.

(4) Perform an open-road simulation (not the Wind Tunnel Simulation).

(5) Use a free stream turbulence intensity of 0.0 %.

(6) Choose time steps that can accurately resolve intrinsic flow instabilities, consistent with good engineering judgment.

(7) The result must be drag area (C_dA), not drag coefficient (C_d), based on an air speed of 65 mi/hr.

(8) Submit information as described in paragraph (g) of this section.

*   *   *   *   *

155. Amend §1037.534 by revising paragraph (c)(1), (c)(2), (d)(4)(i), and (f)(4)(iv) to read as follows:

§1037.534 Constant-speed procedure for calculating drag area (*C_dA*).

*   *   *   *   *

(c) *   *   *

(1) Measure torque at each of the drive wheels using a hub torque meter or a rim torque meter. If testing a tractor with two drive axles, you may disconnect one of the drive axles from receiving torque from the driveshaft, in which case you would measure torque at only the wheels that receive torque from the driveshaft. Set up instruments to read engine speed for calculating angular speed at the point of the torque measurements, or install instruments for measuring the angular speed of the wheels directly.

(2) Install instrumentation to measure vehicle speed at 10 Hz, with an accuracy and resolution of 0.1 mi/hr. Also install instrumentation for reading engine speed from the engine's onboard computer.

*   *   *   *   *

(d) *   *   *

(4) *   *   *

(i) Measure the angular speed of the driveshaft, axle, or wheel where the torque is measured, or calculate it from engine speed in conjunction with gear and axle ratios, as applicable.

*   *   *   *   *

(f) *   *   *

(4) *   *   *

(iv) Calculate C_dA for each 10 second increment from the 50 mi/hr and 70 mi/hr test segments using the following equation:

$$C_dA_{i[\text{speed}]} = \left[\frac{2 \cdot \overline{F}_{\text{aero[speed]}}}{\overline{v}^2_{\text{air[speed]}}} \cdot \frac{R \cdot \overline{T}}{\overline{p}_{\text{act}}}\right]_i$$

Eq. 1037.534-6

Where:

$C_dA_{i[\text{speed}]}$ = the mean drag area for each 10 second increment, *i*.

$\overline{F}_{\text{aero[speed]}}$ = mean aerodynamic force over a given 10 second increment = $\overline{F}_{\text{RL[speed]}}$ – $\overline{F}_{\text{RL10,test}}$.

$\overline{v}_{\text{air[speed]}}$ = mean aerodynamic force over a given 10 second increment.

R = specific gas constant = 287.058 J/(kg·K).

$\overline{T}$ = mean air temperature.

$\overline{p}_{\text{act}}$ = mean absolute air pressure.

Example:

$\overline{F}_{\text{RL70}}$ = 4310.6 N

$\overline{F}_{\text{RL10,test}}$ = 900.1 N

$\overline{F}_{\text{aero70}}$ = 4310.6 – 900.1 = 3410.5 N

$\overline{v}^2_{\text{air70}}$ = 1089.5 m²/s²

R = 287.058 J/(kg·K)

$\overline{T}$ = 293.68 K

$\overline{p}_{\text{act}}$ = 101300 Pa

$$C_dA_{i70} = \left[\frac{2\cdot 3410.5}{1089.5}\cdot\frac{287.058\cdot 293.68}{101300}\right]_i$$

C_dA_{i70} = 5.210 m²

* * * * *

156. Amend §1037.540 by revising paragraphs (b)(3), (b)(8), (d)(2), (e)(2), and (f) to read as follows:

§1037.540 Special procedures for testing vehicles with hybrid power take-off.

* * * * *

(b) * * *

(3) Denormalize the PTO duty cycle in Appendix II of this part using the following equation:

$$p_{\text{ref}i} = p_i \cdot \left(\overline{p}_{\max} - \overline{p}_{\min}\right) + \overline{p}_{\min}$$

Eq. 1037.540-1

Where:

$p_{\text{ref}i}$ = the reference pressure at each point *i* in the PTO cycle.

p_i = the normalized pressure at each point *i* in the PTO cycle (relative to $\overline{p}_{\max}$).

$\overline{p}_{\max}$ = the mean maximum pressure measured in paragraph (b)(2) of this section.

$\overline{p}_{\min}$ = the mean minimum pressure measured in paragraph (b)(2) of this section.

* * * * *

(8) Measured pressures must meet the cycle-validation specifications in the following table

for each test run over the duty cycle:

Table 1 of §1037.540 – Statistical criteria for validating each test run over the duty cycle

PARAMETER[a]	PRESSURE
Slope, a_1	$0.950 \leq a_1 \leq 1.030$
Absolute value of intercept, $\|a_0\|$	≤ 2.0 % of maximum mapped pressure
Standard error of the estimate, *SEE*	≤ 10 % of maximum mapped pressure
Coefficient of determination, r^2	≥ 0.970

[a]Determine values for specified parameters as described in 40 CFR 1065.514(e) by comparing measured values to denormalized pressure values from the duty cycle in Appendix II of this part.

* * * * *

(d) * * *

(2) For fractions of a test, use the following equation to calculate the time:

$$t_{\text{test-partial}} = \frac{\sum_{i=1}^{N}\left(p_{\text{circuit-1},i} + p_{\text{circuit-2},i}\right)\cdot \Delta t}{\overline{p}_{\text{circuit-1}} + \overline{p}_{\text{circuit-2}}}$$

Eq. 1037.540-2

Where:

i = an indexing variable that represents one recorded value.

N = number of measurement intervals.

$p_{\text{circuit-1},i}$ = normalized pressure command from circuit 1 of the PTO cycle for each point, i, starting from i = 1.

$p_{\text{circuit-2},i}$ = normalized pressure command from circuit 2 of the PTO cycle for each point, i, starting from i = 1. Let $p_{\text{circuit-2}}$ = 0 if there is only one circuit.

$\overline{p}_{\text{circuit-1}}$ = the mean normalized pressure command from circuit 1 over the entire PTO cycle.

$\overline{p}_{\text{circuit-2}}$ = the mean normalized pressure command from circuit 2 over the entire PTO cycle. Let $\overline{p}_{\text{circuit-2}}$ = 0 if there is only one circuit.

Δt = the time interval between measurements. For example, at 100 Hz, Δt = 0.0100 seconds.

* * * * *

(e) * * *

(2) Divide the CO_2 mass from the PTO cycle by the distance determined in paragraph (d)(4) of this section and the standard payload as defined in §1037.801 to get the CO_2 emission rate in g/ton-mile. For plug-in hybrid electric vehicles follow paragraph (f)(3) of this section to calculate utility factor weighted CO_2 emissions in g/ton-mile.

* * * * *

(f) For Phase 2, calculate the delta PTO fuel results for input into GEM during vehicle certification as follows:

(1) Calculate fuel consumption in grams per test, m_{fuelPTO}, without rounding, as described in 40 CFR 1036.540(d)(4) for both the conventional vehicle and the charge-sustaining and charge-depleting portions of the test for the hybrid vehicle as applicable.

(2) Divide the fuel mass by the applicable distance determined in paragraph (d)(4) of this

section and the appropriate standard payload as defined in §1037.801 to determine the fuel rate in g/ton-mile.

(3) For plug-in hybrid electric vehicles calculate the utility factor weighted fuel consumption in g/ton-mile, as follows:

(i) Determine the utility factor fraction for the PTO system from the table in Appendix V of this part using interpolation based on the total time of the charge-depleting portion of the test as determined in paragraphs (c)(6) and (d)(3) of this section.

(ii) Weight the emissions from the charge-sustaining and charge-depleting portions of the test using the following equation:

$$m_{\text{fuelPTO,plug-in}} = m_{\text{PTO,CD}} \cdot UF_{\text{t,CD}} + m_{\text{PTO,CS}} \cdot \left(1 - UF_{\text{t,CD}}\right)$$

Eq. 1037.540-3

Where:

$m_{\text{PTO,CD}}$ = mass of fuel per ton-mile while in charge-depleting mode.

$UF_{\text{t,CD}}$ = utility factor fraction at time t_{CD} as determined in paragraph (f)(3)(i) of this section.

$m_{\text{PTO,CS}}$ = mass of fuel per ton-mile while in charge-sustaining mode.

(4) Calculate the difference between the conventional PTO emissions result and the hybrid PTO emissions result for input into GEM.

* * * * *

157. Revise §1037.550 to read as follows:

§1037.550 Powertrain testing.

This section describes the procedure to measure fuel consumption and create engine fuel maps by testing a powertrain that includes an engine coupled with a transmission, drive axle, and hybrid components or any assembly with one or more of those hardware elements. Engine fuel maps are part of demonstrating compliance with Phase 2 vehicle standards under this part 1037; the powertrain test procedure in this section is one option for generating this fuel-mapping information as described in 40 CFR 1036.503. Additionally, this powertrain test procedure is one option for certifying hybrids to the engine standards in 40 CFR part 1036.108.

(a) General provisions. The following provisions apply broadly for testing under this section:

(1) Measure NO_x emissions as described in paragraph (k) of this section. Include these measured NO_x values any time you report to us your greenhouse gas emissions or fuel consumption values from testing under this section.

(2) The procedures of 40 CFR part 1065 apply for testing in this section except as specified. This section uses engine parameters and variables that are consistent with 40 CFR part 1065.

(3) Powertrain testing depends on models to calculate certain parameters. You can use the detailed equations in this section to create your own models, or use the GEM HIL model (incorporated by reference in §1037.810) to simulate vehicle hardware elements as follows:

(i) Create driveline and vehicle models that calculate the angular speed setpoint for the test cell dynamometer, $f_{\text{nref,dyno}}$, based on the torque measurement location. Use the detailed equations in paragraph (f) of this section, the GEM HIL model's driveline and vehicle submodels, or a combination of the equations and the submodels. You may use the GEM HIL model's transmission submodel in paragraph (f) of this section to simulate a transmission only if testing hybrid engines.

(ii) Create a driver model or use the GEM HIL model's driver submodel to simulate a human driver modulating the throttle and brake pedals to follow the test cycle as closely as possible.

(iii) Create a cycle-interpolation model or use the GEM HIL model's cycle submodel to interpolate the duty-cycles and feed the driver model the duty-cycle reference vehicle speed for each point in the duty-cycle.

(4) The powertrain test procedure in this section is designed to simulate operation of different vehicle configurations over specific duty cycles. See paragraphs (h) and (j) of this section.

(5) For each test run, record engine speed and torque as defined in 40 CFR 1065.915(d)(5) with a minimum sampling frequency of 1 Hz. These engine speed and torque values represent a duty cycle that can be used for separate testing with an engine mounted on an engine dynamometer under §1037.551, such as for a selective enforcement audit as described in §1037.301.

(6) For hybrid powertrains with no plug-in capability, correct for the net energy change of the energy storage device as described in 40 CFR 1066.501. For PHEV powertrains, follow 40 CFR 1066.501 to determine End-of-Test for charge-depleting operation. You must get our approval in advance for your utility factor curve; we will approve it if you can show that you created it from sufficient in-use data of vehicles in the same application as the vehicles in which the PHEV powertrain will be installed.

(b) Test configuration. Select a powertrain for testing as described in §1037.235 or 40 CFR 1036.235 as applicable. Set up the engine according to 40 CFR 1065.110 and 40 CFR 1065.405(b). Set the engine's idle speed to the minimum warm-idle speed. If warm idle speed is not adjustable, simply let the engine operate at its warm idle speed.

(1) The default test configuration consists of a powertrain with all components upstream of the axle. This involves connecting the powertrain's output shaft directly to the dynamometer or to a gear box with a fixed gear ratio and measuring torque at the axle input shaft. You may instead set up the dynamometer to connect at the wheel hubs and measure torque at that location. This may apply if your powertrain configuration requires it, such as for hybrid powertrains or if you want to represent the axle performance with powertrain test results.

(2) For testing hybrid engines, connect the engine's crankshaft directly to the dynamometer and measure torque at that location.

(c) Powertrain temperatures during testing. Cool the powertrain during testing so temperatures for oil, coolant, block, head, transmission, battery, and power electronics are within the manufacturer's expected ranges for normal operation. You may use electronic control module outputs to comply with this requirement. You may use auxiliary coolers and fans.

(d) Engine break in. Break in the engine according to 40 CFR 1065.405, the axle assembly according to §1037.560, and the transmission according to §1037.565. You may instead break in the powertrain as a complete system using the engine break in procedure in 40 CFR 1065.405.

(e) Dynamometer setup. Set the dynamometer to operate in speed-control mode (or torque-control mode for hybrid engine testing at idle, including idle portions of transient duty cycles). Record data as described in 40 CFR 1065.202. Command and control the dynamometer speed at a minimum of 5 Hz, or 10 Hz for testing engine hybrids. Run the vehicle model to calculate the dynamometer setpoints at a rate of at least 100 Hz. If the dynamometer's command frequency is less than the vehicle model dynamometer setpoint frequency, subsample the calculated setpoints for commanding the dynamometer setpoints.

(f) Driveline and vehicle model. Use the GEM HIL model's driveline and vehicle submodels or the equations in this paragraph (f) of this section to calculate the dynamometer speed setpoint, $f_{nref,dyno}$, based on the torque measurement location. Note that the GEM HIL model is configured to set the accessory load to zero and it comes configured with the tire slip model disabled.

(1) Driveline model with a transmission in hardware. For testing with torque measurement at the axle input shaft or wheel hubs, calculate, $f_{\text{nref,dyno}}$, using the GEM HIL model's driveline submodel or the following equation:

$$f_{\text{nref}i\text{,dyno}} = \frac{k_{\text{a[speed]}} \cdot v_{\text{ref}i}}{2 \cdot \pi \cdot r_{\text{[speed]}}}$$

Eq. 1037.550-1

Where:

$k_{\text{a[speed]}}$ = drive axle ratio as determined in paragraph (h) of this section. Set $k_{\text{a[speed]}}$ equal to 1.0 if torque is measured at the wheel hubs.

$v_{\text{ref}i}$ = simulated vehicle reference speed as calculated in paragraph (f)(3) of this section.

$r_{\text{[speed]}}$ = tire radius as determined in paragraph (h) of this section.

(2) Driveline model with a simulated transmission. For testing with the torque measurement at the engine's crankshaft, $f_{\text{nref,dyno}}$ is the dynamometer target speed from the GEM HIL model's transmission submodel. You may request our approval to change the transmission submodel, as long as the changes do not affect the gear selection logic. Before testing, initialize the transmission model with the engine's measured torque curve and the applicable steady-state fuel map from the GEM HIL model. You may request our approval to input your own steady-state fuel map. Configure the torque converter to simulate neutral idle when using this procedure to generate engine fuel maps in 40 CFR 1036.503 or to perform SET testing under 40 CFR 1036.505. You may change engine commanded torque at idle to better represent CITT for transient testing under 40 CFR 1036.510. You may change the simulated engine inertia to match the inertia of the engine under test. We will evaluate your requests under this paragraph (f)(3) based on your demonstration that that the adjusted testing better represents in-use operation.

(i) The transmission submodel needs the following model inputs:

(A) Torque measured at the engine's crankshaft.

(B) Engine estimated torque determined from the electronic control module or by converting the instantaneous operator demand to an instantaneous torque in N·m.

(C) Dynamometer mode when idling (speed-control or torque-control).

(D) Measured engine speed when idling.

(E) Transmission output angular speed, $f_{\text{n}i\text{,transmission}}$, calculated as follows:

$$f_{\text{n}i\text{,transmission}} = \frac{k_{\text{a[speed]}} \cdot v_{\text{ref}i}}{2 \cdot \pi \cdot r_{\text{[speed]}}}$$

Eq. 1037.550-2

Where:

$k_{\text{a[speed]}}$ = drive axle ratio as determined in paragraph (h) of this section.

$v_{\text{ref}i}$ = simulated vehicle reference speed as calculated in paragraph (f)(3) of this section.

$r_{\text{[speed]}}$ = tire radius as determined in paragraph (h) of this section.

(ii) The transmission submodel generates the following model outputs:

(A) Dynamometer target speed.

(B) Dynamometer idle load.

(C) Transmission engine load limit.

(D) Engine speed target.

(3) Vehicle model. Calculate the simulated vehicle reference speed, $v_{\text{ref}i}$, using the GEM HIL model's vehicle submodel or the equations in this paragraph (f)(3):

$$v_{\text{ref}i} = \left(\begin{array}{l} \dfrac{k_{\text{a}} \cdot T_{i\text{-}1}}{r} \cdot \left(Eff_{\text{axle}} \right) - \\ \left(M \cdot g \cdot C_{\text{rr}} \cdot \cos\left(\text{atan}\left(G_{i\text{-}1}\right)\right) + \dfrac{\rho \cdot C_{\text{d}} A}{2} \cdot v_{\text{ref},i\text{-}1}^2 \right) - F_{\text{brake},i\text{-}1} - F_{\text{grade},i\text{-}1} \end{array} \right) \cdot \frac{\Delta t_{i\text{-}1}}{M + M_{\text{rotating}}} + v_{\text{ref},i\text{-}1}$$

Eq. 1037.550-3

Where:

i = a time-based counter corresponding to each measurement during the sampling period. Let $v_{\text{ref}1} = 0$; start calculations at $i = 2$. A 10-minute sampling period will generally involve 60,000 measurements.

T = instantaneous measured torque at the axle input, measured at the wheel hubs, or simulated by the GEM HIL model's transmission submodel.

Eff_{axle} = axle efficiency. Use $Eff_{\text{axle}} = 0.955$ for $T \geq 0$, and use $Eff_{\text{axle}} = 1/0.955$ for $T < 0$. Use $Eff_{\text{axle}} = 1.0$ if torque is measured at the wheel hubs.

M = vehicle mass for a vehicle class as determined in paragraph (h) of this section.

g = gravitational constant = 9.80665 m/s^2.

C_{rr} = coefficient of rolling resistance for a vehicle class as determined in paragraph (h) of this section.

$G_{i\text{-}1}$ = the percent grade interpolated at distance, $D_{i\text{-}1}$, from the duty cycle in Appendix IV corresponding to measurement (i–1).

$$D_{i\text{-}1} = \sum_{i=1}^{N} \left(v_{\text{ref},i\text{-}1} \cdot \Delta t_{i\text{-}1} \right)$$

Eq. 1037.550-4

ρ = air density at reference conditions. Use ρ = 1.1845 kg/m^3.

$C_{\text{d}}A$ = drag area for a vehicle class as determined in paragraph (h) of this section.

$F_{\text{brake},i\text{-}1}$ = instantaneous braking force applied by the driver model.

$$F_{\text{grade},i\text{-}1} = M \cdot g \cdot \sin\left(\text{atan}\left(G_{i\text{-}1}\right)\right)$$

Eq. 1037.550-5

Δt = the time interval between measurements. For example, at 100 Hz, Δt = 0.0100 seconds.

M_{rotating} = inertial mass of rotating components. Let M_{rotating} = 340 kg for vocational Light HDV or vocational Medium HDV. See paragraph (h) of this section for tractors and for vocational Heavy HDV.

(4) Example. The following example illustrates a calculation of $f_{\text{nref,dyno}}$ using paragraph (f)(1) of this section where torque is measured at the axle input shaft. This example is for a vocational Light HDV or vocational Medium HDV with 6 speed automatic transmission at B speed (Test 4 in Table 2 of 40 CFR 1036.540).

$k_{a\text{B}}$ = 4.0

r_{B} = 0.399 m

T_{999} = 500.0 N·m

C_{rr} = 7.7 kg/tonne = 7.7·10^{-3} kg/kg

M = 11408 kg

$C_{\text{d}}A$ = 5.4 m^2

G_{999} = 0.39 % = 0.0039

$$D_{999}=\sum_{i=0}^{998}\left(19.99\cdot 0.01+20.0\cdot 0.01+...+v_{\text{ref},998}\cdot\Delta t_{998}\right)=1792\text{ m}$$

$F_{\text{brake},999}$ = 0 N

$v_{\text{ref},999}$ = 20.0 m/s

$$F_{\text{grade},999}=11408\cdot 9.81\cdot\sin\left(\text{atan}\left(0.0039\right)\right)=436.5\text{ N}$$

Δt = 0.0100 s

M_{rotating} = 340 kg

$$v_{\text{ref}1000}=\left(\begin{array}{l}\frac{4.0\cdot 500.0}{0.399}\cdot(0.955)-\\ \left(\left(11408\cdot 9.80665\cdot 7.7\cdot 10^{-3}\cdot\cos\left(\text{atan}\left(0.0039\right)\right)+\frac{1.1845\cdot 5.4}{2}\cdot 20.0^2\right)-0-436.5\right)\end{array}\right)\cdot\frac{0.0100}{11408+340}+20.0$$

$v_{\text{ref}1000}$ = 20.00189 m/s

$$f_{\text{nref}1000,\text{dyno}}=\frac{4.0\cdot 20.00189}{2\cdot 3.14\cdot 0.399}=31.93\text{ r/s}=1915.8\text{ r/min}$$

(g) Driver model. Use the GEM HIL model's driver submodel or design a driver model to simulate a human driver modulating the throttle and brake pedals. In either case, tune the model to follow the test cycle as closely as possible meeting the following specifications:

(1) The driver model must meet the speed requirements for operation over the highway cruise cycles as described in §1037.510 and for operation over the transient cycle as described in 40 CFR 1066.425(b). The exceptions in 40 CFR 1066.425(b)(4) apply to the transient cycle and the highway cruise cycles.

(2) Send a brake signal when operator demand is zero and vehicle speed is greater than the reference vehicle speed from the test cycle. Include a delay before changing the brake signal to prevent dithering, consistent with good engineering judgment.

(3) Allow braking only if operator demand is zero.

(4) Compensate for the distance driven over the duty cycle over the course of the test. Use the following equation to perform the compensation in real time to determine your time in the cycle:

$$t_{\text{cycle}i}=\sum_{i=1}^{N}\left(\left(\frac{v_{\text{vehicle},i\text{-}1}}{v_{\text{cycle},i\text{-}1}}\right)\cdot\Delta t_{i\text{-}1}\right)$$

Eq. 1037.550-6

Where:

v_{vehicle} = measured vehicle speed.

v_{cycle} = reference speed from the test cycle. If $v_{\text{cycle},i\text{-}1}$ < 1.0 m/s, set $v_{\text{cycle},i\text{-}1} = v_{\text{vehicle},i\text{-}1}$.

(h) Vehicle configurations to evaluate for generating fuel maps as defined in 40 CFR 1036.503. Configure the driveline and vehicle models from paragraph (f) of this section in the test cell to test the powertrain. Simulate multiple vehicle configurations that represent the range of intended vehicle applications. Use at least three equally spaced axle ratios or tire sizes and three different road loads (nine configurations), or at least four equally spaced axle ratios or tire sizes and two different road loads (eight configurations). Select axle ratios to represent the full range of expected vehicle installations.

(1) Determine the vehicle model inputs for M, M_{rotating}, C_dA, and C_{rr} for a set of vehicle configurations as described in 40 CFR 1036.540(c)(3). Instead of selecting axle ratios and

tire sizes based on the range of intended vehicle applications as described in this paragraph (h), you may select axle ratios and tire sizes such that the ratio of engine speed to vehicle speed covers the range of ratios of minimum and maximum engine speed to vehicle speed when the transmission is in top gear for the vehicles in which the powertrain will be installed. Note that you do not have to use the same axle ratios and tire sizes for each GEM regulatory subcategory.

(2) For hybrid powertrain systems where the transmission will be simulated, use the transmission parameters defined in Table 1 of 40 CFR 1036.540 to determine transmission type and gear ratio. Use a fixed transmission efficiency of 0.95. The GEM HIL transmission model uses a transmission parameter file for each test that includes the transmission type, gear ratios, lockup gear, torque limit per gear from Table 1 of 40 CFR 1036.540, and the values from 40 CFR 1036.503(b)(4) and (c).

(i) [Reserved]

(j) Duty cycles to evaluate. Operate the powertrain over each of the duty cycles specified in §1037.510(a)(2), and for each applicable vehicle configuration from paragraph (h) of this section. Determine cycle-average powertrain fuel maps by testing the powertrain using the procedures in 40 CFR 1036.540(d) with the following exceptions:

(1) Understand “engine” to mean “powertrain”.

(2) If the preceding duty cycle does not end at 0 mi/hr, transition between duty cycles by decelerating at a rate of 2 mi/hr/s at 0 % grade until the vehicle reaches zero speed. Shut off the powertrain. Prepare the powertrain and test cell for the next duty-cycle. Start the next duty-cycle within 60 to 180 seconds after shutting off the powertrain. Do not run the powertrain or change its physical state before starting the next duty cycle. If the next duty cycle begins at 0 mi/hr vehicle speed, key on the vehicle and start the duty-cycle after 10 seconds, otherwise key on the vehicle and transition to the next duty cycle by accelerating at a rate of 1 mi/hr/s at 0 % grade for vehicle configurations given in Table 2 of 40 CFR 1036.540 or 2 mi/hr/s at 0 % grade for vehicle configurations given in Table 3 and Table 4 of 40 CFR 1036.540, then stabilize for 10 seconds at the initial duty cycle conditions.

(3) Calculate cycle work using GEM or the speed and torque from the driveline and vehicle models from paragraph (f) of this section to determine the sequence of duty cycles.

(4) Calculate the mass of fuel consumed for idle duty cycles as described in paragraph (n) of this section.

(5) Warm up the powertrain as described in 40 CFR 1036.527(c)(1).

(k) Measuring NO_x emissions. Measure NO_x emissions for each sampling period in grams. You may perform these measurements using a NO_x emission-measurement system that meets the requirements of 40 CFR part 1065, subpart J. If a system malfunction prevents you from measuring NO_x emissions during a test under this section but the test otherwise gives valid results, you may consider this a valid test and omit the NO_x emission measurements; however, we may require you to repeat the test if we determine that you inappropriately voided the test with respect to NO_x emission measurement.

(l) [Reserved]

(m) Measured output speed validation. For each test point, validate the measured output speed with the corresponding reference values. If the range of reference speed is less than 10 percent of the mean reference speed, you need to meet only the standard error of the estimate in Table 1 of this section. You may delete points when the vehicle is stopped. If your speed measurement is not at the location of f_{nref}, correct your measured speed using the constant speed ratio between the two locations. Apply cycle-validation criteria for each separate transient or highway cruise cycle based on the following parameters:

Table 1 of §1037.550 – Statistical criteria for validating duty cycles

PARAMETER[a]	SPEED CONTROL
Slope, a_1	$0.990 \leq a_1 \leq 1.010$
Absolute value of intercept, $\lvert a_0 \rvert$	≤ 2.0 % of maximum f_{nref} speed
Standard error of the estimate, *SEE*	≤ 2.0 % of maximum f_{nref} speed
Coefficient of determination, r^2	≥ 0.990

[a]Determine values for specified parameters as described in 40 CFR 1065.514(e) by comparing measured and reference values for $f_{nref,dyno}$.

(n) Fuel consumption at idle. Determine the mass of fuel consumed at idle for the applicable duty cycles described in §1037.510(a)(2) as follows:

(1) Measure fuel consumption with a fuel flow meter and report the mean idle fuel mass flow rate for each duty cycle as applicable, $\bar{\dot{m}}_{fuelidle}$.

(2) If you do not measure fuel mass flow rate, calculate the idle fuel mass flow rate for each duty cycle, $\bar{\dot{m}}_{fuelidle}$, for each set of vehicle settings, as follows:

$$\bar{\dot{m}}_{fuelidle} = \frac{M_C}{w_{Cmeas}} \cdot \left(\bar{\dot{n}}_{exh} \cdot \frac{\bar{x}_{Ccombdry}}{1 + \bar{x}_{H2Oexhdry}} - \frac{\bar{\dot{m}}_{CO2DEF}}{M_{CO2}} \right)$$

Eq. 1037.550-7

Where:

M_C = molar mass of carbon.

w_{Cmeas} = carbon mass fraction of fuel (or mixture of test fuels) as determined in 40 CFR 1065.655(d), except that you may not use the default properties in Table 1 of 40 CFR 1065.655 to determine α, β, and w_C for liquid fuels.

$\bar{\dot{n}}_{exh}$ = the mean raw exhaust molar flow rate from which you measured emissions according to 40 CFR 1065.655.

$\bar{x}_{Ccombdry}$ = the mean concentration of carbon from fuel and any injected fluids in the exhaust per mole of dry exhaust.

$\bar{x}_{H2Oexhdry}$ = the mean concentration of H_2O in exhaust per mole of dry exhaust.

$\bar{\dot{m}}_{CO2DEF}$ = the mean CO_2 mass emission rate resulting from diesel exhaust fluid decomposition over the duty cycle as determined in 40 CFR 1036.535(b)(10). If your engine does not use diesel exhaust fluid, or if you choose not to perform this correction, set $\bar{\dot{m}}_{CO2DEF}$ equal to 0.

M_{CO2} = molar mass of carbon dioxide.

Example:

M_C = 12.0107 g/mol

w_{Cmeas} = 0.867

$\bar{\dot{n}}_{exh}$ = 25.534 mol/s

$\bar{x}_{Ccombdry} = 2.805 \cdot 10^{-3}$ mol/mol

$\bar{x}_{H2Oexhdry} = 3.53 \cdot 10^{-2}$ mol/mol

$\bar{m}_{CO2DEF}$ = 0.0726 g/s

M_{CO2} = 44.0095

$$\bar{m}_{fuelidle} = \frac{12.0107}{0.867} \cdot \left(25.534 \cdot \frac{2.805 \cdot 10^{-3}}{1 + 3.53 \cdot 10^{-2}} - \frac{0.0726}{44.0095} \right)$$

$\bar{m}_{fuelidle}$ = 0.405 g/s = 1458.6 g/hr

(o) Create GEM inputs. Use the results of powertrain testing to determine GEM inputs for the different simulated vehicle configurations as follows:

(1) Correct the measured or calculated fuel masses, $m_{fuel[cycle]}$, and mean idle fuel mass flow rates, $\bar{m}_{fuelidle}$, if applicable, for each test result to a mass-specific net energy content of a reference fuel as described in 40 CFR 1036.535(f), replacing $\bar{m}_{fuel}$ with $m_{fuel[cycle]}$ where applicable in Eq. 1036.535-4.

(2) Declare fuel masses, $m_{fuel[cycle]}$, in g/cycle. In addition, declare mean fuel mass flow rate for each applicable idle duty cycle, $\bar{m}_{fuelidle}$. These declared values may not be lower than any corresponding measured values determined in this section. If you use multiple measurement methods as allowed in 40 CFR 1036.540(d), follow 40 CFR 1036.535(g) regarding the use of direct and indirect fuel measurements and the carbon balance error verification. These declared values, which serve as emission standards, collectively represent the powertrain fuel map for certification.

(3) Calculate powertrain output speed per unit of vehicle speed, $\left[\frac{\bar{f}_{npowertrain}}{\bar{v}_{powertrain}}\right]_{[cycle]}$, using one of the following methods:

(i) For testing with torque measurement at the axle input shaft:

$$\left[\frac{\bar{f}_{npowertrain}}{\bar{v}_{powertrain}}\right]_{[cycle]} = \frac{k_a}{2 \cdot \pi \cdot r_{[speed]}}$$

Eq. 1037.550-8

Example:

k_a = 4.0

r_B = 0.399 m

$$\left[\frac{\bar{f}_{npowertrain}}{\bar{v}_{powertrain}}\right]_{transienttest4} = \frac{4.0}{2 \cdot 3.14 \cdot 0.399} = 1.596 \text{ r/m}$$

(ii) For testing with torque measurement at the wheel hubs, use Eq. 1037.550-8 setting k_a equal to 1.

(iii) For testing with torque measurement at the engine's crankshaft:

$$\left[\frac{\bar{f}_{npowertrain}}{\bar{v}_{powertrain}}\right]_{[cycle]} = \frac{\bar{f}_{nengine}}{\bar{v}_{ref}}$$

Eq. 1037.550-9

Where:

$\bar{f}_{nengine}$ = average engine speed when vehicle speed is at or above 0.100 m/s.

$\bar{v}_{ref}$ = average simulated vehicle speed at or above 0.100 m/s.

Example:

$\bar{f}_{nengine}$ = 1870 r/min = 31.17 r/s

$\bar{v}_{ref}$ = 19.06 m/s

$$\left[\frac{\bar{f}_{npowertrain}}{\bar{v}_{powertrain}}\right]_{transienttest4} = \frac{31.17}{19.06} = 1.635 \text{ r/m}$$

(4) Calculate positive work, $W_{[cycle]}$, as the work over the duty cycle at the axle input shaft, wheel hubs, or the engine's crankshaft, as applicable, when vehicle speed is at or above 0.100 m/s.

(5) Calculate engine idle speed, by taking the average engine speed measured during the transient cycle test while the vehicle speed is below 0.100 m/s.

(6) The following table illustrates the GEM data inputs corresponding to the different vehicle configurations for a given duty cycle:

Table 2 of §1037.550 – Example vehicle configuration test result output matrix for Heavy HDV

	VEHICLE CONFIGURATION NUMBER								
	1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
$m_{fuel[cycle]}$									
$\left[\frac{\bar{f}_{npowertrain}}{\bar{v}_{powertrain}}\right]_{[cycle]}$									
$W_{[cycle]}$									
$\bar{f}_{nidle}$ [a]									

[a]Idle speed applies only for the transient duty cycle.

158. Amend §1037.551 by revising paragraph (b) to read as follows:

§1037.551 Engine-based simulation of powertrain testing**.**

* * * * *

(b) Operate the engine over the applicable engine duty cycles corresponding to the vehicle cycles specified in §1037.510(a)(2) for powertrain testing over the applicable vehicle simulations described in §1037.550(i). Warm up the engine to prepare for the transient test or one of the highway cruise cycles by operating it one time over one of the simulations of the corresponding duty cycle. Warm up the engine to prepare for the idle test by operating it over a simulation of the 65-mi/hr highway cruise cycle for 600 seconds. Within 60 seconds after concluding the warm up cycle, start emission sampling while the engine operates over the duty cycle. You may perform any number of test runs directly in succession once the engine is warmed up. Perform cycle validation as described in 40 CFR 1065.514 for engine speed, torque, and power.

* * * * *

159. Amend §1037.555 by revising paragraphs (d), (e), and (f) to read as follows:

§1037.555 Special procedures for testing Phase 1 hybrid systems.

* * * * *

(d) Calculate the transmission output shaft's angular speed target for the driver model, $f_{nref,driver}$, from the linear speed associated with the vehicle cycle using the following equation:

$$f_{\text{nref}i,\text{driver}} = \frac{v_{\text{cycle}i} \cdot k_{\text{a}}}{2 \cdot \pi \cdot r}$$

Eq. 1037.555-1

Where:

$v_{\text{cycle}i}$ = vehicle speed of the test cycle for each point, i, starting from i = 1.

k_{a} = drive axle ratio, as declared by the manufacturer.

r = radius of the loaded tires, as declared by the manufacturer.

(e) Use speed control with a loop rate of at least 100 Hz to program the dynamometer to follow the test cycle, as follows:

(1) Calculate the transmission output shaft's angular speed target for the dynamometer, $f_{\text{nref,dyno}}$, from the measured linear speed at the dynamometer rolls using the following equation:

$$f_{\text{nref}_{\text{i,dyno}}} = \frac{v_{\text{ref}_{\text{i}}} \cdot k_{\text{a}}}{2 \cdot \pi \cdot r}$$

Eq. 1037.555-2

Where:

$$v_{\text{ref}i} = \left(\frac{k_{\text{a}} \cdot T_{i-1}}{r} - \left(A + B \cdot v_{\text{ref},i-1} + C \cdot v_{\text{ref},i-1}^{2} \right) - F_{\text{brake},i-1} \right) \cdot \frac{t_{\text{i}} - t_{i-1}}{M} + v_{\text{ref},i-1}$$

Eq. 1037.555-3

T = instantaneous measured torque at the transmission output shaft.

F_{brake} = instantaneous brake force applied by the driver model to add force to slow down the vehicle.

t = elapsed time in the driving schedule as measured by the dynamometer, in seconds.

(2) For each test, validate the measured transmission output shaft's speed with the corresponding reference values according to 40 CFR 1065.514(e). You may delete points when the vehicle is stopped. Perform the validation based on speed values at the transmission output shaft. For steady-state tests (55 mi/hr and 65 mi/hr cruise), apply cycle-validation criteria by treating the sampling periods from the two tests as a continuous sampling period. Perform this validation based on the following parameters:

Table 1 of §1037.555 – Statistical criteria for validating duty cycles

PARAMETER	SPEED CONTROL
Slope, a_1	$0.950 \leq a_1 \leq 1.030$
Absolute value of intercept, $\|a_0\|$	≤ 2.0 % of maximum test speed
Standard error of the estimate, *SEE*	≤ 5 % of maximum test speed
Coefficient of determination, r^2	≥ 0.970

(f) Send a brake signal when operator demand is equal to zero and vehicle speed is greater than the reference vehicle speed from the test cycle. Set a delay before changing the brake state to prevent the brake signal from dithering, consistent with good engineering judgment.

* * * * *

160. Revise §1037.560 to read as follows:

§1037.560 Axle efficiency test.

This section describes a procedure for mapping axle efficiency through a determination of axle power loss.

(a) You may establish axle power loss maps based on testing any number of axle configurations within an axle family as specified in §1037.232. You may share data across a family of axle configurations, as long as you test the axle configuration with the lowest efficiency from the axle family; this will generally involve testing the axle with the highest axle ratio. For vehicles with tandem drive axles, always test each drive axle separately. For tandem axles that can be disconnected, test both single-drive and tandem axle configurations. This includes 4×4 axles where one of the axles is disconnectable. Alternatively, you may analytically derive power loss maps for untested configurations within the same axle family as described in paragraph (h) of this section.

(b) Prepare an axle assembly for testing as follows:

(1) Select an axle assembly with less than 500 hours of operation before testing. Assemble the axle in its housing, along with wheel ends and bearings.

(2) If you have a family of axle assemblies with different axle ratios, you may test multiple configurations using a common axle housing, wheel ends, and bearings.

(3) Install the axle assembly on the dynamometer with an input shaft angle perpendicular to the axle.

(i) For axle assemblies with or without a locking main differential, test the axle assembly using one of the following methods:

(A) Lock the main differential and test it with one electric motor on the input shaft and a second electric motor on the output side of the output shaft that has the speed-reduction gear attached to it.

(B) Test with the main differential unlocked and with one electric motor on the input shaft and electric motors on the output sides of each of the output shafts.

(ii) For drive-through tandem-axle setups, lock the longitudinal and inter-wheel differentials.

(4) Add gear oil according to the axle manufacturer's instructions. If the axle manufacturer specifies multiple gear oils, select the one with the highest viscosity at operating temperature. You may use a lower-viscosity gear oil if we approve that as critical emission-related maintenance under §1037.125. Fill the gear oil to a level that represents in-use operation. You may use an external gear oil conditioning system, as long as it does not affect measured values.

(5) Install equipment for measuring the bulk temperature of the gear oil in the oil sump or a similar location. Report temperature to the nearest 0.1 °C.

(6) Break in the axle assembly using good engineering judgment. Maintain gear oil temperature at or below 100 °C throughout the break-in period.

(7) You may drain the gear oil following the break-in procedure and repeat the filling procedure described in paragraph (b)(4) of this section. We will follow your practice for our testing.

(c) Measure input and output speed and torque as described in 40 CFR 1065.210(b). You must use a speed-measurement system that meets an accuracy of ±0.05 % of point. Use torque transducers that meet an accuracy requirement of ±1.0 N·m for unloaded test points and ±0.2 % of the maximum tested axle input torque or output torque, respectively, for loaded test points. Calibrate and verify measurement instruments according to 40 CFR part 1065, subpart D. Command speed and torque at a minimum of 10 Hz, and record all data, including bulk oil temperature, as 1 Hz mean values.

(d) The test matrix consists of test points representing output torque and wheel speed values meeting the following specifications:

(1) Output torque includes both loaded and unloaded operation. For measurement involving unloaded output torque, also called spin loss testing, the wheel end is not connected to the dynamometer and is left to rotate freely; in this condition the input torque (to maintain constant wheel speed) equals the power loss. Test axles at a range of output torque values, as follows:

(i) 0, 500, 1000, 2000, 3000, and 4000 N·m for single drive axle applications for tractors and for vocational Heavy HDV with a single drive axle.

(ii) 0, 250, 500, 1000, 1500, and 2000 N·m for tractors, for vocational Heavy HDV with tandem drive axles, and for all vocational Light HDV or vocational Medium HDV.

(iii) You may exclude values that exceed your axle's maximum torque rating.

(2) Determine maximum wheel speed corresponding to a vehicle speed of 65 mi/hr based on the smallest tire (as determined using §1037.520(c)(1)) that will be used with the axle. If you do not know the smallest tire size, you may use a default size of 650 r/mi. Use wheel angular speeds for testing that include 50 r/min and speeds in 100 r/min increments that encompass the maximum wheel speed (150, 250, etc.).

(3) You may test the axle assembly at additional speed and torque setpoints.

(e) Determine axle efficiency using the following procedure:

(1) Maintain ambient temperature between (15 and 35) °C throughout testing. Measure ambient temperature within 1.0 m of the axle assembly. Verify that critical axle settings (such as bearing preload, backlash, and oil sump level) are within specifications before and after testing.

(2) Maintain gear oil temperature at (81 to 83) °C. You may alternatively specify a lower range by shifting both temperatures down by the same amount. We will test your axle assembly using the same temperature range you specify for your testing. You may use an external gear oil conditioning system, as long as it does not affect measured values.

(3) Use good engineering judgment to warm up the axle assembly by operating it until the gear oil is within the specified temperature range.

(4) Stabilize operation at each point in the test matrix for at least 10 seconds, then measure the input torque, output torque, and wheel angular speed for at least 10 seconds. Record arithmetic mean values for all three parameters over the measurement period. Calculate power loss as described in paragraph (f) of this section based on these values for mean input torque, $\overline{T}_{\text{in}}$, mean output torque, $\overline{T}_{\text{out}}$, and mean wheel angular speed, $\overline{f}_{\text{nwheel}}$, at each test point.

(5) Perform the map sequence described in paragraph (e)(4) of this section three times. Remove torque from the input shaft and allow the axle to come to a full stop before each repeat measurement.

(6) You may need to perform additional testing at a given test point based on a calculation of a confidence interval to represent repeatability at a 95 % confidence level for that test point. If the confidence limit is greater than 0.10 % for loaded tests or greater than 0.05 % for unloaded tests, perform another repeat of measurements at that test point and recalculate the repeatability for the whole set of test results. Continue testing until the confidence interval is at or below the specified values for all test points. Calculate a confidence interval

representing the repeatability in establishing a 95 % confidence level using the following equation:

$$Confidence\ Interval = \frac{1.96 \cdot \sigma_{\text{Ploss}}}{\sqrt{N} \cdot P_{\max}} \cdot 100\ \%$$

Eq. 1037.560-1

Where:

σ_{Ploss} = standard deviation of power loss values at a given torque-speed setting (see 40 CFR 1065.602(c)).

N = number of repeat tests.

$P_{\max}$ = maximum output torque setting from the test matrix.

Example:

σ_{Ploss} = 0.1650 kW

N = 3

$P_{\max}$ = 314.2000 kW

$$Confidence\ Interval = \frac{1.96 \cdot 0.1650}{\sqrt{3} \cdot 314.2000} \cdot 100\ \%$$

Confidence Interval = 0.0594 %

(f) Calculate the mean power loss, $\bar{\bar{P}}_{\text{loss}}$, at each test point as follows:

(1) Calculate $\bar{P}_{\text{loss}}$ for each measurement at each test point as follows:

$$\bar{P}_{\text{loss}} = \bar{T}_{\text{in}} \cdot \bar{f}_{\text{nwheel}} \cdot k_{\text{a}} - \bar{T}_{\text{out}} \cdot \bar{f}_{\text{nwheel}}$$

Eq. 1037.560-2

Where:

$\bar{T}_{\text{in}}$ = mean input torque from paragraph (e)(4) of this section.

$\bar{f}_{\text{nwheel}}$ = mean wheel angular speed from paragraph (e)(4) of this section in rad/s.

k_{a} = drive axle ratio, expressed to at least the nearest 0.001.

$\bar{T}_{\text{out}}$ = mean output torque from paragraph (e)(4) of this section. Let $\bar{T}_{\text{out}}$ = 0 for all unloaded tests.

(2) Calculate $\bar{\bar{P}}_{\text{loss}}$ as the mean power loss from all measurements at a given test point.

(3) The following example illustrates a calculation of $\bar{\bar{P}}_{\text{loss}}$:

$\bar{T}_{\text{in,1}}$ = 845.10 N·m

$\bar{f}_{\text{nwheel,1}}$ = 100.0 r/min = 10.472 rad/s

k_{a} = 3.731

$\bar{T}_{\text{out,1}}$ = 3000.00 N·m

$\bar{P}_{\text{loss,1}} = 845.10 \cdot 10.472 \cdot 3.731 - 3000.00 \cdot 10.472$

$\bar{P}_{\text{loss,1}}$ = 1602.9 W = 1.6029 kW

$\bar{P}_{\text{loss,2}}$ = 1601.9 W = 1.6019 kW

$\bar{P}_{\text{loss,3}}$ = 1603.9 W = 1.6039 kW

$$\bar{\bar{P}}_{\text{loss}} = \frac{1.6029+1.6019+1.6039}{3} = 1.6029 \text{ kW}$$

(g) Create a table with the mean power loss, $\bar{\bar{P}}_{\text{loss}}$, corresponding to each test point for input into GEM. Express wheel angular speed in r/min to one decimal place; express output torque in N·m to two decimal places; express power loss in kW to four decimal places.

(1) Record $\bar{\bar{P}}_{\text{loss}}$, $\bar{\bar{T}}_{\text{out}}$, and $\bar{\bar{f}}_{\text{nin}}$ for each test point. Calculate $\bar{\bar{T}}_{\text{out}}$ and $\bar{\bar{f}}_{\text{nin}}$ for each test point by calculating the arithmetic average of $\bar{T}_{\text{out}}$ and $\bar{f}_{\text{nin}}$ for all the repeat tests at that test point.

(2) Record declared mean power loss values at or above the corresponding value calculated in paragraph (f) of this section. Use good engineering judgment to select values that will be at or above the mean power loss values for your production axles. Vehicle manufacturers will use these declared mean power loss values for certification. For vehicles with tandem drive axles, the GEM input is the sum of the power loss and output torque from the individual axles. For vehicles with a disconnectable axle, GEM uses separate inputs for single and tandem drive axle configurations.

(h) You may analytically derive axle power loss maps for untested configurations within an axle family as follows:

(1) Test at least three axle assemblies within the same family representing at least the smallest axle ratio, the largest axle ratio, and an axle ratio closest to the arithmetic mean from the two other tested axle assemblies. Test each axle assembly as described in this section at the same speed and torque setpoints.

(2) Perform a second-order least-squares regression between declared power loss and axle ratio using each speed and torque setpoint described in paragraph (d) of this section for your tested axle assemblies. Use the declared power loss values from paragraph (g) of this section; however, for purposes of analytically deriving power loss maps under this paragraph (h), you must select declared values for the largest and smallest axle ratios in the axle family that are adjusted relative to the calculated values for mean power loss by the same multiplier. If the coefficent of the second-order term is negative, include testing from additional axle ratios, or increase your declared power loss for the largest and smallest axle ratios by the same multiplier as needed for the second-order term to become positive.

(3) Determine $\bar{\bar{P}}_{\text{loss}}$ of untested axles for each speed and torque setpoint based on a linear relationship between your declared power loss and axle ratio as follows:

(i) Determine the slope of the correlation line by connecting the declared power loss values for the smallest and largest axle ratios.

(ii) Fix the intercept for the correlation line by shifting it upward as needed so all the declared power loss values are on the correlation line or below it. Note that for cases involving three tested axle assemblies, the correlation line will always include the declared power loss for the smallest and largest axle ratio.

(4) Select declared values of $\bar{\bar{P}}_{\text{loss}}$ for untested configurations that are at or above the values you determined in paragraph (h)(3) of this section.

161. Revise §1037.565 to read as follows:

§1037.565 Transmission efficiency test.

This section describes a procedure for mapping transmission efficiency through a determination of transmission power loss.

(a) You may establish transmission power loss maps based on testing any number of transmission configurations within a transmission family as specified in §1037.232. You may share data across any configurations within the family, as long as you test the transmission configuration with the lowest efficiency from the transmission family. Alternatively, you may ask us to approve analytically derived power loss maps for untested configurations within the same transmission family (see §1037.235(h)).

(b) Prepare a transmission for testing as follows:

(1) Select a transmission with less than 500 hours of operation before testing.

(2) Mount the transmission to the dynamometer such that the geared shaft in the transmission is aligned with the input shaft from the dynamometer.

(3) Add transmission oil according to the transmission manufacturer's instructions. If the transmission manufacturer specifies multiple transmission oils, select the one with the highest viscosity at operating temperature. You may use a lower-viscosity transmission oil if we approve it as critical emission-related maintenance under §1037.125. Fill the transmission oil to a level that represents in-use operation. You may use an external transmission oil conditioning system, as long as it does not affect measured values.

(4) Include any internal and external pumps for hydraulic fluid and lubricating oil in the test. Determine the work required to drive an external pump according to 40 CFR 1065.210.

(5) Install equipment for measuring the bulk temperature of the transmission oil in the oil sump or a similar location.

(6) If the transmission is equipped with a torque converter, lock it for all testing performed in this section.

(7) Break in the transmission using good engineering judgment. Maintain transmission oil temperature at (87 to 93) °C for automatic transmissions and transmissions having more than two friction clutches, and at (77 to 83) °C for all other transmissions. You may ask us to approve a different range of transmission oil temperatures if you have data showing that it better represents in-use operation.

(c) Measure input and output shaft speed and torque as described in 40 CFR 1065.210(b). You must use a speed measurement system that meets an accuracy of ±0.05 % of point. Accuracy requirements for torque transducers depend on the highest loaded transmission input and output torque as described in paragraph (d)(2) of this section. Use torque transducers for torque input measurements that meet an accuracy requirement of ±0.2 % of the highest loaded transmission input for loaded test points and ±0.1 % of the highest loaded transmission input torque for unloaded test points. For torque output measurements, torque transducers must meet an accuracy requirement of ±0.2 % of the highest loaded transmission output torque for each gear ratio. Calibrate and verify measurement instruments according to 40 CFR part 1065, subpart D. Command speed and torque at a minimum of 10 Hz, and record all data, including bulk oil temperature, at a minimum of 1 Hz mean values.

(d) Test the transmission at input shaft speeds and torque setpoints as described in this paragraph (d). You may exclude lower gears from testing; however, you must test all the gears above the highest excluded gear. GEM will use default values for any untested gears. The test matrix consists of test points representing transmission input shaft speeds and torque setpoints meeting the following specifications for each tested gear:

(1) Test at the following transmission input shaft speeds:

(i) 600.0 r/min or transmission input shaft speed when paired with the engine operating at idle.

(ii) The transmission's maximum rated input shaft speed. You may alternatively select a value representing the highest expected in-use transmission input shaft speed.

(iii) Three equally spaced intermediate speeds. The intermediate speed points may be adjusted to the nearest 50 or 100 r/min. You may test any number of additional speed setpoints to improve accuracy.

(2) Test at certain transmission input torque setpoints as follows:

(i) Include one unloaded (zero-torque) setpoint.

(ii) Include one loaded torque setpoint between 75 % and 105 % of the transmission's maximum rated input shaft torque. However, you may use a lower torque setpoint as needed to avoid exceeding dynamometer torque limits, as long as testing accurately represents in-use performance. If your loaded torque setpoint is below 75 % of the transmission's maximum rated input shaft torque, you must demonstrate that the sum of time for all gears where demanded engine torque is between your maximum torque setpoint and 75 % of the transmission's maximum rated input shaft torque is no more than 10 % of the time for each vehicle drive cycle specified in subpart F of this part. This demonstration must be made available upon request.

(iii) You may test at any number of additional torque setpoints to improve accuracy.

(iv) Note that GEM calculates power loss between tested or default values by linear interpolation, except that GEM may extrapolate outside of measured values to account for testing at torque setpoints below 75 % as specified in paragraph (d)(2)(ii) of this section.

(3) In the case of transmissions that automatically go into neutral when the vehicle is stopped, also perform tests at 600 r/min and 800 r/min with the transmission in neutral and the transmission output fixed at zero speed.

(e) Determine transmission efficiency using the following procedure:

(1) Maintain ambient temperature between (15 and 35) °C throughout testing. Measure ambient temperature within 1.0 m of the transmission.

(2) Maintain transmission oil temperature as described in paragraph (b)(7) of this section.

(3) Use good engineering judgment to warm up the transmission according to the transmission manufacturer's specifications.

(4) Perform unloaded transmission tests by disconnecting the transmission output shaft from the dynamometer and letting it rotate freely. If the transmission adjusts pump pressure based on whether the vehicle is moving or stopped, set up the transmission for unloaded tests to operate as if the vehicle is moving.

(5) For transmissions that have multiple configurations for a given gear ratio, such as dual-clutch transmissions that can pre-select an upshift or downshift, set the transmission to operate in the configuration with the greatest power loss. Alternatively, test in each configuration and use good engineering judgment to calculate a weighted power loss for each test point under this section based on field data that characterizes the degree of in-use operation in each configuration.

(6) For a selected gear, operate the transmission at one of the test points from paragraph (d) of this section for at least 10 seconds. Measure the speed and torque of the input and output shafts for at least 10 seconds. You may omit measurement of output shaft speeds if your transmission is configured to not allow slip. Calculate arithmetic mean values for mean input

shaft torque, $\overline{T}_{\text{in}}$, mean output shaft torque, $\overline{T}_{\text{out}}$, mean input shaft speed, $\overline{f}_{\text{nin}}$, and mean output shaft speed, $\overline{f}_{\text{nout}}$, for each point in the test matrix for each test. Repeat this stabilization, measurement, and calculation for the other speed and torque setpoints from the test matrix for the selected gear in any sequence. Calculate power loss as described in paragraph (f) of this section based on mean speed and torque values at each test point.

(7) Repeat the procedure described in paragraph (e)(6) of this section for all gears, or for all gears down to a selected gear. This section refers to an "operating condition" to represent operation at a test point in a specific gear.

(8) Perform the test sequence described in paragraphs (e)(6) and (7) of this section three times. You may do this repeat testing at any given test point before you perform measurements for the whole test matrix. Remove torque from the transmission input shaft and bring the transmission to a complete stop before each repeat measurement.

(9) You may need to perform additional testing at a given operating condition based on a calculation of a confidence interval to represent repeatability at a 95 % confidence level at that operating condition. If the confidence interval is greater than 0.10 % for loaded tests or greater than 0.05 % for unloaded tests, perform another measurement at that operating condition and recalculate the repeatability for the whole set of test results. Continue testing until the confidence interval is at or below the specified values for all operating conditions. As an alternative, for any operating condition that does not meet this repeatability criterion, you may determine a maximum power loss instead of calculating a mean power loss as described in paragraph (g) of this section. Calculate a confidence interval representing the repeatability in establishing a 95 % confidence level using the following equation:

$$Confidence\ Interval = \frac{1.96 \cdot \sigma_{\text{Ploss}}}{\sqrt{N} \cdot P_{\text{rated}}} \cdot 100\ \%$$

Eq. 1037.565-1

Where:

σ_{Ploss} = standard deviation of power loss values at a given operating condition (see 40 CFR 1065.602(c)).

N = number of repeat tests for an operating condition.

P_{rated} = the transmission's rated input power for a given gear. For testing in neutral, use the value of P_{rated} for the top gear.

Example:

σ_{Ploss} = 0.1200 kW

N = 3

P_{rated} = 314.2000 kW

$$Confidence\ Interval = \frac{1.96 \cdot 0.1650}{\sqrt{3} \cdot 314.2000} \cdot 100\ \%$$

Confidence Interval = 0.0432 %

(f) Calculate the mean power loss, $\overline{\overline{P}}_{\text{loss}}$, at each operating condition as follows:

(1) Calculate $\overline{P}_{\text{loss}}$ for each measurement at each operating condition as follows:

$$\overline{P}_{\text{loss}} = \overline{T}_{\text{in}} \cdot \overline{f}_{\text{nin}} - \overline{T}_{\text{out}} \cdot \overline{f}_{\text{nout}}$$

Eq. 1037.565-2

Where:

$\overline{T}_{in}$ = mean input shaft torque from paragraph (e)(6) of this section.

$\overline{f}_{nin}$ = mean input shaft speed from paragraph (e)(6) of this section in rad/s.

$\overline{T}_{out}$ = mean output shaft torque from paragraph (e)(6) of this section. Let $\overline{T}_{out}$ = 0 for all unloaded tests.

$\overline{f}_{nout}$ = mean output shaft speed from paragraph (e)(6) of this section in rad/s. Let $\overline{f}_{nout}$ = 0 for all tests with the transmission in neutral. See paragraph (f)(2) of this section for calculating $\overline{f}_{nout}$ as a function of $\overline{f}_{nin}$ instead of measuring f_{nout}.

(2) For transmissions that are configured to not allow slip, you may calculate $\overline{f}_{nout}$ based on the gear ratio using the following equation:

$$\overline{f}_{nout} = \frac{\overline{f}_{nin}}{k_g}$$

Eq. 1037.565-3

Where:

k_g = transmission gear ratio, expressed to at least the nearest 0.001.

(3) Calculate $\overline{\overline{P}}_{loss}$ as the mean power loss from all measurements at a given operating condition.

(4) The following example illustrates a calculation of $\overline{\overline{P}}_{loss}$:

Example:

$\overline{T}_{in,1}$ = 1000.0 N·m

$\overline{f}_{nin,1}$ = 1000 r/min = 104.72 rad/sec

$\overline{T}_{out,1}$ = 2654.5 N·m

$\overline{f}_{nout,1}$ = 361.27 r/min = 37.832 rad/s

$\overline{P}_{loss,1} = 1000.0 \cdot 104.72 - 2654.5 \cdot 37.832$

$\overline{P}_{loss,1}$ = 4295 W = 4.295 kW

$\overline{P}_{loss,2}$ = 4285 W = 4.285 kW

$\overline{P}_{loss,3}$ = 4292 W = 4.292 kW

$$\overline{\overline{P}}_{loss} = \frac{4.295 + 4.285 + 4.292}{3} = 4.291 \text{ kW}$$

(g) Create a table with the mean power loss, $\overline{\overline{P}}_{loss}$, corresponding to each operating condition for input into GEM. Also include power loss in neutral for each tested engine's speed, if applicable. Express transmission input speed in r/min to one decimal place; express input torque in N·m to two decimal places; express power loss in kW to four decimal places. Record the following values:

(1) Recored $\overline{\overline{P}}_{loss}$, $\overline{\overline{T}}_{in}$, and $\overline{\overline{f}}_{nin}$ for each operating condition meeting the repeatability criterion in in paragraph (e)(9) of this section. Calculate $\overline{\overline{T}}_{in}$ and $\overline{\overline{f}}_{nin}$ for each operating

condition by calculating the arithmetic average of $\overline{T}_{\text{in}}$ and $\overline{f}_{\text{nin}}$ for all the repeat tests at that operating condition.

(2) For any operating condition not meeting the repeatability criterion in paragraph (e)(9) of this section, record the maximum value of $\overline{P}_{\text{loss}}$ for that operating condition along with the corresponding values of $\overline{T}_{\text{in}}$ and $\overline{f}_{\text{nin}}$.

(h) Record declared power loss values at or above the corresponding value calculated in paragraph (f) of this section. Use good engineering judgment to select values that will be at or above the mean power loss values for your production transmissions. Vehicle manufacturers will use these declared mean power loss values for certification.

162. Add §1037.570 to subpart F to read as follows:

§1037.570 Procedures to characterize torque converters.

GEM includes input values related to torque converters. This section describes a procedure for mapping a torque converter's capacity factors and torque ratios over a range of operating conditions. You may ask us to approve analytically derived input values based on this testing for additional untested configurations as described in §1037.235(h).

(a) Prepare a torque converter for testing as follows:

(1) Select a torque converter with less than 500 hours of operation before the start of testing.

(2) If the torque converter has a locking feature, unlock it for all testing performed under this section. If the torque converter has a slipping lockup clutch, you may ask us to approve a different strategy based on data showing that it represents better in-use operation.

(3) Mount the torque converter with a transmission to the dynamometer in series or parallel arrangement or mount the torque converter without a transmission to represent a series configuration.

(4) Add transmission oil according to the torque converter manufacturer's instructions, with the following additional specifications:

(i) If the torque converter manufacturer specifies multiple transmission oils, select the one with the highest viscosity at operating temperature. You may use a lower-viscosity transmission oil if we approve that as critical emission-related maintenance under §1037.125.

(ii) Fill the transmission oil to a level that represents in-use operation. If you are testing the torque converter without the transmission, keep output pressure and the flow rate of transmission oil into the torque converter within the torque converter manufacturer's limits.

(iii) You may use an external transmission oil conditioning system, as long as it does not affect measured values.

(5) Install equipment for measuring the bulk temperature of the transmission oil in the oil sump or a similar location and at the torque converter inlet. If the torque converter is tested without a transmission, measure the oil temperature at the torque converter inlet.

(6) Break in the torque converter and transmission (if applicable) using good engineering judgment. Maintain transmission oil temperature at (87 to 93) °C. You may ask us to approve a different range of transmission oil temperatures if you have data showing that it better represents in-use operation.

(b) Measure pump and turbine shaft speed and torque as described in 40 CFR 1065.210(b). You must use a speed measurement system that meets an accuracy of ±0.1 % of point or ±1 r/min, whichever is greater. Use torque transducers that meet an accuracy of ±1.0 % of the torque converter's maximum rated input and output torque, respectively. Calibrate and verify measurement instruments according to 40 CFR part 1065, subpart D. Command speed and torque at a minimum of 10 Hz. Record all speed and torque data at a minimum of 1 Hz mean values. Note that this section relies on the convention of describing the input shaft as the pump and the output shaft as the turbine shaft.

(c) Determine torque converter characteristics based on a test matrix using either constant input speed or constant input torque as follows:

(1) Constant input speed. Test at constant input speed as follows:

(i) Select a fixed pump speed, f_{npum}, between (1000 and 2000) r/min.

(ii) Test the torque converter at multiple speed ratios, v, in the range of $v = 0.00$ to $v = 0.95$. Use a step width of 0.10 for the range of $v = 0.00$ to 0.60 and 0.05 for the range of $v = 0.60$ to 0.95. Calculate speed ratio, v, as turbine shaft speed divided by pump speed.

(2) Constant input torque. Test at constant input torque as follows:

(i) Set the pump torque, T_{pum}, to a fixed positive value at $f_{npum} = 1000$ r/min with the torque converter's turbine shaft locked in a non-rotating state (i.e., turbine's speed, n_{tur}, = 0 r/min).

(ii) Test the torque converter at multiple speed ratios, v, in the range of $v = 0.00$ up to a value of f_{ntur} that covers the usable range of v. Use a step width of 0.10 for the range of $v = 0.00$ to 0.60 and 0.05 for the range of $v = 0.60$ to 0.95.

(3) You may limit the maximum speed ratio to a value below 0.95 if you have data showing this better represents in-use operation. You must use the step widths defined in paragraph (c)(1) or (2) of this section and include the upper limit as a test point. If you choose a value less than 0.60, you must test at least seven evenly distributed points between $v = 0$ and your new upper speed ratio.

(d) Characterize the torque converter using the following procedure:

(1) Maintain ambient temperature between (15 and 35) °C throughout testing. Measure ambient temperature within 1.0 m of the torque converter.

(2) Maintain transmission oil temperature as described in paragraph (a)(6) of this section. You may use an external transmission oil conditioning system, as long as it does not affect measured values.

(3) Use good engineering judgment to warm up the torque converter according to the torque converter manufacturer's specifications.

(4) Test the torque converter at constant input speed or constant input torque as described in paragraph (c) of this section. Operate the torque converter at $v = 0.00$ for (5 to 60) seconds, then measure pump torque, turbine shaft torque, angular pump speed, angular turbine shaft speed, and the transmission oil temperature at the torque converter inlet for (5 to 15) seconds. Calculate arithmetic mean values for pump torque, $\overline{T}_{pum}$, turbine shaft torque, $\overline{T}_{tur}$, angular pump speed, $\overline{f}_{npum}$, and angular turbine shaft speed, $\overline{f}_{ntur}$, over the measurement period. Repeat this stabilization, measurement, and calculation for the other speed ratios from the test matrix in order of increasing speed ratio. Adjust the speed ratio by increasing the angular turbine shaft speed.

(5) Complete a test run by performing the test sequence described in paragraph (d)(4) of this section two times.

(6) Invalidate the test run if the difference between the pair of mean torque values for the repeat tests at any test point differ by more than ±1 N·m or by more than ±5 % of the average

of those two values. This applies separately for mean pump torque and mean turbine shaft torque at each test point.

(7) Invalidate the test run if any calculated value for mean angular pump speed does not stay within ±5 r/min of the speed setpoint or if any calculated value for mean pump torque does not stay within ±5 N·m of the torque setpoint.

(e) Calculate the mean torque ratio, $\bar{\bar{\mu}}$, at each tested speed ratio, *v*, as follows:

(1) Calculate $\bar{\mu}$ at each tested speed ratio as follows:

$$\bar{\mu} = \frac{\bar{T}_{tur}}{\bar{T}_{pum}}$$

Eq. 1037.570-1

Where:

$\bar{T}_{tur}$ = mean turbine shaft torque from paragraph (d)(4) of this section.

$\bar{T}_{pum}$ = mean pump torque from paragraph (d)(4) of this section.

(2) Calculate $\bar{\bar{\mu}}$ as the average of the two values of $\bar{\mu}$ at each tested speed ratio.

(3) The following example illustrates a calculation of $\bar{\bar{\mu}}$:

$\bar{T}_{tur,v=0,1}$ = 332.4 N·m

$\bar{T}_{pum,v=0,1}$ = 150.8 N·m

$\bar{T}_{tur,v=0,2}$ = 333.6 N·m

$\bar{T}_{pum,v=0,2}$ = 150.3 N·m

$$\bar{\mu}_{v=0,1} = \frac{332.4}{150.8} = 2.20$$

$$\bar{\mu}_{v=0,2} = \frac{333.6}{150.3} = 2.22$$

$$\bar{\bar{\mu}}_{v=0} = \frac{2.20 + 2.22}{2} = 2.21$$

(f) Calculate the mean capacity factor, $\bar{\bar{K}}$, at each tested speed ratio, *v*, as follows:

(1) Calculate $\bar{K}$ at each tested speed ratio as follows:

$$\bar{K} = \frac{\bar{f}_{npum}}{\sqrt{\bar{T}_{pum}}}$$

Eq. 1037.570-2

Where:

$\bar{f}_{npum}$ = mean angular pump speed from paragraph (d)(4) of this section.

$\bar{T}_{pum}$ = mean pump torque from paragraph (d)(4) of this section.

(2) Calculate $\bar{\bar{K}}$ as the average of the two values of $\bar{K}$ at each tested speed ratio.

(3) The following example illustrates a calculation of $\bar{\bar{K}}$:

$$\bar{f}_{\text{npum},v=0,1} = \bar{f}_{\text{npum},v=0,2} = 1000.0 \text{ r/min}$$

$$\bar{T}_{\text{pum},v=0,1} = 150.8 \text{ N·m}$$

$$\bar{K}_{v=0,1} = \frac{1000.0}{\sqrt{150.8}} = 81.43 \text{ r/(min}\cdot(\text{N}\cdot\text{m})^{0.5})$$

$$\bar{T}_{\text{pum},v=0,2} = 150.4 \text{ N·m}$$

$$\bar{K}_{v=0,2} = \frac{1000.0}{\sqrt{150.4}} = 81.54 \text{ r/(min}\cdot(\text{N}\cdot\text{m})^{0.5})$$

$$\bar{\bar{K}}_{v=0} = \frac{81.43 + 81.54}{2} = 81.49 \text{ r/(min}\cdot(\text{N}\cdot\text{m})^{0.5})$$

(g) Create a table of GEM inputs showing $\bar{\bar{\mu}}$ and $\bar{\bar{K}}$ at each tested speed ratio, *v*. Express $\bar{\bar{\mu}}$ to two decimal places; express $\bar{\bar{K}}$ to one decimal place; express *v* to two decimal places.

163. Amend §1037.601 by revising paragraph (a)(2) to read as follows:

§1037.601 General compliance provisions.

(a) * * *

(2) The provisions of 40 CFR 1068.105(a) apply for vehicle manufacturers installing engines certified under 40 CFR part 1036 as further limited by this paragraph (a)(2). If new engine emission standards apply in a given model year, you may install normal inventories of engines from the preceding model year under the provisions of 40 CFR 1068.105(a) through March 31 of that year without our approval; you may not install such engines after March 31 of that year unless we approve it in advance. Installing such engines after March 31 without our prior approval is considered to be prohibited stockpiling of engines. In a written request for our approval, you must describe how your circumstances led you and your engine supplier to have normal inventories of engines that were not used up in the specified time frame. We will approve your request for up to three additional months to install engines under this paragraph (a)(2) if we determine that the excess inventory is a result of unforeseeable circumstances and should not be considered circumvention of emission standards. We will limit this approval to a certain number of engines consistent with your normal production and inventory practices. Note that 40 CFR 1068.105(a) allows vehicle manufacturers to use up only normal inventories of engines meeting less stringent standards; if, for example, a vehicle manufacturer's normal practice is to receive a shipment of engines every two weeks, it will deplete its potential to install previous-tier engines under this paragraph (a)(2) well before March 31 in the year that new standards apply.

* * * * *

164. Amend §1037.615 by revising paragraph (f) to read as follows:

§1037.615 Advanced technologies.

* * * * *

(f) For electric vehicles and for fuel cells powered by hydrogen, calculate CO_2 credits using an FEL of 0 g/ton-mile.

* * * * *

165. Amend §1037.621 by revising paragraph (g) introductory text to read as follows:
§1037.621 Delegated assembly.
* * * * *
(g) We may allow certifying vehicle manufacturers to authorize dealers or distributors to reconfigure/recalibrate vehicles after the vehicles have been introduced into commerce if they have not yet been delivered to the ultimate purchaser as follows:
* * * * *

166. Amend §1037.635 by revising paragraph (c)(1) introductory text to read as follows:
§1037.635 Glider kits and glider vehicles.
* * * * *
(c) * * *
(1) The allowance in this paragraph (c) applies only for the following engines:
* * * * *

167. Amend §1037.660 by revising paragraphs (a)(2) and (b) to read as follows:
§1037.660 Idle-reduction technologies.
* * * * *
(a) * * *
(2) Neutral idle. Phase 2 vehicles with hydrokinetic torque converters paired with automatic transmissions qualify for neutral-idle credit in GEM modeling if the transmission reduces torque equivalent to shifting into neutral throughout the interval during which the vehicle's brake pedal is depressed and the vehicle is at a zero-speed condition (beginning within five seconds of the vehicle reaching zero speed with the brake depressed). If a vehicle reduces torque partially but not enough to be equivalent to shifting to neutral, you may use the provisions of §1037.610(g) to apply for an appropriate partial emission reduction; this may involve A to B testing with the powertrain test procedure in §1037.550 or the spin-loss portion of the transmission efficiency test in §1037.565.
* * * * *
(b) Override conditions. The system may limit activation of the idle-reduction technology while any of the conditions of this paragraph (b) apply. These conditions allow the system to delay engine shutdown, adjust engine restarting, or delay disengaging transmissions, but do not allow for resetting timers. Engines may restart and transmissions may re-engage during override conditions if the vehicle is set up to do this automatically. We may approve additional override criteria as needed to protect the engine and vehicle from damage and to ensure safe vehicle operation.
(1) For AES systems on tractors, the system may delay shutdown—
(i) When an exhaust emission control device is regenerating. The period considered to be regeneration for purposes of this allowance must be consistent with good engineering judgment and may differ in length from the period considered to be regeneration for other purposes. For example, in some cases it may be appropriate to include a cool down period for this purpose but not for infrequent regeneration adjustment factors.
(ii) When the vehicle's main battery state-of-charge is not sufficient to allow the main engine to be restarted.
(iii) When the vehicle's transmission, fuel, oil, or engine coolant temperature is too low or too high according to the manufacturer's specifications for protecting against system

damage. This allows the engine to continue operating until it is in a predefined temperature range, within which the shutdown sequence of paragraph (a) of this section would resume.

(iv) When the vehicle's main engine is operating in power take-off (PTO) mode. For purposes of this paragraph (b), an engine is considered to be in PTO mode when a switch or setting designating PTO mode is enabled.

(v) When external ambient conditions prevent managing cabin temperatures for the driver’s safety.

(vi) When necessary while servicing the vehicle, provided the deactivation of the AES system is accomplished using a diagnostic scan tool. The system must be automatically reactivated when the engine is shut down for more than 60 minutes.

(2) For AES systems on vocational vehicles, the system may limit activation—

(i) When any condition specified in paragraph (b)(1)(i) through (v) of this section applies.

(ii) When the engine compartment is open.

(3) For neutral idle, the system may delay shifting the transmission to neutral—

(i) When the system meets the PTO conditions specified in paragraph (b)(1)(iv) of this section.

(ii) When the transmission is in reverse gear.

(iii) When the vehicle is ascending or descending a road with grade at or above 6.0 %.

(4) For stop-start, the system may limit activation—

(i) When any condition specified in paragraphs (b)(2) or (b)(3)(ii) or (iii) of this section applies.

(ii) When air brake pressure is too low according to the manufacturer’s specifications for maintaining vehicle-braking capability.

(iii) When an automatic transmission is in “park” or “neutral” and the parking brake is engaged.

(iv) When recent vehicle speeds indicate an abnormally high shutdown and restart frequency, such as with congested driving. For example, a vehicle not exceeding 10 mi/hr for the previous 300 seconds or since the most recent engine start would be a proper basis for overriding engine shutdown. You may also design this override to protect against system damage or malfunction of safety systems.

(v) When the vehicle detects that a system or component is worn or malfunctioning in a way that could reasonably prevent the engine from restarting, such as low battery voltage.

(vi) When the steering angle is at or near the limit of travel.

(vii) When flow of diesel exhaust fluid is limited due to freezing.

(viii) When a sensor failure could prevent the anti-lock braking system from properly detecting vehicle speed.

(ix) When a protection mode designed to prevent component failure is active.

(x) When a fault on a system component needed for starting the engine is active.

* * * * *

168. Amend §1037.665 by revising paragraph (c) to read as follows:

§1037.665 Production and in-use tractor testing.

* * * * *

(c) We may approve your request to perform alternative testing that will provide equivalent or better information compared to the specified testing. For example, we may allow you to provide

CO_2 data from in-use operation or from manufacturer-run on-road testing as long as it allows for reasonable year-to-year comparisons and includes testing from production vehicles. We may also direct you to do less testing than we specify in this section.
*   *   *   *   *

169. Amend §1037.670 by revising paragraphs (a) and (b) to read as follows:

§1037.670 Optional CO_2 emission standards for tractors at or above 120,000 pounds GCWR.

(a) You may certify tractors at or above 120,000 pounds GCWR to the following CO_2 standards instead of the Phase 2 CO_2 standards of §1037.106:

Table 1 of §1037.670—Optional Phase 2 CO_2 Standards for Tractors above 120,000 Pounds GCWR (g/ton-mile)[a]

SUBCATEGORY	MODEL YEARS 2021 -2023	MODEL YEARS 2024 -2026	MODEL YEARS 2026 AND LATER
Heavy Class 8 Low-Roof Day Cab	53.5	50.8	48.9
Heavy Class 8 Low-Roof Sleeper Cab	47.1	44.5	42.4
Heavy Class 8 Mid-Roof Day Cab	55.6	52.8	50.8
Heavy Class 8 Mid-Roof Sleeper Cab	49.6	46.9	44.7
Heavy Class 8 High-Roof Day Cab	54.5	51.4	48.6
Heavy Class 8 High-Roof Sleeper Cab	47.1	44.2	41.0

[a]Note that these standards are not directly comparable to the standards for Heavy-Haul Tractors in §1037.106 because GEM handles aerodynamic performance differently for the two sets of standards.

(b) Determine subcategories as described in §1037.230 for tractors that are not heavy-haul tractors. For example, the subcategory for tractors that would otherwise be considered Class 8 low-roof day cabs would be Heavy Class 8 Low-Roof Day Cabs and would be identified as HC8_DC_LR for the GEM run.
*   *   *   *   *

170. Amend §1037.701 by revising paragraphs (h) and (i) to read as follows:

§1037.701 General provisions.

*   *   *   *   *

(h) See §1037.740 for special credit provisions that apply for credits generated under 40 CFR 86.1819-14 (k)(7), 40 CFR 1036.615, or §1037.615.

(i) Unless the regulations explicitly allow it, you may not calculate Phase 1 credits more than once for any emission reduction. For example, if you generate Phase 1 CO_2 emission credits for a given hybrid vehicle under this part, no one may generate CO_2 emission credits for the associated hybrid engine under 40 CFR part 1036. However, Phase 1 credits could be generated for identical engines used in vehicles that did not generate credits under this part.
*   *   *   *   *

171. Amend §1037.705 by revising paragraph (c)(2) to read as follows:

§1037.705 Generating and calculating emission credits.

*   *   *   *   *

(c) *   *   *

(2) Exported vehicles. This exclusion applies even for exported vehicles that are certified

under this part and labeled accordingly.

* * * * *

172. Amend §1037.740 by revising paragraph (b)(1) to read as follows:

§1037.740 Restrictions for using emission credits.

* * * * *

(b) * * *

(1) The maximum amount of credits you may bring into the following service class groups is 60,000 Mg per model year:

(i) Spark-ignition engines, light heavy-duty compression-ignition engines, and Light HDV. This group comprises the averaging set listed in paragraphs (a)(1) of this section and the averaging set listed in 40 CFR 1036.740(a)(1) and (2).

(ii) Medium heavy-duty compression-ignition engines and Medium HDV. This group comprises the averaging sets listed in paragraph (a)(2) of this section and 40 CFR 1036.740(a)(3).

(iii) Heavy heavy-duty compression-ignition engines and Heavy HDV. This group comprises the averaging sets listed in paragraph (a)(3) of this section and 40 CFR 1036.740(a)(4).

* * * * *

173. Amend §1037.801 by–

a. Revising the definitions for "Auxiliary emission control device", "Compression-ignition", and "Electric vehicle".

b. Adding a definition for "Electronic control module" in alphabetical order.

c. Revising the definitions for "Gear ratio or Transmission gear ratio, k_g" and "Heavy-duty vehicle".

d. Adding a definition for "High-strength steel" in alphabetical order.

e. Revising the definitions for "Hybrid engine or hybrid powertrain", "Hybrid vehicle", "Light-duty truck", "Low rolling resistance tire", "Model year", and "Small manufacturer".

f. Adding a definition for "Tonne" in alphabetical order.

The new and revised definitions read as follows:

§1037.801 Definitions.

* * * * *

<u>Auxiliary emission control device</u> means any element of design that senses temperature, motive speed, engine speed (r/min), transmission gear, or any other parameter for the purpose of activating, modulating, delaying, or deactivating the operation of any part of the emission control system.

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<u>Compression-ignition</u> has the meaning given in §1037.101.

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<u>Electric vehicle</u> means a motor vehicle that does not include an engine, and is powered solely by an external source of electricity and/or solar power. Note that this does not include hybrid electric vehicles or fuel-cell vehicles that use a chemical fuel such as gasoline, diesel fuel, or hydrogen. Electric vehicles may also be referred to as all-electric vehicles to distinguish them from hybrid vehicles.

<u>Electronic control module</u> has the meaning given in 40 CFR 1065.1001.

*   *   *   *   *

Gear ratio or Transmission gear ratio, k_g, means the dimensionless number representing the angular speed of the transmission's input shaft divided by the angular speed of the transmission's output shaft when the transmission is operating in a specific gear.

*   *   *   *   *

Heavy-duty vehicle means any trailer and any other motor vehicle that has a GVWR above 8,500 pounds. An incomplete vehicle is also a heavy-duty vehicle if it has a curb weight above 6,000 pounds or a basic vehicle frontal area greater than 45 square feet.

*   *   *   *   *

High-strength steel has the meaning given in §1037.520.

Hybrid engine or hybrid powertrain means an engine or powertrain that includes energy storage features other than a conventional battery system or conventional flywheel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Note other examples of systems that qualify as hybrid engines or powertrains are systems that recover kinetic energy and use it to power an electric heater in the aftertreatment. Note that certain provisions in this part treat hybrid engines and hybrid powertrains intended for vehicles that include regenerative braking different than those intended for vehicles that do not include regenerative braking.

Hybrid vehicle means a vehicle that includes energy storage features (other than a conventional battery system or conventional flywheel) in addition to an internal combustion engine or other engine using consumable chemical fuel. Supplemental electrical batteries and hydraulic accumulators are examples of hybrid energy storage systems. Note other examples of systems that qualify as hybrid engines or powertrains are systems that recover kinetic energy and use it to power an electric heater in the aftertreatment. Note that certain provisions in this part treat hybrid vehicles that include regenerative braking different than those that do not include regenerative braking.

*   *   *   *   *

Light-duty truck means any motor vehicle that is not a heavy-duty vehicle, but is:

(1) Designed primarily for purposes of transportation of property or is a derivation of such a vehicle; or

(2) Designed primarily for transportation of persons and has a capacity of more than 12 persons; or

(3) Available with special features enabling off-street or off-highway operation and use.

*   *   *   *   *

Low rolling resistance tire means a tire on a vocational vehicle with a TRRL at or below of 7.7 kg/tonne, a steer tire on a tractor with a TRRL at or below 7.7 kg/tonne, a drive tire on a tractor with a TRRL at or below 8.1 kg/tonne, a tire on a non-box trailer with a TRRL at or below of 6.5 kg/tonne, or a tire on a box van with a TRRL at or below of 6.0 kg/tonne.

*   *   *   *   *

Model year means one of the following for compliance with this part 1037. Note that manufacturers may have other model year designations for the same vehicle for compliance with other requirements or for other purposes:

(1) For tractors and vocational vehicles with a date of manufacture on or after January 1, 2021, *model year* means the manufacturer's annual new model production period based on the vehicle's date of manufacture, where the model year is the calendar year corresponding to the date of manufacture, except as follows:

(i) The vehicle's model year may be designated as the year before the calendar year corresponding to the date of manufacture if the engine's model year is also from an earlier year. You may ask us to extend your prior model year certificate to include such vehicles. Note that §1037.601(a)(2) limits the extent to which vehicle manufacturers may install engines built in earlier calendar years.

(ii) The vehicle's model year may be designated as the year after the calendar year corresponding to the vehicle's date of manufacture. For example, a manufacturer may produce a new vehicle by installing the engine in December 2023 and designating it as a model year 2024 vehicle.

(2) For trailers and for Phase 1 tractors and vocational vehicles with a date of manufacture before January 1, 2021, *model year* means the manufacturer's annual new model production period, except as restricted under this definition and 40 CFR part 85, subpart X. It must include January 1 of the calendar year for which the model year is named, may not begin before January 2 of the previous calendar year, and it must end by December 31 of the named calendar year. The model year may be set to match the calendar year corresponding to the date of manufacture.

(i) The manufacturer who holds the certificate of conformity for the vehicle must assign the model year based on the date when its manufacturing operations are completed relative to its annual model year period. In unusual circumstances where completion of your assembly is delayed, we may allow you to assign a model year one year earlier, provided it does not affect which regulatory requirements will apply.

(ii) Unless a vehicle is being shipped to a secondary vehicle manufacturer that will hold the certificate of conformity, the model year must be assigned prior to introduction of the vehicle into U.S. commerce. The certifying manufacturer must redesignate the model year if it does not complete its manufacturing operations within the originally identified model year. A vehicle introduced into U.S. commerce without a model year is deemed to have a model year equal to the calendar year of its introduction into U.S. commerce unless the certifying manufacturer assigns a later date.

* * * * *

<u>Small manufacturer</u> means a manufacturer meeting the criteria specified in 13 CFR 121.201. Apply the small business criteria for NAICS code 336120 for vocational vehicles and tractors and 336212 for trailers. The employee and revenue limits apply to the total number employees and total revenue together for affiliated companies.

* * * * *

<u>Tonne</u> means metric ton, which is exactly 1000 kg.

* * * * *

174. Amend §1037.805 by revising paragraphs (b), (c), (d), (e), and (f) to read as follows:

§1037.805 Symbols, abbreviations, and acronyms.

* * * * *

(b) <u>Symbols for quantities</u>. This part 1037 uses the following symbols and units of measure for various quantities:

SYMBOL	QUANTITY	UNIT	UNIT SYMBOL	UNIT IN TERMS OF SI BASE UNITS
A	vehicle frictional load	pound force or newton	lbf or N	$kg{\cdot}m{\cdot}s^{-2}$
a	axle position regression coefficient			

α	atomic hydrogen-to-carbon ratio	mole per mole	mol/mol	1
α	axle position regression coefficient			
α_0	intercept of air speed correction			
α_1	slope of air speed correction			
a_g	acceleration of Earth's gravity	meters per second squared	m/s^2	m·s^{-2}
a_0	intercept of least squares regression			
a_1	slope of least squares regression			
B	vehicle load from drag and rolling resistance	pound force per mile per hour or newton second per meter	lbf/(mi/hr) or N·s/m	kg·s^{-1}
b	axle position regression coefficient			
β	atomic oxygen-to-carbon ratio	mole per mole	mol/mol	1
β	axle position regression coefficient			
β_0	intercept of air direction correction			
β_1	slope of air direction correction			
C	vehicle-specific aerodynamic effects	pound force per mile per hour squared or newton-second squared per meter squared	lbf/mph^2 or N·s^2/m^2	kg·m^{-1}
c	axle position regression coefficient			
c_i	axle test regression coefficients			
C_i	constant			
ΔC_dA	differential drag area	meter squared	m^2	m^2
C_dA	drag area	meter squared	m^2	m^2
C_d	drag coefficient			
CF	correction factor			
C_{rr}	coefficient of rolling resistance	kilogram per metric ton	kg/tonne	10^{-3}
D	distance	miles or meters	mi or m	m
e	mass-weighted emission result	grams/ton-mile	g/ton-mi	g/kg-km
Eff	efficiency			
F	adjustment factor			
F	force	pound force or newton	lbf or N	kg·m·s^{-2}
f_n	angular speed (shaft)	revolutions per minute	r/min	π·30·s^{-1}
G	road grade	percent	%	10^{-2}
g	gravitational acceleration	meters per second squared	m/s^2	m·s^{-2}
h	elevation or height	meters	m	m
i	indexing variable			

k_a	drive axle ratio			1
k_d	transmission gear ratio			
$k_{topgear}$	highest available transmission gear			
L	load over axle	pound force or newton	lbf or N	$kg{\cdot}m{\cdot}s^{-2}$
m	mass	pound mass or kilogram	lbm or kg	kg
M	molar mass	gram per mole	g/mol	$10^{-3}{\cdot}kg{\cdot}mol^{-1}$
M	vehicle mass	kilogram	kg	kg
M_e	vehicle effective mass	kilogram	kg	kg
$M_{rotating}$	inertial mass of rotating components	kilogram	kg	kg
N	total number in series			
n	number of tires			
$\dot{n}$	amount of substance rate	mole per second	mol/s	$mol{\cdot}s^{-1}$
P	power	kilowatt	kW	$10^3{\cdot}m^2{\cdot}kg{\cdot}s^{-3}$
p	pressure	pascal	Pa	$kg{\cdot}m^{-1}{\cdot}s^{-2}$
ρ	mass density	kilogram per cubic meter	kg/m^3	$kg{\cdot}m^{-3}$
PL	payload	tons	ton	kg
ϕ	direction	degrees	°	°
ψ	direction	degrees	°	°
r	tire radius	meter	m	m
r^2	coefficient of determination			
$Re^{\#}$	Reynolds number			
SEE	standard error of the estimate			
σ	standard deviation			
$TRPM$	tire revolutions per mile	revolutions per mile	r/mi	
$TRRL$	tire rolling resistance level	kilogram per metric ton	kg/tonne	10^{-3}
T	absolute temperature	kelvin	K	K
T	Celsius temperature	degree Celsius	°C	K – 273.15
T	torque (moment of force)	newton meter	N·m	$m^2{\cdot}kg{\cdot}s^{-2}$
t	time	hour or second	hr or s	s
Δt	time interval, period, 1/frequency	second	s	s
UF	utility factor			
v	speed	miles per hour or meters per second	mi/hr or m/s	$m{\cdot}s^{-1}$
w	weighting factor			
w	wind speed	miles per hour	mi/hr	$m{\cdot}s^{-1}$
W	work	kilowatt-hour	kW·hr	$3.6{\cdot}m^2{\cdot}kg{\cdot}s^{-1}$
w_C	carbon mass fraction	gram/gram	g/g	1
WR	weight reduction	pound mass	lbm	kg
x	amount of substance mole fraction	mole per mole	mol/mol	1

(c) Superscripts. This part uses the following superscripts for modifying quantity symbols:

SUPERSCRIPT	MEANING
overbar (such as $\bar{y}$)	arithmetic mean

Double overbar (such as $\overline{\overline{y}}$)	arithmetic mean of arithmetic mean
overdot (such as $\dot{y}$)	quantity per unit time

(d) Subscripts. This part uses the following subscripts for modifying quantity symbols:

SUBSCRIPT	MEANING
±6	±6° yaw angle sweep
A	A speed
air	air
aero	aerodynamic
alt	alternative
act	actual or measured condition
air	air
axle	axle
B	B speed
brake	brake
C	C speed
Ccombdry	carbon from fuel per mole of dry exhaust
CD	charge-depleting
circuit	circuit
CO2DEF	CO_2 resulting from diesel exhaust fluid decomposition
CO2PTO	CO_2 emissions for PTO cycle
coastdown	coastdown
comp	composite
CS	charge-sustaining
cycle	test cycle
drive	drive axle
drive-idle	idle with the transmission in drive
driver	driver
dyno	dynamometer
effective	effective
end	end
eng	engine
event	event
fuel	fuel
full	full
grade	grade
H2Oexhaustdry	H_2O in exhaust per mole of exhaust
hi	high
i	an individual of a series
idle	idle
in	inlet
inc	increment
lo	low
loss	loss
max	maximum
meas	measured quantity
med	median
min	minimum
moving	moving
out	outlet

P	power
pair	pair of speed segments
parked-idle	idle with the transmission in park
partial	partial
ploss	power loss
plug-in	plug-in hybrid electric vehicle
powertrain	powertrain
PTO	power take-off
rated	rated speed
record	record
ref	reference quantity
RL	road load
rotating	rotating
seg	segment
speed	speed
spin	axle spin loss
start	start
steer	steer axle
t	tire
test	test
th	theoretical
total	total
trac	traction
trac10	traction force at 10 mi/hr
trailer	trailer axle
transient	transient
TRR	tire rolling resistance
urea	urea
veh	vehicle
w	wind
wa	wind average
yaw	yaw angle
ys	yaw sweep
zero	zero quantity

(e) Other acronyms and abbreviations. This part uses the following additional abbreviations and acronyms:

ACRONYM	MEANING
ABT	averaging, banking, and trading
AECD	auxiliary emission control device
AES	automatic engine shutdown
APU	auxiliary power unit
CD	charge-depleting
CFD	computational fluid dynamics
CFR	Code of Federal Regulations
CITT	curb idle transmission torque
CS	charge-sustaining
DOT	Department of Transportation
ECM	electronic control module
EPA	Environmental Protection Agency
FE	fuel economy
FEL	Family Emission Limit

GAWR	gross axle weight rating
GCWR	gross combination weight rating
GEM	greenhouse gas emission model
GVWR	gross vehicle weight rating
Heavy HDV	Heavy heavy-duty vehicle (see §1037.140)
HVAC	heating, ventilating, and air conditioning
ISO	International Organization for Standardization
Light HDV	Light heavy-duty vehicle (see §1037.140)
Medium HDV	Medium heavy-duty vehicle (see §1037.140)
NARA	National Archives and Records Administration
NHTSA	National Highway Transportation Safety Administration
PHEV	plug-in hybrid electric vehicle
PTO	power take-off
RESS	rechargeable energy storage system
SAE	Society of Automotive Engineers
SEE	standard error of the estimate
SKU	stock-keeping unit
TRPM	tire revolutions per mile
TRRL	tire rolling resistance level
U.S.C.	United States Code
VSL	vehicle speed limiter

(f) Constants. This part uses the following constants:

SYMBOL	QUANTITY	VALUE
g	gravitational constant	$9.80665\ \mathrm{m{\cdot}s^{-2}}$
R	specific gas constant	287.058 J/(kg·K)

* * * * *

175. Revise §1037.810 to read as follows:

§1037.810 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a document in the Federal Register and the material must be available to the public. All approved material is available for inspection at EPA Docket Center, WJC West Building, Room 3334, 1301 Constitution Avenue, N.W., Washington, DC 20004, www.epa.gov/dockets, (202) 202-1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, email fedreg.legal@nara.gov, call 202-741-6030, or go to *www.archives.gov/federal-register/cfr/ibr-locations.html.*

(b) International Organization for Standardization, Case Postale 56, CH-1211 Geneva 20, Switzerland, (41) 22749 0111, www.iso.org, or central@iso.org.

(1) ISO 28580:2009(E) "Passenger car, truck and bus tyres – Methods of measuring rolling resistance – Single point test and correlation of measurement results", First Edition, July 1, 2009, ("ISO 28580"), IBR approved for §1037.520(c).

(2) [Reserved]

(c) U.S. EPA, Office of Air and Radiation, 2565 Plymouth Road, Ann Arbor, MI 48105, www.epa.gov.

(1) Greenhouse gas Emissions Model (GEM), Version 2.0.1, September 2012 ("GEM version 2.0.1"), IBR approved for §1037.520.

(2) Greenhouse gas Emissions Model (GEM) Phase 2, Version 3.5.1, November 2020 ("GEM Phase 2, Version 3.5.1"); IBR approved for §1037.520.

(3) GEM's MATLAB/Simulink Hardware-in-Loop model, Version 3.8, December 2020 ("GEM HIL model"); IBR approved for §1037.550(a).

Note 1 to paragraph (c): The computer code for these models is available as noted in paragraph (a) of this section. A working version of the software is also available for download at https://www.epa.gov/regulations-emissions-vehicles-and-engines/greenhouse-gas-emissions-model-gem-medium-and-heavy-duty.

(d) National Institute of Standards and Technology, 100 Bureau Drive, Stop 1070, Gaithersburg, MD 20899-1070, (301) 975-6478, or www.nist.gov.

(1) NIST Special Publication 811, Guide for the Use of the International System of Units (SI), 2008 Edition, March 2008, IBR approved for §1037.805.

(2) [Reserved]

(e) SAE International, 400 Commonwealth Dr., Warrendale, PA 15096–0001, (877) 606-7323 (U.S. and Canada) or (724) 776–4970 (outside the U.S. and Canada), http://www.sae.org.

(1) SAE J1025, Test Procedures for Measuring Truck Tire Revolutions Per Kilometer/Mile, Stabilized August 2012, ("SAE J1025"), IBR approved for §1037.520(c).

(2) SAE J1252, SAE Wind Tunnel Test Procedure for Trucks and Buses, Revised July 2012, ("SAE J1252"), IBR approved for §§1037.525(b) and 1037.530(a).

(3) SAE J1263, Road Load Measurement and Dynamometer Simulation Using Coastdown Techniques, revised March 2010, ("SAE J1263"), IBR approved for §§1037.528 introductory text, (a), (b), (c), (e), and (h) and 1037.665(a).

(4) SAE J1594, Vehicle Aerodynamics Terminology, Revised July 2010, ("SAE J1594"), IBR approved for §1037.530(d).

(5) SAE J2071, Aerodynamic Testing of Road Vehicles - Open Throat Wind Tunnel Adjustment, Revised June 1994, ("SAE J2071"), IBR approved for §1037.530(b).

(6) SAE J2263, Road Load Measurement Using Onboard Anemometry and Coastdown Techniques, Revised December 2008, ("SAE J2263"), IBR approved for §§1037.528 introductory text, (a), (b), (d), and (f) and 1037.665(a).

(7) SAE J2343, Recommended Practice for LNG Medium and Heavy-Duty Powered Vehicles, Revised July 2008, ("SAE J2343"), IBR approved for §1037.103(e).

(8) SAE J2452, Stepwise Coastdown Methodology for Measuring Tire Rolling Resistance, Revised June 1999, ("SAE J2452"), IBR approved for §1037.528(h).

(9) SAE J2966, Guidelines for Aerodynamic Assessment of Medium and Heavy Commercial Ground Vehicles Using Computational Fluid Dynamics, Issued September 2013, ("SAE J2966"), IBR approved for §1037.532(a).

176. Amend §1037.825 by revising paragraph (a) to read as follows:

§1037.825 Reporting and recordkeeping requirements.

(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. We may review these records at any time. You must promptly give us organized, written records in

English if we ask for them. We may require you to submit written records in an electronic format.

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177. Revise Appendix III to part 1037 to read as follows:

Appendix III to Part 1037 — Emission Control Identifiers

This appendix identifies abbreviations for emission control information labels, as required under §1037.135.

Vehicle Speed Limiters

-VSL – Vehicle speed limiter
-VSLS – "Soft-top" vehicle speed limiter
-VSLE – Expiring vehicle speed limiter
-VSLD – Vehicle speed limiter with both "soft-top" and expiration

Idle Reduction Technology

-IRT5 – Engine shutoff after 5 minutes or less of idling
-IRTE – Expiring engine shutoff

Tires

-LRRA – Low rolling resistance tires (all, including trailers)
-LRRD – Low rolling resistance tires (drive)
-LRRS – Low rolling resistance tires (steer)

Aerodynamic Components

-ATS – Aerodynamic side skirt and/or fuel tank fairing
-ARF – Aerodynamic roof fairing
-ARFR – Adjustable height aerodynamic roof fairing
-TGR – Gap reducing tractor fairing (tractor to trailer gap)
-TGRT – Gap reducing trailer fairing (tractor to trailer gap)
-TATS – Trailer aerodynamic side skirt
-TARF – Trailer aerodynamic rear fairing
-TAUD – Trailer aerodynamic underbody device

Other Components

-ADVH – Vehicle includes advanced hybrid technology components
-ADVO – Vehicle includes other advanced-technology components (i.e., non-hybrid system)
-INV – Vehicle includes innovative (off-cycle) technology components
-ATI – Automatic tire inflation system
-TPMS – Tire pressure monitoring system
-WRTW – Weight-reducing trailer wheels
-WRTC – Weight-reducing trailer upper coupler plate
-WRTS – Weight-reducing trailer axle sub-frames
-WBSW – Wide-base single trailer tires with steel wheel
-WBAW – Wide-base single trailer tires with aluminum wheel
-WBLW – Wide-base single trailer tires with light-weight aluminum alloy wheel
-DWSW – Dual-wide trailer tires with high-strength steel wheel
-DWAW – Dual-wide trailer tires with aluminum wheel
-DWLW – Dual-wide trailer tires with light-weight aluminum alloy wheel

178. Revise Appendix IV to part 1037 to read as follows:

Appendix IV to Part 1037 — Heavy-duty Grade Profile for Phase 2 Steady-State Test Cycles

The following table identifies a grade profile for operating vehicles over the highway cruise cycles specified in subpart F of this part. Determine intermediate values by linear interpolation.

Distance (m)	Grade (%)
0	0
402	0
804	0.5
1206	0
1210	0
1222	-0.1
1234	0
1244	0
1294	0.36
1344	0
1354	0
1408	-0.28
1504	-1.04
1600	-0.28
1654	0
1666	0
1792	0.39
1860	0.66
1936	1.15
2098	2.44
2260	1.15
2336	0.66
2404	0.39
2530	0
2548	0
2732	-0.46
2800	-0.69
2880	-1.08
2948	-1.53
3100	-2.75
3252	-1.53
3320	-1.08
3400	-0.69
3468	-0.46
3652	0
3666	0
3742	0.35
3818	0.9
3904	1.59
3990	0.9
4066	0.35
4142	0
4158	0
4224	-0.1
4496	-0.69
4578	-0.97
4664	-1.36
4732	-1.78
4916	-3.23
5100	-1.78
5168	-1.36
5254	-0.97
5336	-0.69
5608	-0.1
5674	0
5724	0
5808	0.1
5900	0.17
6122	0.38
6314	0.58
6454	0.77
6628	1.09
6714	1.29
6838	1.66
6964	2.14
7040	2.57
7112	3
7164	3.27
7202	3.69
7292	5.01
7382	3.69
7420	3.27
7472	3
7544	2.57
7620	2.14
7746	1.66
7870	1.29
7956	1.09
8130	0.77
8270	0.58
8462	0.38
8684	0.17
8776	0.1
8860	0
8904	0
9010	-0.38
9070	-0.69
9254	-2.13
9438	-0.69
9498	-0.38
9604	0
9616	0
9664	0.26
9718	0.7
9772	0.26
9820	0
9830	0
9898	-0.34
10024	-1.33
10150	-0.34
10218	0
10228	0
10316	0.37
10370	0.7
10514	1.85
10658	0.7
10712	0.37
10800	0
10812	0
10900	-0.37
10954	-0.7
11098	-1.85
11242	-0.7
11296	-0.37
11384	0
11394	0
11462	0.34
11588	1.33
11714	0.34
11782	0
11792	0
11840	-0.26
11894	-0.7
11948	-0.26
11996	0
12008	0
12114	0.38
12174	0.69
12358	2.13
12542	0.69
12602	0.38
12708	0
12752	0
12836	-0.1
12928	-0.17
13150	-0.38
13342	-0.58
13482	-0.77
13656	-1.09
13742	-1.29
13866	-1.66
13992	-2.14
14068	-2.57
14140	-3
14192	-3.27
14230	-3.69
14320	-5.01
14410	-3.69
14448	-3.27
14500	-3
14572	-2.57
14648	-2.14
14774	-1.66
14898	-1.29
14984	-1.09
15158	-0.77
15298	-0.58
15490	-0.38
15712	-0.17
15804	-0.1
15888	0
15938	0
16004	0.1
16276	0.69
16358	0.97
16444	1.36
16512	1.78
16696	3.23
16880	1.78
16948	1.36
17034	0.97
17116	0.69
17388	0.1
17454	0
17470	0
17546	-0.35
17622	-0.9
17708	-1.59
17794	-0.9

17870	-0.35
17946	0
17960	0
18144	0.46
18212	0.69
18292	1.08
18360	1.53
18512	2.75
18664	1.53
18732	1.08
18812	0.69
18880	0.46
19064	0
19082	0
19208	-0.39
19276	-0.66
19352	-1.15
19514	-2.44
19676	-1.15
19752	-0.66
19820	-0.39
19946	0
19958	0
20012	0.28
20108	1.04
20204	0.28
20258	0
20268	0
20318	-0.36
20368	0
20378	0
20390	0.1
20402	0
20406	0
20808	-0.5
21210	0
21612	0

PART 1039—CONTROL OF EMISSIONS FROM NEW AND IN-USE NONROAD COMPRESSION-IGNITION ENGINES

179. The authority statement for part 1039 continues to read as follows:
Authority: 42 U.S.C. 7401-7671q.

180. Amend §1039.1 by revising paragraphs (b)(3) and (c) to read as follows:

§1039.1 Does this part apply for my engines?

* * * * *

(b) * * *

(3) Engines originally meeting Tier 1, Tier 2, or Tier 3 standards as specified in Appendix I of this part remain subject to those standards. This includes uncertified engines that meet standards under 40 CFR 1068.265. Affected engines remain subject to recall provisions as specified in 40 CFR part 1068, subpart F, throughout the useful life corresponding to the original certification. Also, tampering and defeat-device prohibitions continue to apply for those engines as specified in 40 CFR 1068.101.

* * * * *

(c) The definition of nonroad engine in 40 CFR 1068.30 excludes certain engines used in stationary applications. These engines may be required by 40 CFR part 60, subpart IIII, to comply with some of the provisions of this part 1039; otherwise, these engines are only required to comply with the requirements in §1039.20. In addition, the prohibitions in 40 CFR 1068.101 restrict the use of stationary engines for nonstationary purposes unless they are certified to the same standards that would apply to certain nonroad engines for the same model year.

* * * * *

181. Amend §1039.20 by revising paragraph (a) introductory text, paragraphs (b)(2), (4), and (c) to read as follows:

§1039.20 What requirements from this part apply to excluded stationary engines?

* * * * *

(a) You must add a permanent label or tag to each new engine you produce or import that is excluded under §1039.1(c) as a stationary engine and is not required by 40 CFR part 60, subpart IIII, to meet the requirements described in this part 1039, or the requirements described in 40 CFR part 1042, that are equivalent to the requirements applicable to marine or land-based nonroad engines for the same model year. To meet labeling requirements, you must do the following things:

* * * * *

(b) * * *

(2) Include your full corporate name and trademark.

* * * * *

(4) State: "THIS ENGINE IS EXEMPTED FROM NONROAD CERTIFICATION REQUIREMENTS AS A "STATIONARY ENGINE." INSTALLING OR USING THIS ENGINE IN ANY OTHER APPLICATION MAY BE A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTY."

(c) Stationary engines required by 40 CFR part 60, subpart IIII, to meet the requirements described in this part 1039 or 40 CFR part 1042, must meet the labeling requirements of 40 CFR 60.4210.

182. Amend §1039.101 by revising the introductory text and paragraph (b) to read as follows:

§1039.101 What exhaust emission standards must my engines meet after the 2014 model year?

The exhaust emission standards of this section apply after the 2014 model year. Certain of these standards also apply for model year 2014 and earlier. This section presents the full set of emission standards that apply after all the transition and phase-in provisions of §1039.102 and §1039.104 expire. Section 1039.105 specifies smoke standards.

* * * * *

(b) *Emission standards for steady-state testing*. Steady-state exhaust emissions from your engines may not exceed the applicable emission standards in Table 1 of this section. Measure emissions using the applicable steady-state test procedures described in subpart F of this part.

Table 1 of §1039.101—Tier 4 Exhaust Emission Standards After the 2014 Model Year, g/kW-hr[a]

Maximum Engine Power	Application	PM	NOx	NMHC	NOx+NMHC	CO
kW < 19	All	0.40[b]	-	-	7.5	6.6[c]
19 ≤ kW < 56	All	0.03	-	-	4.7	5.0[d]
56 ≤ kW < 130	All	0.02	0.40	0.19	-	5.0
130 ≤ kW ≤560	All	0.02	0.40	0.19	-	3.5
kW > 560	Generator sets	0.03	0.67	0.19	-	3.5
kW > 560	All except generator sets	0.04	3.5	0.19	-	3.5

[a]Note that some of these standards also apply for 2014 and earlier model years. This table presents the full set of emission standards that apply after all the transition and phase-in provisions of §1039.102 expire.

[b]See paragraph (c) of this section for provisions related to an optional PM standard for certain engines below 8 kW.

[c]The CO standard is 8.0 g/kW-hr for engines below 8 kW.

[d]The CO standard is 5.5 g/kW-hr for engines below 37 kW.

* * * * *

183. Amend §1039.102 by:

a. Revising the introductory text and paragraph (a)(2);

b. Revising Tables 1, 3, and 6 in paragraph (b); and

c. Revising paragraphs (d)(1), (e)(3), (g)(1)(iv), and (g)(2).

The revisions read as follows:

§1039.102 What exhaust emission standards and phase-in allowances apply for my engines in model year 2014 and earlier?

The exhaust emission standards of this section apply for 2014 and earlier model years. See §1039.101 for exhaust emission standards that apply to later model years.

(a) * * *

(2) The transient standards in this section for gaseous pollutants do not apply to phase-out engines that you certify to the same numerical standards (and FELs if the engines are certified using ABT) for gaseous pollutants as you certified under the Tier 3 requirements identified in Appendix I of this part. However, except as specified by paragraph (a)(1) of this section, the transient PM emission standards apply to these engines.

(b) * * *

Table 1 of §1039.102—Tier 4 Exhaust Emission Standards (g/kW-hr): kW <19

Maximum engine power	Model years	PM	NOx + NMHC	CO
kW <8	2008-2014	0.40[a]	7.5	8.0
8 ≤kW <19	2008-2014	0.40	7.5	6.6

[a]For engines that qualify for the special provisions in §1039.101(c), you may delay certifying to the standards in this part 1039 until 2010. In 2009 and earlier model years, these engines must instead meet the applicable Tier 2 standards and other requirements identified in Appendix I of this part. Starting in 2010, these engines must meet a PM standard of 0.60 g/kW-hr, as described in §1039.101(c). Engines certified to the 0.60 g/kWhr PM standard may not generate ABT credits.

* * * * *

Table 3 of §1039.102—Interim Tier 4 Exhaust Emission Standards (g/kW-hr): 37 ≤kW <56

Option[a]	Model years	PM	NOx + NMHC	CO
#1	2008-2012	0.30	4.7	5.0
#2	2012	0.03	4.7	5.0
All	2013-2014	0.03	4.7	5.0

[a]You may certify engines to the Option #1 or Option #2 standards starting in the listed model year. Under Option #1, all engines at or above 37 kW and below 56 kW produced before the 2013 model year must meet the applicable Option #1 standards in this table. These engines are considered to be "Option #1 engines." Under Option #2, all these engines produced before the 2012 model year must meet the applicable standards identified in Appendix I of this part. Engines certified to the Option #2 standards in model year 2012 are considered "Option #2 engines."

* * * * *

Table 6 of §1039.102—Interim Tier 4 Exhaust Emission Standards (g/kW-hr): 130 < kW < 560

Model years	Phase-in Option	PM	NOx	NMHC	NOx+NMHC	CO
2011-2013	Phase-in	0.02	0.40	0.19	-	3.5
	Phase-out	0.02	-	-	4.0	3.5
2014	All engines	0.02	0.40	0.19	-	3.5

* * * * *

(d) * * *

(1) For model years 2012 through 2014, you may use banked NOx + NMHC credits from any Tier 2 engine at or above 37 kW certified under the standards identified in Appendix I of this part to meet the NOx phase-in standards or the NOx + NMHC phase-out standards under paragraphs (b) and (c) of this section, subject to the additional ABT provisions in §1039.740.

* * * * *

(e) * * *

(3) You use NOx + NMHC emission credits to certify an engine family to the alternate NOx + NMHC standards in this paragraph (e)(3) instead of the otherwise applicable alternate NOx and NMHC standards. Calculate the alternate NOx + NMHC standard by adding 0.1 g/kW-hr to the numerical value of the applicable alternate NOx standard of paragraph (e)(1) or (2) of this section. Engines certified to the NOx + NMHC standards of this paragraph (e)(3) may not generate emission credits. The FEL caps for engine families certified under this paragraph (e)(3) are the previously applicable NOx + NMHC standards identified in Appendix I of this part (generally the Tier 3 standards).

* * * * *

(g) * * *

(1) * * *

(iv) Gaseous pollutants for phase-out engines that you certify to the same numerical standards and FELs for gaseous pollutants to which you certified under the Tier 3 requirements identified in Appendix I of this part. However, the NTE standards for PM apply to these engines.
(2) *Interim FEL caps*. As described in §1039.101(d), you may participate in the ABT program in subpart H of this part by certifying engines to FELs for PM, NOx, or NOx + NMHC instead of the standards in Tables 1 through 7 of this section for the model years shown. The FEL caps listed in the following table apply instead of the FEL caps in §1039.101(d)(1), except as allowed by §1039.104(g):

Table 8 of §1039.102—Interim Tier 4 FEL Caps, g/kW-hr

Maximum engine power	Phase-in option	Model years[a]	PM	NOx	NOx+NMHC
kW <19	—	2008-2014	0.80	—	9.5[b]
19 ≤ kW < 37	—	2008-2012	0.60	—	9.5
37 ≤ kW < 56	—	2008-2012[c]	0.40	—	7.5
56 ≤ kW < 130	phase-in	2012-2013	0.04	0.80	—
56 ≤ kW <130	phase-out	2012-2013	0.04	—	6.6[d]
130 ≤ kW ≤ 560	phase-in	2011-2013	0.04	0.80	—
130 ≤ kW ≤ 560	phase-out	2011-2013	0.04	—	6.4[e]
kW > 560	—	2011-2014	0.20	6.2	—

[a]For model years before 2015 where this table does not specify FEL caps, apply the FEL caps shown in §1039.101.
[b]For engines below 8 kW, the FEL cap is 10.5 g/kW-hr for NOx + NMHC emissions.
[c]For manufacturers certifying engines to the standards of this part 1039 in 2012 under Option #2 of Table 3 of §1039.102, the FEL caps for 37-56 kW engines in the 19-56 kW category of Table 2 of §1039.101 apply for model year 2012 and later; see Appendix I of this part for provisions that apply to earlier model years.
[d]For engines below 75 kW, the FEL cap is 7.5 g/kW-hr for NOx + NMHC emissions.
[e]For engines below 225 kW, the FEL cap is 6.6 g/kW-hr for NOx + NMHC emissions.

184. Amend §1039.104 by revising paragraphs (c)(1), (c)(2)(ii), (c)(4), and (g)(4) to read as follows:

§1039.104 Are there interim provisions that apply only for a limited time?

* * * * *

(c) * * *

(1) You may delay complying with certain otherwise applicable Tier 4 emission standards and requirements as described in the following table:

If your engine's maximum power is . . .	You may delay meeting . . .	Until model year . . .	Before that model year the engine must comply with . . .
kW <19	The standards and requirements of this part	2011	The standards and requirements described in Appendix I of this part.
19 ≤kW <37	The Tier 4 standards and requirements of this part that would otherwise be applicable in model year 2013	2016	The Tier 4 standards and requirements that apply for model year 2008.
37 ≤kW <56	See paragraph (c)(2) of this section for special provisions that apply for engines in this power category.		
56 ≤kW <130	The standards and requirements of this part	2015	The standards and requirements described in Appendix I of this part.

(2) * * *

(ii) If you do not choose to comply with paragraph (c)(2)(i) of this section, you may continue to comply with the standards and requirements described in Appendix I of this part for model years through 2012, but you must begin complying in 2013 with Tier 4 standards and requirements specified in Table 3 of §1039.102 for model years 2013 and later.

* * * * *

(4) For engines not in the 19-56 kW power category, if you delay compliance with any standards under this paragraph (c), you must do all the following things for the model years when you are delaying compliance with the otherwise applicable standards:

(i) Produce engines that meet all the emission standards identified in Appendix I of this part and other requirements applicable for that model year, except as noted in this paragraph (c).

(ii) Meet the labeling requirements that apply for certified engines but use the following alternative compliance statement: “THIS ENGINE COMPLIES WITH U.S. EPA REGULATIONS FOR [CURRENT MODEL YEAR] NONROAD COMPRESSION-IGNITION ENGINES UNDER 40 CFR 1039.104(c).”.

* * * * *

(g) * * *

(4) Do not apply TCAFs to gaseous emissions for phase-out engines that you certify to the same numerical standards (and FELs if the engines are certified using ABT) for gaseous pollutants as you certified under the Tier 3 requirements identified in Appendix I of this part.

Table 1 of §1039.104—Alternate FEL Caps

Maximum engine power	PM FEL cap, g/kW-hr	Model years for the alternate PM FEL cap	NOx FEL cap, g/kW-hr[a]	Model years for the alternate NOx FEL cap
19 ≤ kW < 56	0.30	2012-2015[b]		
56 ≤ kW < 130[c]	0.30	2012-2015	3.8	2012-2015[d]
130 ≤ kW ≤ 560	0.20	2011-2014	3.8	2011-2014[e]
kW > 560[f]	0.10	2015-2018	3.5	2015-2018

aThe FEL cap for engines demonstrating compliance with a NOx + NMHC standard is equal to the previously applicable NOx + NMHC standard specified in Appendix I of this part (generally the Tier 3 standards).
bFor manufacturers certifying engines under Option #1 of Table 3 of §1039.102, these alternate FEL caps apply to all 19-56 kW engines for model years from 2013 through 2016 instead of the years indicated in this table. For manufacturers certifying engines under Option #2 of Table 3 of §1039.102, these alternate FEL caps do not apply to 19-37 kW engines except in model years 2013 to 2015.
cFor engines below 75 kW, the FEL caps are 0.40 g/kW-hr for PM emissions and 4.4 g/kW-hr for NOx emissions.
dFor manufacturers certifying engines in this power category using a percentage phase-in/phase-out approach instead of the alternate NOx standards of §1039.102(e)(1), the alternate NOx FEL cap in the table applies only in the 2014-2015 model years if certifying under §1039.102(d)(1), and only in the 2015 model year if certifying under §1039.102(d)(2).
eFor manufacturers certifying engines in this power category using the percentage phase-in/phase-out approach instead of the alternate NOx standard of §1039.102(e)(2), the alternate NOx FEL cap in the table applies only for the 2014 model year.
fFor engines above 560 kW, the provision for alternate NOx FEL caps is limited to generator-set engines.

* * * * *

185. Amend §1039.135 by revising paragraph (e) introductory text to read as follows:

§1039.135 How must I label and identify the engines I produce?

* * * * *

(e) For model year 2019 and earlier, create a separate label with the statement: “ULTRA LOW SULFUR FUEL ONLY”. Permanently attach this label to the equipment near the fuel inlet or, if you do not manufacture the equipment, take one of the following steps to ensure that the equipment will be properly labeled:

* * * * *

186. Amend §1039.205 by adding paragraph (c) to read as follows:

§1039.205 What must I include in my application?

* * * * *

(c) If your engines are equipped with an engine diagnostic system as required under §1039.110, explain how it works, describing especially the engine conditions (with the corresponding diagnostic trouble codes) that cause the warning lamp to go on and the design features that minimize the potential for operation without reductant. Also identify the communication protocol (SAE J1939, SAE J1979, etc.)

* * * * *

187. Amend §1039.245 by revising paragraph (a) to read as follows:

§1039.245 How do I determine deterioration factors from exhaust durability testing?

* * * * *

(a) You may ask us to approve deterioration factors for an engine family with established technology based on engineering analysis instead of testing. Engines certified to a NOx + NMHC standard or FEL greater than the Tier 3 NOx + NMHC standard described in Appendix I of this part are considered to rely on established technology for gaseous emission control, except that this does not include any engines that use exhaust-gas recirculation or aftertreatment. In most cases, technologies used to meet the Tier 1 and Tier 2 emission standards would be considered to be established technology.
* * * * *

188. Revise §1039.255 to read as follows:
§1039.255 What decisions may EPA make regarding a certificate of conformity?
(a) If we determine an application is complete and shows that the engine family meets all the requirements of this part and the Act, we will issue a certificate of conformity for the engine family for that model year. We may make the approval subject to additional conditions.
(b) We may deny an application for certification if we determine that an engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.
(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:
(1) Refuse to comply with any testing or reporting requirements.
(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.
(3) Cause any test data to become inaccurate.
(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.
(5) Produce engines for importation into the United States at a location where local law prohibits us from carrying out authorized activities.
(6) Fail to supply requested information or amend an application to include all engines being produced.
(7) Take any action that otherwise circumvents the intent of the Act or this part.
(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).
(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.
(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1039.820).

189. Amend §1039.601 by revising paragraph (b) to read as follows:
§1039.601 What compliance provisions apply?
* * * * *
(b) Subpart C of this part describes how to test and certify dual-fuel and flexible-fuel engines. Some multi-fuel engines may not fit either of those defined terms. For such engines, we will determine whether it is most appropriate to treat them as single-fuel engines, dual-fuel engines,

or flexible-fuel engines based on the range of possible and expected fuel mixtures. For example, an engine might burn natural gas but initiate combustion with a pilot injection of diesel fuel. If the engine is designed to operate with a single fueling algorithm (i.e., fueling rates are fixed at a given engine speed and load condition), we would generally treat it as a single-fuel engine. In this context, the combination of diesel fuel and natural gas would be its own fuel type. If the engine is designed to also operate on diesel fuel alone, we would generally treat it as a dual-fuel engine. If the engine is designed to operate on varying mixtures of the two fuels, we would generally treat it as a flexible-fuel engine. To the extent that requirements vary for the different fuels or fuel mixtures, we may apply the more stringent requirements.

190. Amend §1039.620 by revising paragraph (b) to read as follows:

§1039.620 What are the provisions for exempting engines used solely for competition?

* * * * *

(b) The definition of nonroad engine in 40 CFR 1068.30 excludes engines used solely for competition. These engines are not required to comply with this part 1039, but 40 CFR 1068.101 prohibits the use of competition engines for noncompetition purposes.

* * * * *

191. Amend §1039.625 by revising the introductory text, paragraph (d)(4) introductory text, paragraphs (e)(1), (e)(3), and (g)(1)(vi), paragraph (j) introductory text, and paragraph (j)(1) to read as follows:

§1039.625 What requirements apply under the program for equipment-manufacturer flexibility?

The provisions of this section allow equipment manufacturers to produce equipment with engines that are subject to less stringent emission standards after the Tier 4 emission standards begin to apply. To be eligible to use these provisions, you must follow all the instructions in this section. See §1039.626 for requirements that apply specifically to companies that manufacture equipment outside the United States and to companies that import such equipment without manufacturing it. Engines and equipment you produce under this section are exempt from the prohibitions in 40 CFR 1068.101(a)(1), subject to the provisions of this section.

* * * * *

(d) * * *

(4) You may start using the allowances under this section for engines that are not yet subject to Tier 4 standards, as long as the seven-year period for using allowances under the Tier 2 or Tier 3 program has expired. Table 3 of this section shows the years for which this applies. To use these early allowances, you must use engines that meet the emission standards described in paragraph (e) of this section. You must also count these units or calculate these percentages as described in paragraph (c) of this section and apply them toward the total number or percentage of equipment with exempted engines we allow for the Tier 4 standards as described in paragraph (b) of this section. The maximum number of cumulative early allowances under this paragraph (d)(4) is 10 percent under the percent-of-production allowance or 100 units under the small-volume allowance. For example, if you produce 5 percent of your equipment with engines between 130 and 560 kW that use allowances under this paragraph (d)(4) in 2009, you may use up to an additional 5 percent of your allowances in 2010. If you use allowances for 5 percent of your equipment in both 2009 and 2010, your 80 percent allowance for 2011-2017 in the 130-560 kW power category decreases to 70 percent. Manufacturers using allowances under this paragraph

(d)(4) must comply with the notification and reporting requirements specified in paragraph (g) of this section.
* * * * *
(e) * * *
(1) If you are using the provisions of paragraph (d)(4) of this section, engines must meet the applicable Tier 1 or Tier 2 emission standards described in Appendix I of this part.
* * * * *
(3) In all other cases, engines at or above 56 kW and at or below 560 kW must meet the appropriate Tier 3 standards described in Appendix I of this part. Engines below 56 kW and engines above 560 kW must meet the appropriate Tier 2 standards described in Appendix I of this part.
* * * * *
(g) * * *
(1) * * *
(vi) The number of units in each power category you have sold in years for which the Tier 2 and Tier 3 standards apply.
* * * * *
(j) *Provisions for engine manufacturers*. As an engine manufacturer, you may produce exempted engines as needed under this section. You do not have to request this exemption for your engines, but you must have written assurance from equipment manufacturers that they need a certain number of exempted engines under this section. Send us an annual report of the engines you produce under this section, as described in §1039.250(a). Exempt engines must meet the emission standards in paragraph (e) of this section and you must meet all the requirements of 40 CFR 1068.265, except that engines produced under the provisions of paragraph (a)(2) of this section must be identical in all material respects to engines previously certified under this part 1039. If you show under 40 CFR 1068.265(c) that the engines are identical in all material respects to engines that you have previously certified to one or more FELs above the standards specified in paragraph (e) of this section, you must supply sufficient credits for these engines. Calculate these credits under subpart H of this part using the previously certified FELs and the alternate standards. You must meet the labeling requirements in §1039.135, as applicable, with the following exceptions:
(1) Add the following statement instead of the compliance statement in §1039.135(c)(12):
THIS ENGINE MEETS U.S. EPA EMISSION STANDARDS UNDER 40 CFR 1039.625. SELLING OR INSTALLING THIS ENGINE FOR ANY PURPOSE OTHER THAN FOR THE EQUIPMENT FLEXIBILITY PROVISIONS OF 40 CFR 1039.625 MAY BE A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTY.
* * * * *

192. Amend §1039.626 by revising paragraph (b)(1)(iv) to read as follows:

§1039.626 What special provisions apply to equipment imported under the equipment-manufacturer flexibility program?

* * * * *
(b) * * *
(1) * * *
(iv) The number of units in each power category you have imported in years for which the Tier 2 and Tier 3 standards apply.

* * * * *

193. Amend §1039.655 by revising paragraphs (a)(2) and (b) to read as follows:

§1039.655 What special provisions apply to engines sold in Guam, American Samoa, or the Commonwealth of the Northern Mariana Islands?

(a) * * *

(2) The engine meets the latest applicable emission standards in Appendix I of this part.

* * * * *

(b) If you introduce an engine into commerce in the United States under this section, you must meet the labeling requirements in §1039.135, but add the following statement instead of the compliance statement in §1039.135(c)(12):

THIS ENGINE DOES NOT COMPLY WITH U.S. EPA TIER 4 EMISSION REQUIREMENTS. IMPORTING THIS ENGINE INTO THE UNITED STATES OR ANY TERRITORY OF THE UNITED STATES EXCEPT GUAM, AMERICAN SAMOA, OR THE COMMONWEALTH OF THE NORTHERN MARIANA ISLANDS MAY BE A VIOLATION OF FEDERAL LAW SUBJECT TO CIVIL PENALTY.

* * * * *

194. Amend §1039.740 by revising paragraph (b) to read as follows:

§1039.740 What restrictions apply for using emission credits?

* * * * *

(b) *Emission credits from earlier tiers of standards*. (1) For purposes of ABT under this subpart, you may not use emission credits generated from engines subject to emission standards identified in Appendix I of this part, except as specified in §1039.102(d)(1) or the following table:

If the maximum power of the credit-generating engine is . . .	**And it was certified to the following standards identified in Appendix I of this part . . .**	**Then you may use those banked credits for the following Tier 4 engines . . .**
(i) kW <19	Tier 2	kW <19
(ii) 19 ≤kW <37	Tier 2	kW ≥19
(iii) 37 ≤kW ≤560	Tier 3	kW ≥19
(iv) kW >560	Tier 2	kW ≥19

(2) Emission credits generated from marine engines certified to the standards identified in Appendix I of this part for land-based engines may not be used under this part.

* * * * *

195. Amend §1039.801 by:

a. Revising the definition for “Low-hour”;

b. Revising paragraph (5)(ii) for the definition of “Model year”; and

c. Revising the definitions for “Small-volume engine manufacturer”, “Tier 1”, “Tier 2”, and “Tier 3”.

The revisions read as follows.

§1039.801 What definitions apply to this part?

* * * * *

Low-hour means relating to an engine with stabilized emissions and represents the undeteriorated emission level. This would generally involve less than 300 hours of operation for engines with NOx aftertreatment and 125 hours of operation for other engines.

* * * * *

Model year means one of the following things:

* * * * *

(5) * * *

(ii) For imported engines described in paragraph (5)(ii) of the definition of "new nonroad engine," model year means the calendar year in which the engine is modified.

* * * * *

Small-volume engine manufacturer means an engine manufacturer with 1,000 or fewer employees that has had annual U.S.-directed production volume of no more than 2,500 units. For manufacturers owned by a parent company, these limits apply to the total number of employees and production volume from the parent company and all its subsidiaries.

* * * * *

Tier 1 means relating to the Tier 1 emission standards identified in Appendix I of this part.
Tier 2 means relating to the Tier 2 emission standards identified in Appendix I of this part.
Tier 3 means relating to the Tier 3 emission standards identified in Appendix I of this part.

* * * * *

196. Add Appendix I to part 1039 to read as follows:

Appendix I to Part 1039— Summary of Previous Emission Standards

The following standards, which EPA originally adopted under 40 CFR part 89, apply to nonroad compression-ignition engines produced before the model years specified in §1039.1:

(a) Tier 1 standards apply as summarized in the following table:

Table 1 to Appendix I—Tier 1 Emission Standards (g/kW-hr)

Rated Power (kW)	Starting Model Year	NOx	HC	NOx+NMHC	CO	PM
kW< 8	2000	—	—	10.5	8.0	1.0
8 ≤ kW < 19	2000	—	—	9.5	6.6	0.80
19 ≤ kW < 37	1999	—	—	9.5	5.5	0.80
37 ≤ kW < 75	1998	9.2	—	—	—	—
75 ≤ kW < 130	1997					
130 ≤ kW ≤ 560	1996	9.2	1.3	—	11.4	0.54
kW > 560	2000					

(b) Tier 2 standards apply as summarized in the following table:

Table 2 to Appendix I—Tier 2 Emission Standards (g/kW-hr)

Rated Power (kW)	Starting Model Year	NOx+NMHC	CO	PM
kW< 8	2005	7.5	8.0	0.80
8 ≤ kW < 19	2005	7.5	6.6	0.80
19 ≤ kW < 37	2004	7.5	5.5	0.60
37 ≤ kW < 75	2004	7.5	5.0	0.40
75 ≤ kW < 130	2003	6.6	5.0	0.30
130 ≤ kW < 225	2003	6.6	3.5	0.20
225 ≤ kW < 450	2001	6.4	3.5	0.20
450 ≤ kW ≤ 560	2002			
kW > 560	2006			

(c) Tier 3 standards apply as summarized in the following table:

Table 3 to Appendix I—Tier 3 Emission Standards (g/kW-hr)

Rated Power (kW)	Starting Model Year	NOx+NMHC	CO	PM
37 ≤ kW < 75	2008	4.7	5.0	0.40
75 ≤ kW < 130	2007	4.0	5.0	0.30
130 ≤ kW ≤ 560	2006	4.0	3.5	0.20

(d) Tier 1 through Tier 3 standards applied only for discrete-mode steady-state testing. There were no not-to-exceed standards or transient testing.

PART 1042—CONTROL OF EMISSIONS FROM NEW AND IN-USE MARINE COMPRESSION-IGNITION ENGINES AND VESSELS

197. The authority statement for part 1042 continues to read as follows:
Authority: 42 U.S.C. 7401-7671q.

198. Amend §1042.1 by:
a. Revising paragraphs (b) and (c); and
b. Removing and reserving paragraph (d).
The revisions read as follows:

§1042.1 Applicability.

* * * * *

(b) New engines with maximum engine power below 37 kW and originally manufactured and certified before the model years identified in Table 1 to this section are subject to emission standards as specified in Appendix I of this part. The provisions of this part 1042 do not apply for such engines, except as follows beginning June 29, 2010:

(1) The allowances of this part apply.

(2) The definitions of “new marine engine” and “model year” apply.

(c) Marine engines originally meeting Tier 1 or Tier 2 standards as specified in Appendix I of this part remain subject to those standards. This includes uncertified engines that meet standards under 40 CFR 1068.265. Those engines remain subject to recall provisions as specified in 40 CFR part 1068, subpart F, throughout the useful life corresponding to the original certification.

Also, tampering and defeat-device prohibitions continue to apply for those engines as specified in 40 CFR 1068.101. The remanufacturing provisions in subpart I of this part may apply for remanufactured engines originally manufactured in model years before the model years identified in Table 1 to this section.

* * * * *

199. Amend §1042.101 by revising paragraphs (a)(6), (c)(2), and (e)(2) to read as follows:

§1042.101 Exhaust emission standards for Category 1 and Category 2 engines.

(a) * * *

(6) Interim Tier 4 PM standards apply for 2014 and 2015 model year engines between 2000 and 3700 kW as specified in this paragraph (a)(6). These engines are considered Tier 4 engines.

(i) For Category 1 engines, the Tier 3 PM standards from Table 1 to this section continue to apply. PM FELs for these engines may not be higher than the applicable Tier 2 PM standards specified in Appendix I of this part.

(ii) For Category 2 engines with per-cylinder displacement below 15.0 liters, the Tier 3 PM standards from Table 2 to this section continue to apply. PM FELs for these engines may not be higher than 0.27 g/kW-hr.

(iii) For Category 2 engines with per-cylinder displacement at or above 15.0 liters, the PM standard is 0.34 g/kW-hr for engines at or above 2000 kW and below 3300 kW, and 0.27 g/kW-hr for engines at or above 3300 kW and below 3700 kW. PM FELs for these engines may not be higher than 0.50 g/kW-hr.

* * * * *

(c) * * *

(2) Determine the applicable NTE zone and subzones as described in §1042.515. Determine NTE multipliers for specific zones and subzones and pollutants as follows:

(i) For marine engines certified using the duty cycle specified in §1042.505(b)(1), except for variable-speed propulsion marine engines used with controllable-pitch propellers or with electrically coupled propellers, apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NOx+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 PM and CO standards.

(C) Subzone 2: 1.5 for Tier 4 NOx and HC standards and for Tier 3 NOx+HC standards.

(D) Subzone 2: 1.9 for PM and CO standards.

(ii) For recreational marine engines certified using the duty cycle specified in §1042.505(b)(2), except for variable-speed marine engines used with controllable-pitch propellers or with electrically coupled propellers, apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NOx+HC standards.

(B) Subzone 1: 1.5 for Tier 3 PM and CO standards.

(C) Subzones 2 and 3: 1.5 for Tier 3 NOx+HC standards.

(D) Subzones 2 and 3: 1.9 for PM and CO standards.

(iii) For variable-speed marine engines used with controllable-pitch propellers or with electrically coupled propellers that are certified using the duty cycle specified in §1042.505(b)(1), (2), or (3), apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NOx+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 PM and CO standards.

(C) Subzone 2: 1.5 for Tier 4 NOx and HC standards and for Tier 3 NOx+HC standards.

(D) Subzone 2: 1.9 for PM and CO standards. However, there is no NTE standard in Subzone 2b for PM emissions if the engine family's applicable standard for PM is at or above 0.07 g/kW-hr.

(iv) For constant-speed engines certified using a duty cycle specified in §1042.505(b)(3) or (4), apply the following NTE multipliers:

(A) Subzone 1: 1.2 for Tier 3 NOx+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 PM and CO standards.

(C) Subzone 2: 1.5 for Tier 4 NOx and HC standards and for Tier 3 NOx+HC standards.

(D) Subzone 2: 1.9 for PM and CO standards. However, there is no NTE standard for PM emissions if the engine family's applicable standard for PM is at or above 0.07 g/kW-hr.

(v) For variable-speed auxiliary marine engines certified using the duty cycle specified in §1042.505(b)(5)(ii) or (iii):

(A) Subzone 1: 1.2 for Tier 3 NOx+HC standards.

(B) Subzone 1: 1.5 for Tier 4 standards and Tier 3 PM and CO standards.

(C) Subzone 2: 1.2 for Tier 3 NOx+HC standards.

(D) Subzone 2: 1.5 for Tier 4 standards and Tier 3 PM and CO standards. However, there is no NTE standard for PM emissions if the engine family's applicable standard for PM is at or above 0.07 g/kW-hr.

* * * * *

(e) * * *

(2) Specify a longer useful life in hours for an engine family under either of two conditions:

(i) If you design your engine to operate longer than the minimum useful life. Indicators of design life include your recommended overhaul interval and may also include your advertising and marketing materials.

(ii) If your basic mechanical warranty is longer than the minimum useful life.

* * * * *

200. Amend §1042.104 by revising paragraphs (a)(2) and (c) to read as follows:

§1042.104 Exhaust emission standards for Category 3 engines.

(a) * * *

(2) NOx standards apply based on the engine's model year and maximum in-use engine speed as shown in the following table:

Table 1 to §1042.104—NOx Emission Standards for Category 3 Engines (g/kW-hr)

Emission standards	Model year	Maximum in-use engine speed		
		Less than 130 RPM	130-2000 RPM[a]	Over 2000 RPM
Tier 1	2004-2010	17.0	$45.0 \cdot n^{(-0.20)}$	9.8
Tier 2	2011-2015	14.4	$44.0 \cdot n^{(-0.23)}$	7.7
Tier 3[b]	2016 and later	3.4	$9.0 \cdot n^{(-0.20)}$	2.0

[a]Applicable standards are calculated from n (maximum in-use engine speed, in RPM, as specified in §1042.140). Round the standards to one decimal place.

[b]For engines designed with on-off controls as specified in §1042.115(g), the Tier 2 standards continue to apply any time the engine has disabled its Tier 3 NOx emission controls.

* * * * *

(c) *Mode caps*. Measured NOx emissions from Tier 3 engines may not exceed the cap specified in this paragraph (c) for any applicable duty-cycle test modes with power greater than 10 percent maximum engine power. Calculate the mode cap by multiplying the applicable Tier 3 NOx

standard by 1.5 and rounding to the nearest 0.1 g/kW-hr. Note that mode caps do not apply for pollutants other than NOx and do not apply for any modes of operation outside of the applicable duty cycles in §1042.505. Category 3 engines are not subject to not-to-exceed standards.
*   *   *   *   *

201. Amend §1042.115 by revising paragraph (g) to read as follows:
§1042.115 Other requirements.
*   *   *   *   *
(g) *On-off controls for engines on Category 3 vessels*. Manufacturers may equip Category 3 propulsion engines with features that disable Tier 3 NOx emission controls subject to the provisions of this paragraph (g). For auxiliary engines allowed to use on-off controls as specified in §1042.650(d), read "Tier 2" to mean "IMO Tier II" and read "Tier 3" to mean "IMO Tier III".

(1) Features that disable Tier 3 NOx emission controls are considered to be AECDs whether or not they meet the definition of an AECD. For example, manually operated on-off features are AECDs under this paragraph (g). The features must be identified in your application for certification as AECDs. For purposes of this paragraph (g), the term "features that disable Tier 3 emission controls" includes (but is not limited to) any combination of the following that cause the engine's emissions to exceed any Tier 3 emission standard:

(i) Bypassing of exhaust aftertreatment.

(ii) Reducing or eliminating flow of reductant to an SCR system.

(iii) Modulating engine calibration in a manner that increases engine-out emissions of a regulated pollutant.

(2) You must demonstrate that the AECD will not disable NOx emission controls while operating shoreward of the boundaries of the North American ECA and the U.S. Caribbean Sea ECA. You must demonstrate that the AECD will not disable emission control while operating in these waters. (Note: See the regulations in 40 CFR part 1043 for requirements related to operation in ECAs, including foreign ECAs.) Compliance with this paragraph will generally require that the AECD operation be based on Global Positioning System (GPS) inputs. We may consider any relevant information to determine whether your AECD conforms to this paragraph (g).

(3) The onboard computer log must record in nonvolatile computer memory all incidents of engine operation with the Tier 3 NOx emission controls disabled.

(4) The engine must comply with the Tier 2 NOx standard when the Tier 3 NOx emission controls are disabled.

202. Amend §1042.125 by revising paragraph (e) to read as follows:
§1042.125 Maintenance instructions.
*   *   *   *   *
(e) *Maintenance that is not emission-related*. For maintenance unrelated to emission controls, you may schedule any amount of inspection or maintenance. You may also take these inspection or maintenance steps during service accumulation on your emission-data engines, as long as they are reasonable and technologically necessary. This might include adding engine oil, changing air, fuel, or oil filters, servicing engine-cooling systems or fuel-water separator cartridges or elements, and adjusting idle speed, governor, engine bolt torque, valve lash, or injector lash.

You may not perform this nonemission-related maintenance on emission-data engines more often than the least frequent intervals that you recommend to the ultimate purchaser.
* * * * *

203. Amend §1042.135 by revising paragraph (c)(13) to read as follows:

§1042.135 Labeling.

* * * * *

(c) * * *

(13) For engines above 130 kW that are intended for installation on domestic or public vessels, include the following statement: "THIS ENGINE DOES NOT COMPLY WITH INTERNATIONAL MARINE REGULATIONS UNLESS IT IS ALSO COVERED BY AN EIAPP CERTIFICATE."

* * * * *

204. Amend §1042.145 by removing and reserving paragraphs (b), (c), (e), (h), and (i) and revising paragraph (j) to read as follows:

§1042.145 Interim provisions.

* * * * *

(j) *Installing land-based engines in marine vessels.* Vessel manufacturers and marine equipment manufacturers may apply the provisions of §§1042.605 and 1042.610 to land-based engines with maximum engine power at or above 37 kW and at or below 560 kW if they meet the Tier 3 emission standards in Appendix I of 40 CFR part 1039 as specified in 40 CFR 1068.265. All the provisions of §1042.605 or §1042.610 apply as if those engines were certified to emission standards under 40 CFR part 1039. Similarly, engine manufacturers, vessel manufacturers, and marine equipment manufacturers must comply with all the provisions of 40 CFR part 1039 as if those engines were installed in land-based equipment. The following provisions apply for engine manufacturers shipping engines to vessel manufacturers or marine equipment manufacturers under this paragraph (j):

(1) You must label the engine as described in 40 CFR 1039.135, but identify the engine family name as it was last certified under 40 CFR part 1039 and include the following alternate compliance statement: "THIS ENGINE MEETS THE TIER 3 STANDARDS FOR LAND-BASED NONROAD DIESEL ENGINES UNDER 40 CFR PART 1039. THIS ENGINE MAY BE USED ONLY IN A MARINE VESSEL UNDER THE DRESSING PROVISIONS OF 40 CFR 1042.605 OR 40 CFR 1042.610."

(2) You must use the provisions of 40 CFR 1068.262 for shipping uncertified engines under this section to secondary engine manufacturers.

* * * * *

205. Amend §1042.235 by revising paragraph (d)(3) to read as follows:

§1042.235 Emission testing related to certification.

* * * * *

(d) * * *

(3) The data show that the emission-data engine would meet all the requirements that apply to the engine family covered by the application for certification. For engines originally tested to demonstrate compliance with Tier 1 or Tier 2 standards, you may consider those test procedures to be equivalent to the procedures we specify in subpart F of this part.

* * * * *

206. Revise §1042.255 to read as follows:

§1042.255 EPA decisions.

(a) If we determine an application is complete and shows that the engine family meets all the requirements of this part and the Clean Air Act, we will issue a certificate of conformity for the engine family for that model year. We may make the approval subject to additional conditions.

(b) We may deny an application for certification if we determine that an engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.

(3) Cause any test data to become inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce engines for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend an application to include all engines being produced.

(7) Take any action that otherwise circumvents the intent of the Clean Air Act or this part.

(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Clean Air Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete after submission.

(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1042.920).

207. Amend §1042.302 by revising paragraph (a) to read as follows:

§1042.302 Applicability of this subpart for Category 3 engines.

* * * * *

(a) You must test each Category 3 engine at the sea trial of the vessel in which it is installed or within the first 300 hours of operation, whichever occurs first. This may involve testing a fully assembled production engine before it is installed in the vessel. For engines with on-off controls, you may omit testing to demonstrate compliance with Tier 2 standards if the engine does not rely on aftertreatment when Tier 3 emission controls are disabled. Since you must test each engine, the provisions of §§1042.310 and 1042.315(b) do not apply for Category 3 engines. If we determine that an engine failure under this subpart is caused by defective components or design deficiencies, we may revoke or suspend your certificate for the engine family as described in §1042.340. If we determine that an engine failure under this subpart is caused only by incorrect assembly, we may suspend your certificate for the engine family as described in §1042.325. If the engine fails, you may continue operating only to complete the sea trial and return to port. It is a violation of 40 CFR 1068.101(b)(1) to operate the vessel further until you remedy the cause of failure. Each two-hour period of such operation constitutes a separate offense. A violation lasting less than two hours constitutes a single offense.

*   *   *   *   *

208. Amend §1042.605 by revising paragraphs (a), (b), (c), (d)(1)(ii), (d)(2), (d)(3)(ii), (f), and (h) to read as follows:

§1042.605   Dressing engines already certified to other standards for nonroad or heavy-duty highway engines for marine use.

(a) *General provisions*. If you are an engine manufacturer (including someone who marinizes a land-based engine), this section allows you to introduce new marine engines into U.S. commerce if they are already certified to the requirements that apply to compression-ignition engines under 40 CFR parts 85 and 86 or 40 CFR part 1033 or 1039 for the appropriate model year. If you comply with all the provisions of this section, we consider the certificate issued under 40 CFR part 86, 1033, or 1039 for each engine to also be a valid certificate of conformity under this part 1042 for its model year, without a separate application for certification under the requirements of this part 1042. This section does not apply for Category 3 engines.

(b) *Vessel-manufacturer provisions*. If you are not an engine manufacturer, you may install an engine certified for the appropriate model year under 40 CFR part 86, 1033, or 1039 in a marine vessel as long as you do not make any of the changes described in paragraph (d)(3) of this section and you meet the requirements of paragraph (e) of this section. If you modify the non-marine engine in any of the ways described in paragraph (d)(3) of this section, we will consider you a manufacturer of a new marine engine. Such engine modifications prevent you from using the provisions of this section.

(c) *Liability*. Engines for which you meet the requirements of this section are exempt from all the requirements and prohibitions of this part, except for those specified in this section. Engines exempted under this section must meet all the applicable requirements from 40 CFR parts 85 and 86 or 40 CFR part1033 or 1039. This paragraph (c) applies to engine manufacturers, vessel manufacturers that use such an engine, and all other persons as if the engine were used in its originally intended application. The prohibited acts of 40 CFR 1068.101(a)(1) apply to these new engines and vessels; however, we consider the certificate issued under 40 CFR part 86, 1033, or 1039 for each engine to also be a valid certificate of conformity under this part 1042 for its model year. If we make a determination that these engines do not conform to the regulations during their useful life, we may require you to recall them under 40 CFR part 85 or 1068.

(d) *   *   *

(1) *   *   *

(ii) Land-based compression-ignition nonroad engines (40 CFR part 1039).

*   *   *   *   *

(2) The engine must have the label required under 40 CFR part 86, 1033, or 1039.

(3) *   *   *

(ii) Replacing an original turbocharger, except that small-volume engine manufacturers may replace an original turbocharger on a recreational engine with one that matches the performance of the original turbocharger.

*   *   *   *   *

(f) *Failure to comply*. If your engines do not meet the criteria listed in paragraph (d) of this section, they will be subject to the standards, requirements, and prohibitions of this part 1042 and the certificate issued under 40 CFR part 86, 1033, or 1039 will not be deemed to also be a certificate issued under this part 1042. Introducing these engines into U.S. commerce as marine engines without a valid exemption or certificate of conformity under this part violates the prohibitions in 40 CFR 1068.101(a)(1).

* * * * *

(h) *Participation in averaging, banking and trading*. Engines adapted for marine use under this section may not generate or use emission credits under this part 1042. These engines may generate credits under the ABT provisions in 40 CFR part(s) 86, 1033, or 1039, as applicable. These engines must use emission credits under 40 CFR part(s) 86, 1033, or 1039 as applicable if they are certified to an FEL that exceeds an emission standard.

* * * * *

209. Amend §1042.610 by revising paragraphs (a), (c), (d)(1), (f), and (g) to read as follows:

§1042.610 Certifying auxiliary marine engines to land-based standards.

* * * * *

(a) *General provisions*. If you are an engine manufacturer, this section allows you to introduce new marine engines into U.S. commerce if they are already certified to the requirements that apply to compression-ignition engines under 40 CFR part 1039 for the appropriate model year. If you comply with all the provisions of this section, we consider the certificate issued under 40 CFR part 1039 for each engine to also be a valid certificate of conformity under this part 1042 for its model year, without a separate application for certification under the requirements of this part 1042.

* * * * *

(c) *Liability*. Engines for which you meet the requirements of this section are exempt from all the requirements and prohibitions of this part, except for those specified in this section. Engines exempted under this section must meet all the applicable requirements from 40 CFR part 1039. This paragraph (c) applies to engine manufacturers, vessel manufacturers that use such an engine, and all other persons as if the engine were used in its originally intended application. The prohibited acts of 40 CFR 1068.101(a)(1) apply to these new engines and vessels; however, we consider the certificate issued under 40 CFR part 1039 for each engine to also be a valid certificate of conformity under this part 1042 for its model year. If we make a determination that these engines do not conform to the regulations during their useful life, we may require you to recall them under 40 CFR part 1068.

(d) * * *

(1) The marine engine must be identical in all material respects to a land-based engine covered by a valid certificate of conformity for the appropriate model year showing that it meets emission standards for engines of that power rating under 40 CFR part 1039.

* * * * *

(f) *Failure to comply*. If your engines do not meet the criteria listed in paragraph (d) of this section, they will be subject to the standards, requirements, and prohibitions of this part 1042 and the certificate issued under 40 CFR part 1039 will not be deemed to also be a certificate issued under this part 1042. Introducing these engines into U.S. commerce as marine engines without a valid exemption or certificate of conformity under this part 1042 violates the prohibitions in 40 CFR 1068.101(a)(1).

(g) *Participation in averaging, banking and trading*. Engines using this exemption may not generate or use emission credits under this part 1042. These engines may generate credits under the ABT provisions in 40 CFR part 1039, as applicable. These engines must use emission credits under 40 CFR part 1039 as applicable if they are certified to an FEL that exceeds an emission standard.

* * * * *

210. Amend §1042.615 by revising paragraph (a) introductory text and paragraphs (a)(1) and (3) and adding paragraphs (f) and (g) to read as follows:

§1042.615 Replacement engine exemption.

* * * * *

(a) This paragraph (a) applies instead of the provisions of 40 CFR 1068.240(b)(2) for installing new marine engines in vessels that are not “new vessels”. The prohibitions in 40 CFR 1068.101(a)(1) do not apply to a new replacement engine if all the following conditions are met:

(1) You use good engineering judgment to determine that no engine certified to the current requirements of this part is produced by any manufacturer with the appropriate physical or performance characteristics to repower the vessel. We have determined that Tier 4 engines with aftertreatment technology do not have the appropriate physical or performance characteristics to replace uncertified engines or engines certified to emission standards that are less stringent than the Tier 4 standards.

* * * * *

(3) Send us a report by September 30 of each year describing your engine shipments under this section from the preceding calendar year. Your report must include all the following things and be signed by an authorized representative of your company:

(i) Identify the number of Category 1 and Category 2 exempt replacement engines that meet Tier 1, Tier 2, or Tier 3 standards, or that meet no EPA standards. Count engines separately for each tier of standards. Identify the number of those engines that have been shipped (directly or indirectly) to a vessel owner. This includes engines shipped to anyone intending to install engines on behalf of a specific engine owner. Also include commercial Tier 3 engines with maximum engine power at or above 600 kW even if they have not been shipped to or designated for a specific vessel owner in the specified time frame.

(ii) Describe how you made the determinations described in paragraph (a)(1) of this section for each Category 1 and Category 2 exempt replacement engine for each vessel during the preceding year. For Tier 3 replacement engines at or above 600 kW, describe why any engines certified to Tier 4 standards without aftertreatment are not suitable.

(iii) Identify the number of Category 3 exempt replacement engines. We may require you to describe how you made the determinations described in paragraph (a)(1) of this section for each engine.

(iv) Include the following statement:

I certify that the statements and information in the enclosed document are true, accurate, and complete to the best of my knowledge. I am aware that there are significant civil and criminal penalties for submitting false statements and information, or omitting required statements and information.

* * * * *

(f) The provisions of 40 CFR 1068.240(c) allow you to ship a limited number of exempt replacement engines to vessel owners or distributors without making the determinations described in paragraph (a) of this section. Note that such engines do not count toward the production limits of 40 CFR 1068.240(c) if you meet all the requirements of this section by the due date for the annual report. You may count Tier 3 commercial marine replacement engines at or above 600 kW as tracked engines under 40 CFR 1068.240(b) even if they have not been shipped to or designated for a specific vessel owner in the specified time frame.

(g) In unusual circumstances, you may ask us to allow you to apply the replacement engine exemption of this section for repowering a vessel that becomes a "new vessel" under §1042.901 as a result of modifications, as follows:

(1) You must demonstrate that no manufacturer produces an engine certified to Tier 4 standards with the appropriate physical or performance characteristics to repower the vessel. We will consider concerns about the size of the replacement engine and its compatibility with vessel components relative to the overall scope of the project.

(2) Exempt replacement engines under this paragraph (g) must meet the Tier 3 standards specified in §1042.101 (or the Tier 2 standards if there are no Tier 3 standards).

(3) We will not approve a request for an exemption from the Tier 3 standards for any engines.

(4) You may not use the exemption provisions for untracked replacement engines under 40 CFR 1068.240(c) for repowering a vessel that becomes a "new vessel" under §1042.901 as a result of modifications.

211. Amend §1042.650 by revising the introductory text and paragraph (b)(4) to read as follows:

§1042.650 Migratory vessels.

The provisions of paragraphs (a) through (c) of this section apply for Category 1 and Category 2 engines, including auxiliary engines installed on vessels with Category 3 propulsion engines; these provisions do not apply for any Category 3 engines. All engines exempted under this section must comply with the applicable requirements of 40 CFR part 1043.

* * * * *

(b) * * *

(4) Operating a vessel containing an engine exempted under this paragraph (b) violates the prohibitions in 40 CFR 1068.101(a)(1) if the vessel is not in full compliance with applicable requirements for international safety specified in paragraph (b)(1)(i) of this section.

* * * * *

212. Amend §1042.655 by revising the paragraph (b) to read as follows:

§1042.655 Special certification provisions for Category 3 engines with aftertreatment.

* * * * *

(b) *Required testing*. The emission-data engine must be tested as specified in subpart F of this part. Testing engine-out emissions to simulate operation with disabled Tier 3 emission controls must simulate backpressure and other parameters as needed to represent in-use operation with an SCR catalyst. The catalyst material or other aftertreatment device must be tested under conditions that accurately represent actual engine conditions for the test points. This catalyst or aftertreatment testing may be performed on a bench scale.

* * * * *

§1042.701 [Amended]

213. Amend §1042.701 by removing and reserving paragraph (j).

214. Amend §1042.801 by revising paragraph (f)(1) to read as follows:

§1042.801 General provisions.

* * * * *

(f) * * *

(1) Only fuel additives registered under 40 CFR part 79 may be used under this paragraph (f).

* * * * *

215. Amend §1042.836 by revising the introductory text and paragraph (c) to read as follows:

§1042.836 Marine certification of locomotive remanufacturing systems.

If you certify a Tier 0, Tier 1, or Tier 2 remanufacturing system for locomotives under 40 CFR part 1033, you may also certify the system under this part 1042, according to the provisions of this section.

* * * * *

(c) Systems that were certified to the standards of 40 CFR part 92 are subject to the following restrictions:

(1) Tier 0 locomotive systems may not be used for any Category 1 engines or Tier 1 or later Category 2 engines.

(2) Where systems certified to the standards of 40 CFR part 1033 are also available for an engine, you may not use a system certified to the standards of 40 CFR part 92.

216. Amend §1042.901 by revising the definition for "Low-hour" and paragraph (3) of the definition for "Model year" to read as follows:

§1042.901 Definitions.

* * * * *

Low-hour means relating to an engine that has stabilized emissions and represents the undeteriorated emission level. This would generally involve less than 300 hours of operation for engines with NOx aftertreatment and 125 hours of operation for other engines.

* * * * *

Model year means * * *

* * * * *

(3) For an uncertified marine engine excluded under §1042.5 that is later subject to this part 1042 as a result of being installed in a different vessel, model year means the calendar year in which the engine was installed in the non-excluded vessel. For a marine engine excluded under §1042.5 that is later subject to this part 1042 as a result of reflagging the vessel, model year means the calendar year in which the engine was originally manufactured. For a marine engine that becomes new under paragraph (7) of the definition of "new marine engine," model year means the calendar year in which the engine was originally manufactured. (See definition of "new marine engine," paragraphs (3) and (7).)

* * * * *

217. Revise §1042.910 to read as follows:

§1042.910 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a document in the Federal Register and the material must be available to the public. All approved material is available for inspection at EPA Docket Center, WJC West Building, Room 3334, 1301 Constitution Avenue, N.W., Washington, DC 20004, www.epa.gov/dockets, (202) 202-1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, email fedreg.legal@nara.gov or go to: http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html.

(b) The International Maritime Organization, 4 Albert Embankment, London SE1 7SR, United Kingdom, or *www.imo.org*, or 44-(0)20-7735-7611.

(1) MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships, Fourth Edition, 2017, and NOx Technical Code 2008.

(i) Revised MARPOL Annex VI, Regulations for the Prevention of Pollution from Ships, Fourth Edition, 2017 (“2008 Annex VI”); IBR approved for §1042.901.

(ii) NOx Technical Code 2008, Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines, 2017 Edition, (“NOx Technical Code”); IBR approved for §§1042.104(g), 1042.230(d), 1042.302(c) and (e), 1042.501(g), and 1042.901.

(2) [Reserved]

218. Amend Appendix I to part 1042 by revising paragraph (a) introductory text, paragraph (b) introductory text, and paragraph (b)(3) to read as follows:

Appendix I to Part 1042—Summary of Previous Emission Standards

* * * * *

(a) *Engines below 37 kW*. Tier 1 and Tier 2 standards for engines below 37 kW originally adopted under 40 CFR part 89 apply as follows:

* * * * *

(b) *Engines at or above 37 kW*. Tier 1 and Tier 2 standards for engines at or above 37 kW originally adopted under 40 CFR part 94 apply as follows:

* * * * *

(3) *Tier 2 supplemental standards*. Not-to-exceed emission standards apply for all engines subject to the Tier 2 standards described in paragraph (b)(2) of this appendix.

PART 1043—CONTROL OF NOx, SOx, AND PM EMISSIONS FROM MARINE ENGINES AND VESSELS SUBJECT TO THE MARPOL PROTOCOL

219. The authority statement for part 1043 continues to read as follows:

Authority: 33 U.S.C. 1901-1912.

220. Amend §1043.41 by revising paragraph (a) to read as follows:

§1043.41 EIAPP certification process.

* * * * *

(a) You must send the Designated Certification Officer a separate application for an EIAPP certificate for each engine family. An EIAPP certificate is valid starting with the indicated effective date and is valid for any production until such time as the design of the engine family changes or more stringent emission standards become applicable, whichever comes first. Note that an EIAPP certificate demonstrating compliance with Tier I or Tier II standards (but not the Tier III standard) is only a limited authorization to install engines on vessels. For example, you may produce such Tier I or Tier II engines, but those engines may not be installed in vessels that are subject to Tier III standards. You may obtain preliminary approval of portions of the application under 40 CFR 1042.210.

* * * * *

221. Revise §1043.100 to read as follows:

§1043.100 Incorporation by reference.

(a) Certain material is incorporated by reference into this part with the approval of the Director of the Federal Register under 5 U.S.C. 552(a) and 1 CFR part 51. To enforce any edition other than that specified in this section, the Environmental Protection Agency must publish a document in the Federal Register and the material must be available to the public. All approved material is available for inspection at EPA Docket Center, WJC West Building, Room 3334, 1301 Constitution Avenue, N.W., Washington, DC 20004, www.epa.gov/dockets, (202) 202-1744, and is available from the sources listed below. It is also available for inspection at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, email fedreg.legal@nara.gov, or go to: *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

(b) The International Maritime Organization, 4 Albert Embankment, London SE1 7SR, United Kingdom, or *www.imo.org*, or 44-(0)20-7735-7611.

(1) MARPOL Annex VI, Regulations for the Prevention of Air Pollution from Ships, Fourth Edition, 2017, and NOx Technical Code 2008.

(i) Revised MARPOL Annex VI, Regulations for the Prevention of Pollution from Ships, Fourth Edition, 2017 ("2008 Annex VI"); IBR approved for §§1043.1 introductory text, 1043.20, 1043.30(f), 1043.60(c), and 1043.70(a).

(ii) NOx Technical Code 2008, Technical Code on Control of Emission of Nitrogen Oxides from Marine Diesel Engines, 2017 Edition, ("NOx Technical Code"); IBR approved for §§1043.20, 1043.41(b) and (h), and 1043.70(a).

(2) [Reserved]

PART 1045—CONTROL OF EMISSIONS FROM SPARK-IGNITION PROPULSION MARINE ENGINES AND VESSELS

222. The authority statement for part 1045 continues to read as follows:

Authority: 42 U.S.C. 7401-7671q.

223. Amend §1045.1 by revising paragraph (c) to read as follows:

§1045.1 Does this part apply for my products?

* * * * *

(c) Outboard and personal watercraft engines originally meeting the standards specified in Appendix I remain subject to those standards. Those engines remain subject to recall provisions as specified in 40 CFR part 1068, subpart F, throughout the useful life corresponding to the original certification. Also, tampering and defeat-device prohibitions continue to apply for those engines as specified in 40 CFR 1068.101.

* * * * *

224. Amend §1045.145 by removing and reserving paragraphs (a) through (g), (i) through (k), and (m) and revising paragraph (n) to read as follows:

§1045.145 Are there interim provisions that apply only for a limited time?

* * * * *

(n) *Continued use of 40 CFR part 91 test data*. You may continue to use test data based on the test procedures that applied for engines built before the requirements of this part 1045 started to apply if we allow you to use carryover emission data under 40 CFR 1045.235(d) for your engine family. You may also use those test procedures for production-line testing with any engine family whose certification is based on testing with those procedures. For any EPA testing, we will rely on the procedures described in subpart F of this part, even if you used carryover data based on older test procedures as allowed under this paragraph (n).

* * * * *

225. Amend §1045.235 by revising paragraph (d)(3) to read as follows:

§1045.235 What testing requirements apply for certification?

* * * * *

(d) * * *

(3) The data show that the emission-data engine would meet all the requirements that apply to the engine family covered by the application for certification.

* * * * *

226. Revise §1045.255 to read as follows:

§1045.255 What decisions may EPA make regarding a certificate of conformity?

(a) If we determine an application is complete and shows that the engine family meets all the requirements of this part and the Clean Air Act, we will issue a certificate of conformity for the engine family for that model year. We may make the approval subject to additional conditions.

(b) We may deny an application for certification if we determine that an engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.

(3) Cause any test data to become inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce engines for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend an application to include all engines being produced.

(7) Take any action that otherwise circumvents the intent of the Clean Air Act or this part.

(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Clean Air Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete after submission.
(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1045.820).

227. Amend §1045.310 by revising paragraph (a)(1) introductory text and paragraph (a)(1)(iv) to read as follows:

§1045.310 How must I select engines for production-line testing?

(a) * * *

(1) For engine families with projected U.S.-directed production volume of at least 1,600, the test periods are defined as follows:

* * * * *

(iv) If your annual production period is 301 days or longer, divide the annual production period evenly into four test periods. For example, if your annual production period is 392 days (56 weeks), divide the annual production period into four test periods of 98 days (14 weeks).

* * * * *

228. Amend §1045.501 by revising paragraph (c) to read as follows:

§1045.501 How do I run a valid emission test?

* * * * *

(c) *Fuels*. Use the fuels and lubricants specified in 40 CFR part 1065, subpart H, for all the testing we require in this part, except as specified in §1045.515.

(1) Use gasoline meeting the specifications described in 40 CFR 1065.710(c) for general testing. For service accumulation, use the test fuel or any commercially available fuel that is representative of the fuel that in-use engines will use.

(2) You may alternatively use ethanol-blended fuel meeting the specifications described in 40 CFR 1065.710(b) for general testing without our advance approval. If you use the ethanol-blended fuel for certifying a given engine family, you may also use it for production-line testing or any other testing you perform for that engine family under this part. If you use the ethanol-blended fuel for certifying a given engine family, we may use the ethanol-blended fuel or the specified neat gasoline test fuel with that engine family.

* * * * *

229. Revise Appendix 1 to part 1045 to read as follows:

Appendix I to Part 1045— Summary of Previous Emission Standards

(a) The following standards, which EPA originally adopted under 40 CFR part 91, apply to outboard and personal watercraft engines produced from model year 2006 through 2009:

(1) For engines at or below 4.3 kW, the HC+NOx standard is 81.00 g/kW-hr.

(2) For engines above 4.3 kW, the following HC+NOx standard applies:

HC+NOx standard = (151 + 557/P0.9) · 0.250 + 6.00

Where:

STD = The HC+NOx emission standard, in g/kW-hr.

P = The average power of an engine family, in kW.

(b) Table 1 of this appendix describes the phase-in standards for outboard and personal watercraft engines for model years 1998 through 2005. For engines with maximum engine power above 4.3 kW, the standard is expressed by the following formula, in g/kW-hr, with constants for each year identified in Table 1 of this appendix:

$$HC + NOx\,\text{standard} = \left(151 + \frac{557}{P^{0.9}}\right) \cdot A + B$$

Table 1 of Appendix I—HC+NOx Phase-in Standards for Outboard and Personal Watercraft Engines

Model Year	Maximum engine power < 4.3 kW	Maximum engine power > 4.3 kW	
		A	B
1998	278.00	0.917	2.44
1999	253.00	0.833	2.89
2000	228.00	0.750	3.33
2001	204.00	0.667	3.78
2002	179.00	0.583	4.22
2003	155.00	0.500	4.67
2004	130.00	0.417	5.11
2005	105.00	0.333	5.56

PART 1048—CONTROL OF EMISSIONS FROM NEW, LARGE NONROAD SPARK-IGNITION ENGINES

230. The authority statement for part 1048 continues to read as follows:
Authority: 42 U.S.C. 7401-7671q.

231. Revise §1048.145 to read as follows:

§1048.145 Are there interim provisions that apply only for a limited time?

The provisions in this section apply instead of other provisions in this part. This section describes when these interim provisions expire.

(a) – (f) [Reserved]

(g) *Small-volume provisions*. If you qualify for the hardship provisions in §1068.250 of this chapter, we may approve extensions of up to four years total.

232. Revise §1048.255 to read as follows:

§1048.255 What decisions may EPA make regarding a certificate of conformity?

(a) If we determine an application is complete and shows that the engine family meets all the requirements of this part and the Act, we will issue a certificate of conformity for the engine family for that model year. We may make the approval subject to additional conditions.

(b) We may deny an application for certification if we determine that an engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.

(3) Cause any test data to become inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce engines for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend an application to include all engines being produced.

(7) Take any action that otherwise circumvents the intent of the Act or this part.

(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Act. Note that these are also violations of 40 CFR 1068.101(a)(2).

(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete after submission.

(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1048.820).

233. Amend §1048.501 by revising paragraph (c) to read as follows:

§1048.501 How do I run a valid emission test?

* * * * *

(c) Use the fuels and lubricants specified in 40 CFR part 1065, subpart H, to perform valid tests for all the testing we require in this part, except as noted in §1048.515.

(1) Use gasoline meeting the specifications described in 40 CFR 1065.710(c) for general testing. For service accumulation, use the test fuel or any commercially available fuel that is representative of the fuel that in-use engines will use.

(2) You may alternatively use ethanol-blended fuel meeting the specifications described in 40 CFR 1065.710(b) for general testing without our advance approval. If you use the ethanol-blended fuel for certifying a given engine family, you may also use it for production-line testing or any other testing you perform for that engine family under this part. If you use the ethanol-blended fuel for certifying a given engine family, we may use the ethanol-blended fuel or the specified neat gasoline test fuel with that engine family.

* * * * *

PART 1051—CONTROL OF EMISSIONS FROM RECREATIONAL ENGINES AND VEHICLES

234. The authority statement for part 1051 continues to read as follows:

Authority: 42 U.S.C. 7401-7671q.

235. Revise §1051.145 to read as follows:

§1051.145 What provisions apply only for a limited time?

(a) Apply the provisions in this section instead of others in this part for the periods and circumstances specified in this section.

(b) [Reserved]

236. Revise §1051.255 to read as follows:

§1051.255 What decisions may EPA make regarding a certificate of conformity?

(a) If we determine an application is complete and shows that the engine family meets all the requirements of this part and the Act, we will issue a certificate of conformity for the engine family for that model year. We may make the approval subject to additional conditions.
(b) We may deny an application for certification if we determine that an engine family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.
(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.

(3) Cause any test data to become inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce engines for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend an application to include all engines being produced.

(7) Take any action that otherwise circumvents the intent of the Act or this part.

(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Clean Air Act. Note that these are also violations of 40 CFR 1068.101(a)(2).
(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete after submission.
(f) If we deny an application or suspend, revoke, or void a certificate, you may ask for a hearing (see §1051.820).

237. Amend §1051.310 by revising paragraph (a)(1) introductory text and paragraph (a)(1)(iv) to read as follows:

§1051.310 How must I select vehicles or engines for production-line testing?

(a) * * *

(1) For engine families with projected U.S.-directed production volume of at least 1,600, the test periods are defined as follows:

* * * * *

(iv) If your annual production period is 301 days or longer, divide the annual production period evenly into four test periods. For example, if your annual production period is 392 days (56 weeks), divide the annual production period into four test periods of 98 days (14 weeks).

* * * * *

238. Amend §1051.501 by revising paragraph (d) to read as follows:

§1051.501 What procedures must I use to test my vehicles or engines?

* * * * *

(d) *Fuels*. Use the fuels meeting the following specifications:

(1) *Exhaust*. Use the fuels and lubricants specified in 40 CFR part 1065, subpart H, for all the exhaust testing we require in this part. For service accumulation, use the test fuel or any commercially available fuel that is representative of the fuel that in-use engines will use. The following provisions apply for using specific fuel types:

(i) For gasoline-fueled engines, use the grade of gasoline specified in 40 CFR 1065.710(c) for general testing. You may alternatively use ethanol-blended fuel meeting the specifications described in 40 CFR 1065.710(b) for general testing without our advance approval. If you use the ethanol-blended fuel for certifying a given engine family, you may also use it for production-line testing or any other testing you perform for that engine family under this part. If you use the ethanol-blended fuel for certifying a given engine family, we may use the ethanol-blended fuel or the specified neat gasoline test fuel with that engine family.

(ii) For diesel-fueled engines, use either low-sulfur diesel fuel or ultra low-sulfur diesel fuel meeting the specifications in 40 CFR 1065.703. If you use sulfur-sensitive technology as defined in 40 CFR 1039.801 and you measure emissions using ultra low-sulfur diesel fuel, you must add a permanent label near the fuel inlet with the following statement: "ULTRA LOW SULFUR FUEL ONLY".

(2) *Fuel Tank Permeation*. (i) For the preconditioning soak described in §1051.515(a)(1) and fuel slosh durability test described in §1051.515(d)(3), use the fuel specified in 40 CFR 1065.710(b), or the fuel specified in 40 CFR 1065.710(c) blended with 10 percent ethanol by volume. As an alternative, you may use Fuel CE10, which is Fuel C as specified in ASTM D 471-98 (see 40 CFR 1060.810) blended with 10 percent ethanol by volume.

(ii) For the permeation measurement test in §1051.515(b), use the fuel specified in 40 CFR 1065.710(c). As an alternative, you may use any of the fuels specified in paragraph (d)(2)(i) of this section.

(3) *Fuel Hose Permeation*. Use the fuel specified in 40 CFR 1065.710(b), or the fuel specified in 40 CFR 1065.710(c) blended with 10 percent ethanol by volume for permeation testing of fuel lines. As an alternative, you may use Fuel CE10, which is Fuel C as specified in ASTM D 471-98 (see 40 CFR 1060.810) blended with 10 percent ethanol by volume.

* * * * *

PART 1054—CONTROL OF EMISSIONS FROM NEW, SMALL NONROAD SPARK-IGNITION ENGINES AND EQUIPMENT

239. The authority statement for part 1054 continues to read as follows:
Authority: 42 U.S.C. 7401-7671q.

240. Amend §1054.1 by revising paragraphs (a)(1) and (5), (c), and (d) to read as follows:

§1054.1 Does this part apply for my engines and equipment?

(a) * * *

(1) The requirements of this part related to exhaust emissions apply to new, nonroad spark-ignition engines with maximum engine power at or below 19 kW. This includes auxiliary marine spark-ignition engines.

* * * * *

(5) We specify provisions in §1054.145(f) and in §1054.740 that allow for meeting the requirements of this part before the dates shown in Table 1 to this section. Engines, fuel-system

components, or equipment certified to these standards are subject to all the requirements of this part as if these optional standards were mandatory.
* * * * *
(c) Engines originally meeting Phase 1 or Phase 2 standards as specified in Appendix I remain subject to those standards. Those engines remain subject to recall provisions as specified in 40 CFR part 1068, subpart F, throughout the useful life corresponding to the original certification. Also, tampering and defeat-device prohibitions continue to apply for those engines as specified in 40 CFR 1068.101.
(d) The regulations in this part 1054 optionally apply to engines with maximum engine power at or below 30 kW and with displacement at or below 1,000 cubic centimeters that would otherwise be covered by 40 CFR part 1048. See 40 CFR 1048.615 for provisions related to this allowance.
* * * * *

241. Revise §1054.2 to read as follows:

§1054.2 Who is responsible for compliance?

(a) The requirements and prohibitions of this part apply to manufacturers of engines and equipment, as described in §1054.1. The requirements of this part are generally addressed to manufacturers subject to this part's requirements. The term "you" generally means the certifying manufacturer. For provisions related to exhaust emissions, this generally means the engine manufacturer, especially for issues related to certification (including production-line testing, reporting, etc.). For provisions related to certification with respect to evaporative emissions, this generally means the equipment manufacturer. Note that for engines that become new after being placed into service (such as engines converted from highway or stationary use), the requirements that normally apply for manufacturers of freshly manufactured engines apply to the importer or any other entity we allow to obtain a certificate of conformity.
(b) Equipment manufacturers must meet applicable requirements as described in §1054.20. Engine manufacturers that assemble an engine's complete fuel system are considered to be the equipment manufacturer with respect to evaporative emissions (see 40 CFR 1060.5). Note that certification requirements for component manufacturers are described in 40 CFR part 1060.

242. Revise §1054.30 to read as follows:

§1054.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see §1054.801). See §1054.825 for additional reporting and recordkeeping provisions.

243. Amend §1054.103 by revising paragraph (c) introductory text to read as follows:

§1054.103 What exhaust emission standards must my handheld engines meet?

* * * * *
(c) *Fuel types*. The exhaust emission standards in this section apply for engines using the fuel type on which the engines in the emission family are designed to operate. You must meet the numerical emission standards for hydrocarbon in this section based on the following types of hydrocarbon emissions for engines powered by the following fuels:
* * * * *

244. Amend §1054.105 by revising paragraph (c) introductory text to read as follows:

§1054.105 What exhaust emission standards must my nonhandheld engines meet?
* * * * *
(c) *Fuel types*. The exhaust emission standards in this section apply for engines using the fuel type on which the engines in the emission family are designed to operate. You must meet the numerical emission standards for hydrocarbon in this section based on the following types of hydrocarbon emissions for engines powered by the following fuels:
* * * * *
245. Amend §1054.110 by revising paragraph (b) to read as follows:
§1054.110 What evaporative emission standards must my handheld equipment meet?
* * * * *
(b) *Tank permeation*. Fuel tanks must meet the permeation requirements specified in 40 CFR 1060.103. These requirements apply for handheld equipment starting in the 2010 model year, except that they apply starting in the 2011 model year for structurally integrated nylon fuel tanks, in the 2012 model year for handheld equipment using nonhandheld engines, and in the 2013 model year for all small-volume emission families. For nonhandheld equipment using engines at or below 80 cc, the requirements of this paragraph (b) apply starting in the 2012 model year. You may generate or use emission credits to show compliance with the requirements of this paragraph (b) under the averaging, banking, and trading program as described in subpart H of this part. FEL caps apply as specified in §1054.112(b)(1) through (3) starting in the 2015 model year.
* * * * *

246. Amend §1054.120 by revising paragraph (c) to read as follows:
§1054.120 What emission-related warranty requirements apply to me?
* * * * *
(c) *Components covered*. The emission-related warranty covers all components whose failure would increase an engine's emissions of any regulated pollutant, including components listed in 40 CFR part 1068, Appendix I, and components from any other system you develop to control emissions. The emission-related warranty covers these components even if another company produces the component. Your emission-related warranty does not need to cover components whose failure would not increase an engine's emissions of any regulated pollutant.
* * * * *

247. Amend §1054.125 by revising the introductory text and paragraphs (c) and (e) to read as follows:
§1054.125 What maintenance instructions must I give to buyers?
Give the ultimate purchaser of each new engine written instructions for properly maintaining and using the engine, including the emission control system as described in this section. The maintenance instructions also apply to service accumulation on your emission-data engines as described in §1054.245 and in 40 CFR part 1065.
* * * * *
(c) *Special maintenance*. You may specify more frequent maintenance to address problems related to special situations, such as atypical engine operation. You must clearly state that this additional maintenance is associated with the special situation you are addressing. You may also address maintenance of low-use engines (such as recreational or stand-by engines) by specifying the maintenance interval in terms of calendar months or years in addition to your specifications in terms of engine operating hours. All special maintenance instructions must be consistent with

good engineering judgment. We may disapprove your maintenance instructions if we determine that you have specified special maintenance steps to address engine operation that is not atypical, or that the maintenance is unlikely to occur in use. For example, this paragraph (c) does not allow you to design engines that require special maintenance for a certain type of expected operation. If we determine that certain maintenance items do not qualify as special maintenance under this paragraph (c), you may identify this as recommended additional maintenance under paragraph (b) of this section.

* * * * *

(e) *Maintenance that is not emission-related*. For maintenance unrelated to emission controls, you may schedule any amount of inspection or maintenance. You may also take these inspection or maintenance steps during service accumulation on your emission-data engines, as long as they are reasonable and technologically necessary. This might include adding engine oil, changing fuel or oil filters, servicing engine-cooling systems, and adjusting idle speed, governor, engine bolt torque, valve lash, or injector lash. You may not perform this nonemission-related maintenance on emission-data engines more often than the least frequent intervals that you recommend to the ultimate purchaser.

* * * * *

248. Amend §1054.130 by revising paragraphs (b)(2) and (5) to read as follows:

§1054.130 What installation instructions must I give to equipment manufacturers?

* * * * *

(b) * * *

(2) State: "Failing to follow these instructions when installing a certified engine in a piece of equipment violates federal law (40 CFR 1068.105(b)), subject to fines or other penalties as described in the Clean Air Act."

* * * * *

(5) Describe how your certification is limited for any type of application. For example, if you certify engines only for rated-speed applications, tell equipment manufacturers that the engine must not be installed in equipment involving intermediate-speed operation. Also, if your wintertime engines are not certified to the otherwise applicable HC+NOx standards, tell equipment manufacturers that the engines must be installed in equipment that is used only in wintertime.

* * * * *

249. Amend §1054.135 by revising paragraphs (c)(2) and (e)(1) to read as follows:

§1054.135 How must I label and identify the engines I produce?

* * * * *

(c) * * *

(2) Include your full corporate name and trademark. You may identify another company and use its trademark instead of yours if you comply with the branding provisions of 40 CFR 1068.45.

* * * * *

(e) * * *

(1) You may identify other emission standards that the engine meets or does not meet (such as California standards), as long as this does not cause you to omit any of the information described in paragraph (c) of this section. You may include this information by adding it to the statement we specify or by including a separate statement.

*   *   *   *   *

250. Revise §1054.145 to read as follows:

§1054.145 Are there interim provisions that apply only for a limited time?

The provisions in this section apply instead of other provisions in this part. This section describes how and when these interim provisions apply.

(a) – (b) [Reserved]

(c) *Special provisions for handheld engines*. Handheld engines subject to Phase 3 emission standards must meet the standards at or above barometric pressures of 96.0 kPa in the standard configuration and are not required to meet emission standards at lower barometric pressures. This is intended to allow testing under most weather conditions at all altitudes up to 1,100 feet above sea level. In your application for certification, identify the altitude above which you rely on an altitude kit and describe your plan for making information and parts available such that you would reasonably expect that altitude kits would be widely used at all such altitudes.

(d) *Alignment of model years for exhaust and evaporative standards*. Evaporative emission standards generally apply based on the model year of the equipment, which is determined by the equipment's date of final assembly. However, in the first year of new emission standards, equipment manufacturers may apply evaporative emission standards based on the model year of the engine as shown on the engine's emission control information label. For example, for the fuel line permeation standards starting in 2012, equipment manufacturers may order a batch of 2011 model year engines for installation in 2012 model year equipment, subject to the anti-stockpiling provisions of 40 CFR 1068.105(a). The equipment with the 2011 model year engines would not need to meet fuel line permeation standards, as long as the equipment is fully assembled by December 31, 2012.

(e) [Reserved]

(f) *Early banking for evaporative emission standards—handheld equipment manufacturers*. You may earn emission credits for handheld equipment you produce before the evaporative emission standards of §1054.110 apply. To do this, your equipment must use fuel tanks with a family emission limit below 1.5 g/m2/day (or 2.5 g/m2/day for testing at 40°C). Calculate your credits as described in §1054.706 based on the difference between the family emission limit and 1.5 g/m2/day (or 2.5 g/m2/day for testing at 40°C).

(g) through (i) [Reserved]

(j) *Continued use of 40 CFR part 90 test data*. You may continue to use data based on the test procedures that apply for engines built before the requirements of this part 1054 start to apply if we allow you to use carryover emission data under 40 CFR 1054.235(d) for your emission family. You may also use those test procedures for measuring exhaust emissions for production-line testing with any engine family whose certification is based on testing with those procedures. For any EPA testing, we will rely on the procedures described in subpart F of this part, even if you used carryover data based on older test procedures as allowed under this paragraph (j).

(k) – (m) [Reserved]

(n) *California test fuel*. You may perform testing with a fuel meeting the requirements for certifying the engine in California instead of the fuel specified in §1054.501(b)(2), as follows:

(1) You may certify individual engine families using data from testing conducted with California Phase 2 test fuel through model year 2019. Any EPA testing with such an engine family may use either this same certification fuel or the test fuel specified in §1054.501.

(2) Starting in model year 2013, you may certify individual engine families using data from testing conducted with California Phase 3 test fuel. Any EPA testing with such an engine family may use either this same certification fuel or the test fuel specified in §1054.501, unless you certify to the more stringent CO standards specified in this paragraph (n)(2). If you meet these alternate CO standards, we will also use California Phase 3 test fuel for any testing we perform with engines from that engine family. The following alternate CO standards apply instead of the CO standards specified in §1054.103 or §1054.105:

Table 1 to §1054.145—Alternate CO Standards for Testing with California Phase 3 Test Fuel [g/kW-hr]

Engine type	Alternate CO standard
Class I	549
Class II	549
Class III	536
Class IV	536
Class V	536
Marine generators	4.5

251. Amend §1054.205 by revising paragraphs (o)(1), (p)(1), (v), and (x) to read as follows:

§1054.205 What must I include in my application?

* * * * *

(o) * * *

(1) Present emission data for hydrocarbon (such as THC, THCE, or NMHC, as applicable), NOx, and CO on an emission-data engine to show your engines meet the applicable exhaust emission standards as specified in §1054.101. Show emission figures before and after applying deterioration factors for each engine. Include test data from each applicable duty cycle specified in §1054.505(b). If we specify more than one grade of any fuel type (for example, low-temperature and all-season gasoline), you need to submit test data only for one grade, unless the regulations of this part specify otherwise for your engine.

* * * * *

(p) * * *

(1) Report all valid test results involving measurement of pollutants for which emission standards apply. Also indicate whether there are test results from invalid tests or from any other tests of the emission-data engine, whether or not they were conducted according to the test procedures of subpart F of this part. We may require you to report these additional test results. We may ask you to send other information to confirm that your tests were valid under the requirements of this part and 40 CFR parts 1060 and 1065.

* * * * *

(v) Provide the following information about your plans for producing and selling engines:

(1) Identify the estimated initial and final dates for producing engines from the engine family for the model year.

(2) Identify the estimated date for initially introducing certified engines into U.S. commerce under this certificate.

(3) Include good-faith estimates of U.S.-directed production volumes. Include a justification for the estimated production volumes if they are substantially different than actual production volumes in earlier years for similar models. Also indicate whether you expect the engine family to contain only nonroad engines, only stationary engines, or both.

* * * * *

(x) Include the information required by other subparts of this part. For example, include the information required by §1054.725 if you participate in the ABT program and include the information required by §1054.690 if you need to post a bond under that section.
* * * * *

252. Amend §1054.220 by revising the section heading to read as follows.

§1054.220 How do I amend my maintenance instructions?

* * * * *

253. Amend §1054.225 by:

a. Revising the section heading and paragraphs (b) and (f) introductory text; and

b. Adding paragraph (g).

The revisions and addition read as follows:

§1054.225 How do I amend my application for certification?

* * * * *

(b) To amend your application for certification, send the relevant information to the Designated Compliance Officer.

(1) Describe in detail the addition or change in the model or configuration you intend to make.

(2) Include engineering evaluations or data showing that the amended emission family complies with all applicable requirements. You may do this by showing that the original emission-data engine or emission-data equipment is still appropriate for showing that the amended family complies with all applicable requirements.

(3) If the original emission-data engine for the engine family is not appropriate to show compliance for the new or modified engine configuration, include new test data showing that the new or modified engine configuration meets the requirements of this part.

(4) Include any other information needed to make your application correct and complete.

* * * * *

(f) You may ask us to approve a change to your FEL with respect to exhaust emissions in certain cases after the start of production. The changed FEL may not apply to engines you have already introduced into U.S. commerce, except as described in this paragraph (f). If we approve a changed FEL after the start of production, you must identify the month and year for applying the new FEL. You may ask us to approve a change to your FEL in the following cases:

* * * * *

(g) You may produce engines as described in your amended application for certification and consider those engines to be in a certified configuration if we approve a new or modified engine configuration during the model year under paragraph (d) of this section. Similarly, you may modify in-use engines as described in your amended application for certification and consider those engines to be in a certified configuration if we approve a new or modified engine configuration at any time under paragraph (d) of this section. Modifying a new or in-use engine to be in a certified configuration does not violate the tampering prohibition of 40 CFR 1068.101(b)(1), as long as this does not involve changing to a certified configuration with a higher family emission limit.

254. Amend §1054.235 by revising the section heading and paragraphs (a), (b), (c), and (d) to read as follows:

§1054.235 What testing requirements apply for certification?
* * * * *
(a) Select an emission-data engine from each engine family for testing as described in 40 CFR 1065.401. Select a configuration and set adjustable parameters in a way that is most likely to exceed the HC+NOx standard, using good engineering judgment. Configurations must be tested as they will be produced, including installed governors, if applicable.
(b) Test your emission-data engines using the procedures and equipment specified in subpart F of this part. In the case of dual-fuel engines, measure emissions when operating with each type of fuel for which you intend to certify the engine. In the case of flexible-fuel engines, measure emissions when operating with the fuel mixture that is most likely to cause the engine to exceed the applicable HC+NOx emission standard, though you may ask us to instead perform tests with both fuels separately if you can show that intermediate mixtures are not likely to occur in use.
(c) We may perform confirmatory testing by measuring emissions from any of your emission-data engines or other engines from the emission family, as follows:
(1) We may decide to do the testing at your plant or any other facility. If we do this, you must deliver the engine to a test facility we designate. The engine you provide must include appropriate manifolds, aftertreatment devices, electronic control units, and other emission-related components not normally attached directly to the engine block. If we do the testing at your plant, you must schedule it as soon as possible and make available the instruments, personnel, and equipment we need.
(2) If we measure emissions on one of your engines, the results of that testing become the official emission results for the engine.
(3) We may set the adjustable parameters of your engine to any point within the physically adjustable ranges (see §1054.115(b)).
(4) Before we test one of your engines, we may calibrate it within normal production tolerances for anything we do not consider an adjustable parameter. For example, this would apply for a parameter that is subject to production variability because it is adjustable during production, but is not considered an adjustable parameter (as defined in §1054.801) because it is permanently sealed.
(d) You may ask to use carryover emission data from a previous model year instead of doing new tests, but only if all the following are true:
(1) The emission family from the previous model year differs from the current emission family only with respect to model year, items identified in §1054.225(a), or other characteristics unrelated to emissions. We may waive this criterion for differences we determine not to be relevant.
(2) The emission-data engine from the previous model year remains the appropriate emission-data engine under paragraph (b) of this section.
(3) The data show that the emission-data engine would meet all the requirements that apply to the emission family covered by the application for certification.
* * * * *

255. Amend §1054.240 by revising paragraphs (a), (b), (c), and (d) to read as follows:
§1054.240 How do I demonstrate that my emission family complies with exhaust emission standards?
(a) For purposes of certification, your emission family is considered in compliance with the emission standards in §1054.101(a) if all emission-data engines representing that family have

test results showing official emission results and deteriorated emission levels at or below these standards. This also applies for all test points for emission-data engines within the family used to establish deterioration factors. Note that your FELs are considered to be the applicable emission standards with which you must comply if you participate in the ABT program in subpart H of this part.
(b) Your engine family is deemed not to comply if any emission-data engine representing that family has test results showing an official emission result or a deteriorated emission level for any pollutant that is above an applicable emission standard. This also applies for all test points for emission-data engines within the family used to establish deterioration factors.
(c) Determine a deterioration factor to compare emission levels from the emission-data engine with the applicable emission standards. Section 1054.245 specifies how to test engines to develop deterioration factors that represent the expected deterioration in emissions over your engines' full useful life. Calculate a multiplicative deterioration factor as described in §1054.245(b). If the deterioration factor is less than one, use one. Specify the deterioration factor to one more significant figure than the emission standard. In the case of dual-fuel and flexible-fuel engines, apply deterioration factors separately for each fuel type. You may use assigned deterioration factors that we establish for up to 10,000 nonhandheld engines from small-volume emission families in each model year, except that small-volume engine manufacturers may use assigned deterioration factors for any or all of their engine families.
(d) Determine the official emission result for each pollutant to at least one more decimal place than the applicable standard. Apply the deterioration factor to the official emission result, as described in §1054.245(b), then round the adjusted figure to the same number of decimal places as the emission standard. Compare the rounded emission levels to the emission standard for each emission-data engine. In the case of HC+NOx standards, add the official emission results and apply the deterioration factor to the sum of the pollutants before rounding. However, if your deterioration factors are based on emission measurements that do not cover the engine's full useful life, apply deterioration factors to each pollutant and then add the results before rounding.
* * * * *

256. Amend §1054.245 by:
a. Revising paragraphs (a), (b)(1), (b)(2), (b)(3), (b)(5), and (c); and
b. Adding paragraph (d).
The revisions and addition read as follows:

§1054.245 How do I determine deterioration factors from exhaust durability testing?

* * * * *

(a) You may ask us to approve deterioration factors for an emission family based on emission measurements from similar engines if you have already given us these data for certifying other engines in the same or earlier model years. Use good engineering judgment to decide whether the two engines are similar. We will approve your request if you show us that the emission measurements from other engines reasonably represent in-use deterioration for the engine family for which you have not yet determined deterioration factors.
(b) * * *
(1) Measure emissions from the emission-data engine at a low-hour test point, at the midpoint of the useful life, and at the end of the useful life, except as specifically allowed by this paragraph (b). You may test at additional evenly spaced intermediate points. Collect

emission data using measurements to at least one more decimal place than the emission standard.

(2) Operate the engine over a duty cycle that is representative of in-use operation for a period at least as long as the useful life (in hours). You may operate the engine continuously. You may also use an engine installed in nonroad equipment to accumulate service hours instead of running the engine only in the laboratory.

(3) In the case of dual-fuel or flexible-fuel engines, you may accumulate service hours on a single emission-data engine using the type or mixture of fuel expected to have the highest combustion and exhaust temperatures; you may ask us to approve a different fuel mixture for flexible-fuel engines if you demonstrate that a different criterion is more appropriate. For dual-fuel engines, you must measure emissions on each fuel type at each test point, either with separate engines dedicated to a given fuel, or with different configurations of a single engine.

* * * * *

(5) Calculate your deterioration factor using a linear least-squares fit of your test data but treat the low-hour test point as occurring at hour zero. Your deterioration factor is the ratio of the calculated emission level at the point representing the full useful life to the calculated emission level at zero hours, expressed to one more significant figure than the emission standard.

* * * * *

(c) If you qualify for using assigned deterioration factors under §1054.240, determine the deterioration factors as follows:

(1) For two-stroke engines without aftertreatment, use a deterioration factor of 1.1 for HC, NOx, and CO. For four-stroke engines without aftertreatment, use deterioration factors of 1.4 for HC, 1.0 for NOx, and 1.1 for CO for Class 2 engines, and use 1.5 for HC and NOx, and 1.1 for CO for all other engines.

(2) For Class 2 engines with aftertreatment, use a deterioration factor of 1.0 for NOx. For all other cases involving engines with aftertreatment, calculate separate deterioration factors for HC, NOx, and CO using the following equation:

$$DF = \frac{NE \cdot EDF - CC \cdot F}{NE - CC}$$

Where:

NE = engine-out emission levels (pre-catalyst) from the low-hour test result for a given pollutant, in g/kW-hr.

EDF = the deterioration factor specified in paragraph (c)(1) of this section for the type of engine for a given pollutant.

CC = the catalyst conversion from the low-hour test, in g/kW-hr. This is the difference between the official emission result and *NE*.

F = 1.0 for NOx and 0.8 for HC and CO.

(3) Combine separate deterioration factors for HC and NOx from paragraph (c)(2) of this section into a combined deterioration factor for HC+NOx using the following equation:

$$DF_{\mathrm{HC+NOx}} = \frac{(NE_{\mathrm{HC}} - CC_{\mathrm{HC}}) \cdot DF_{\mathrm{HC}} + (NE_{\mathrm{NOx}} - CC_{\mathrm{NOx}}) \cdot DF_{\mathrm{NOx}}}{(NE_{\mathrm{HC}} - CC_{\mathrm{HC}}) + (NE_{\mathrm{NOx}} - CC_{\mathrm{NOx}})}$$

(d) Include the following information in your application for certification:

(1) If you determine your deterioration factors based on test data from a different emission family, explain why this is appropriate and include all the emission measurements on which you base the deterioration factor.

(2) If you do testing to determine deterioration factors, describe the form and extent of service accumulation, including the method you use to accumulate hours.

(3) If you calculate deterioration factors under paragraph (c) of this section, identify the parameters and variables you used for the calculation.

257. Amend §1054.250 by:

a. Removing and reserving paragraph (a)(3); and

b. Revising paragraphs (b)(3)(iv) and (c).

The revisions read as follows:

§1054.250 What records must I keep and what reports must I send to EPA?

* * * * *

(b) * * *

(3) * * *

(iv) All your emission tests (valid and invalid), including the date and purpose of each test and documentation of test parameters as specified in part 40 CFR part 1065.

* * * * *

(c) Keep required data from emission tests and all other information specified in this section for eight years after we issue your certificate. If you use the same emission data or other information for a later model year, the eight-year period restarts with each year that you continue to rely on the information.

* * * * *

258. Revise §1054.255 to read as follows:

§1054.255 What decisions may EPA make regarding a certificate of conformity?

(a) If we determine an application is complete and shows that the emission family meets all the requirements of this part and the Clean Air Act, we will issue a certificate of conformity for the emission family for that model year. We may make the approval subject to additional conditions.

(b) We may deny an application for certification if we determine that an emission family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing, reporting, or bonding requirements.

(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.

(3) Cause any test data to become inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce engines or equipment for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend an application to include all engines or equipment being produced.

(7) Take any action that otherwise circumvents the intent of the Clean Air Act or this part.
(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Clean Air Act. Note that these are also violations of 40 CFR 1068.101(a)(2).
(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting your application that causes the submitted information to be false or incomplete.
(f) If we deny an application or suspend, revoke, or void a certificate of conformity, you may ask for a hearing (see §1054.820).

259. Amend §1054.301 by revising paragraph (a)(2) to read as follows:

§1054.301 When must I test my production-line engines?

(a) * * *

(2) We may exempt small-volume emission families from routine testing under this subpart. Submit your request for approval as described in §1054.210. In your request, describe your basis for projecting a production volume below 5,000 units. We will approve your request if we agree that you have made good-faith estimates of your production volumes. You must promptly notify us if your actual production exceeds 5,000 units during the model year. If you exceed the production limit or if there is evidence of a nonconformity, we may require you to test production-line engines under this subpart, or under 40 CFR part 1068, subpart E, even if we have approved an exemption under this paragraph (a)(2).

* * * * *

260. Amend §1054.310 by revising paragraph (a)(1) introductory text, paragraphs (a)(1)(iv), and (c)(2) introductory text to read as follows:

§1054.310 How must I select engines for production-line testing?

(a) * * *

(1) For engine families with projected U.S.-directed production volume of at least 1,600, the test periods are defined as follows:

* * * * *

(iv) If your annual production period is 301 days or longer, divide the annual production period evenly into four test periods. For example, if your annual production period is 392 days (56 weeks), divide the annual production period into four test periods of 98 days (14 weeks).

* * * * *

(c) * * *

(2) Calculate the standard deviation, σ, for the test sample using the following formula:

* * * * *

261. Amend §1054.315 by revising paragraph (a)(1) to read as follows:

§1054.315 How do I know when my engine family fails the production-line testing requirements?

* * * * *

(a) * * *

(1) *Initial and final test results*. Calculate and round the test results for each engine. If you do multiple tests on an engine in a given configuration (without modifying the engine), calculate the

initial results for each test, then add all the test results together and divide by the number of tests. Round this final calculated value for the final test results on that engine.

* * * * *

262. Amend §1054.320 by adding paragraph (c) to read as follows:

§1054.320 What happens if one of my production-line engines fails to meet emission standards?

* * * * *

(c) Use test data from a failing engine for the compliance demonstration under §1054.315 as follows:

(1) Use the original, failing test results as described in §1054.315, whether or not you modify the engine or destroy it.

(2) Do not use test results from a modified engine as final test results under §1054.315, unless you change your production process for all engines to match the adjustments you made to the failing engine. If this occurs, count the modified engine as the next engine in the sequence, rather than averaging the results with the testing that occurred before modifying the engine.

263. Amend §1054.501 by revising paragraphs (b)(1) and (2) and paragraph (b)(4) introductory text to read as follows:

§1054.501 How do I run a valid emission test?

* * * * *

(b) * * *

(1) Measure the emissions of all exhaust constituents subject to emission standards as specified in §1054.505 and 40 CFR part 1065. Measure CO_2, N_2O, and CH_4 as described in §1054.235. See §1054.650 for special provisions that apply for variable-speed engines (including engines shipped without governors).

(2) Use the appropriate fuels and lubricants specified in 40 CFR part 1065, subpart H, for all the testing we require in this part. Gasoline test fuel must meet the specifications in 40 CFR 1065.710(c), except as specified in §1054.145(n), 40 CFR 1065.10, and 40 CFR 1065.701. Use gasoline specified for general testing except as specified in paragraph (d) of this section. For service accumulation, use the test fuel or any commercially available fuel that is representative of the fuel that in-use engines will use. Note that §1054.145(n) allows for testing with gasoline test fuels specified by the California Air Resources Board for any individual engine family.

* * * * *

(4) The provisions of 40 CFR 1065.405 describe how to prepare an engine for testing. However, you may consider emission levels stable without measurement after 12 hours of engine operation, except for the following special provisions that apply for engine families with a useful life of 300 hours or less:

* * * * *

264. Amend §1054.505 by revising paragraph (b)(2) to read as follows:

§1054.505 How do I test engines?

* * * * *

(b) * * *

(2) For nonhandheld engines, use the six-mode duty cycle or the corresponding ramped-modal cycle described in paragraph (b) of Appendix II of this part. Control engine speeds and torques

during idle mode as specified in paragraph (c) of this section. Control engine speed during the full-load operating mode as specified in paragraph (d) of this section. For all other modes, control engine speed to within 5 percent of the nominal speed specified in paragraph (d) of this section or let the installed governor (in the production configuration) control engine speed. For all modes except idle, control torque as needed to meet the cycle-validation criteria in paragraph (a)(1) of this section. The governor may be adjusted before emission sampling to target the nominal speed identified in paragraph (d) of this section, but the installed governor must control engine speed throughout the emission-sampling period whether the governor is adjusted or not. Note that ramped-modal testing involves continuous sampling, so governor adjustments may not occur during such a test. Note also that our testing may involve running the engine with the governor in the standard configuration even if you adjust the governor as described in this paragraph (b)(2) for certification or production-line testing.
* * * * *

265. Amend §1054.601 by adding paragraph (d) to read as follows:
§1054.601 What compliance provisions apply?
* * * * *
(d) Subpart C of this part describes how to test and certify dual-fuel and flexible-fuel engines. Some multi-fuel engines may not fit either of those defined terms. For such engines, we will determine whether it is most appropriate to treat them as single-fuel engines, dual-fuel engines, or flexible-fuel engines based on the range of possible and expected fuel mixtures.

266. Amend §1054.612 by revising the introductory text to read as follows:
§1054.612 What special provisions apply for equipment manufacturers modifying certified nonhandheld engines?
The provisions of this section are limited to small-volume emission families.
* * * * *

267. Amend §1054.620 by revising paragraph (c)(2) to read as follows:
§1054.620 What are the provisions for exempting engines used solely for competition?
* * * * *
(c) * * *
(2) Sale of the equipment in which the engine is installed must be limited to professional competition teams, professional competitors, or other qualified competitors. Engine manufacturers may sell loose engines to these same qualified competitors, and to equipment manufacturers supplying competition models for qualified competitors.
* * * * *

§§1054.625 and 1054.626 [Removed]
268. Remove §§1054.625 and 1054.626.

§1054.635 [Amended]
269. Amend §1054.635 by removing and reserving paragraph (c)(6).

§1054.640 [Removed]
270. Remove §1054.640.

271. Revise §1054.655 to read as follows:

§1054.655 What special provisions apply for installing and removing altitude kits?

An action for the purpose of installing or modifying altitude kits and performing other changes to compensate for changing altitude is not considered a prohibited act under 40 CFR 1068.101(b) if it is done consistent with the manufacturer's instructions.

272. Amend §1054.690 by revising paragraphs (f) and (i) to read as follows:

§1054.690 What bond requirements apply for certified engines?

* * * * *

(f) If you are required to post a bond under this section, you must get the bond from a third-party surety that is cited in the U.S. Department of Treasury Circular 570, "Companies Holding Certificates of Authority as Acceptable Sureties on Federal Bonds and as Acceptable Reinsuring Companies" (https://www.fiscal.treasury.gov/surety-bonds/circular-570.html). You must maintain this bond for every year in which you sell certified engines. The surety agent remains responsible for obligations under the bond for two years after the bond is cancelled or expires without being replaced.

* * * * *

(i) If you are required to post a bond under this section, you must note that in your application for certification as described in §1054.205. Your certification is conditioned on your compliance with this section. Your certificate is automatically suspended if you fail to comply with the requirements of this section. This suspension applies with respect to all engines in your possession as well as all engines being imported or otherwise introduced into U.S. commerce. For example, if you maintain a bond sufficient to cover 500 engines, you may introduce into U.S. commerce only 500 engines under your certificate; your certificate would be automatically suspended for any additional engines. Introducing such additional engines into U.S. commerce would violate 40 CFR 1068.101(a)(1). For importation, U.S. Customs may deny entry of engines lacking the necessary bond. This would apply if there is no bond, or if the value of the bond is not sufficient for the appropriate production volumes. We may also revoke your certificate.

* * * * *

273. Amend §1054.701 by revising paragraph (c)(2), paragraph (i) introductory text, and paragraph (i)(1) to read as follows:

§1054.701 General provisions.

* * * * *

(c) * * *

(2) Handheld engines and nonhandheld engines are in separate averaging sets with respect to exhaust emissions except as specified in §1054.740(e). You may use emission credits generated with Phase 2 engines for Phase 3 handheld engines only if you can demonstrate that those credits were generated by handheld engines, except as specified in §1054.740(e). Similarly, you may use emission credits generated with Phase 2 engines for Phase 3 nonhandheld engines only if you can demonstrate that those credits were generated by nonhandheld engines, subject to the provisions of §1054.740.

* * * * *

(i) As described in §1054.730, compliance with the requirements of this subpart is determined at the end of the model year based on actual U.S.-directed production volumes. Do not include any of the following engines or equipment to calculate emission credits:

(1) Engines or equipment with a permanent exemption under subpart G of this part or under 40 CFR part 1068.

* * * * *

274. Amend §1054.710 by revising paragraph (c) to read as follows:

§1054.710 How do I average emission credits?

* * * * *

(c) If you certify a family to an FEL that exceeds the otherwise applicable standard, you must obtain enough emission credits to offset the family's deficit by the due date for the final report required in §1054.730. The emission credits used to address the deficit may come from your other families that generate emission credits in the same model year, from emission credits you have banked from previous model years, or from emission credits generated in the same or previous model years that you obtained through trading.

275. Amend §1054.715 by revising paragraph (b) to read as follows:

§1054.715 How do I bank emission credits?

* * * * *

(b) You may designate any emission credits you plan to bank in the reports you submit under §1054.730 as reserved credits. During the model year and before the due date for the final report, you may designate your reserved emission credits for averaging or trading.

* * * * *

276. Amend §1054.725 by revising paragraph (b)(2) to read as follows:

§1054.725 What must I include in my application for certification?

* * * * *

(b) * * *

(2) Detailed calculations of projected emission credits (positive or negative) based on projected production volumes. We may require you to include similar calculations from your other engine families to demonstrate that you will be able to avoid negative credit balances for the model year. If you project negative emission credits for a family, state the source of positive emission credits you expect to use to offset the negative emission credits.

277. Amend §1054.730 by revising paragraphs (b)(1), (b)(3), (b)(4), (d)(1)(iii), and (d)(2)(iii) to read as follows:

§1054.730 What ABT reports must I send to EPA?

* * * * *

(b) * * *

(1) Family designation and averaging set.

* * * * *

(3) The FEL for each pollutant. If you change the FEL after the start of production, identify the date that you started using the new FEL and/or give the engine identification number for the first engine covered by the new FEL. In this case, identify each applicable FEL and calculate the positive or negative emission credits as specified in §1054.225.

(4) The projected and actual U.S.-directed production volumes for the model year as described in §1054.701(i). For fuel tanks, state the production volume in terms of surface area and production volume for each fuel tank configuration and state the total surface area for the emission family. If you changed an FEL during the model year, identify the actual U.S.-directed production volume associated with each FEL.

* * * * *

(d) * * *

(1) * * *

(iii) The averaging set corresponding to the families that generated emission credits for the trade, including the number of emission credits from each averaging set.

(2) * * *

(iii) How you intend to use the emission credits, including the number of emission credits you intend to apply for each averaging set.

* * * * *

278. Amend §1054.735 by revising paragraphs (a) and (b) to read as follows:

§1054.735 What records must I keep?

(a) You must organize and maintain your records as described in this section.

(b) Keep the records required by this section for at least eight years after the due date for the end-of-year report. You may not use emission credits for any engines or equipment if you do not keep all the records required under this section. You must therefore keep these records to continue to bank valid credits.

* * * * *

279. Amend §1054.740 by revising paragraph (c) and removing and reserving paragraph (d) to read as follows:

§1054.740 What special provisions apply for generating and using emission credits?

* * * * *

(c) You may not use emission credits generated by nonhandheld engines certified to Phase 2 emission standards to demonstrate compliance with the Phase 3 exhaust emission standards in 2014 and later model years.

* * * * *

280. Amend §1054.801 by:

a. Revising the definition for “Designated Compliance Officer”.

b. Removing the definition for “Dual-fuel engine”.

c. Adding a definition for “Dual-fuel” in alphabetical order.

d. Revising the definitions for “Engine configuration” and “Equipment manufacturer”.

e. Removing the definition for “Flexible-fuel engine”.

f. Adding a definition for “Flexible-fuel” in alphabetical order.

g. Revising the definitions for “Fuel type”, “Handheld”, “New nonroad engine”, “New nonroad equipment”, “Nonmethane hydrocarbon”. “Nonroad engine”, “Phase 1”, “Phase 2”, and “Placed into service”.

h. Removing the definition for “Pressurized oil system”.

i. Revising the definitions for “Small-volume emission family”, “Small-volume equipment manufacturer”, “Total hydrocarbon”, and “Total hydrocarbon equivalent”.

The new and revised definitions read as follows:

§1054.801 What definitions apply to this part?

* * * * *

Designated Compliance Officer means the Director, Gasoline Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; complianceinfo@epa.gov.

* * * * *

Dual-fuel means relating to an engine designed for operation on two different fuels but not on a continuous mixture of those fuels (see §1054.601(d)). For purposes of this part, such an engine remains a dual-fuel engine even if it is designed for operation on three or more different fuels.

* * * * *

Engine configuration means a unique combination of engine hardware and calibration within an emission family. Engines within a single engine configuration differ only with respect to normal production variability or factors unrelated to emissions.

* * * * *

Equipment manufacturer means a manufacturer of nonroad equipment. All nonroad equipment manufacturing entities under the control of the same person are considered to be a single nonroad equipment manufacturer.

* * * * *

Flexible-fuel means relating to an engine designed for operation on any mixture of two or more different fuels (see §1054.601(d)).

* * * * *

Fuel type means a general category of fuels such as gasoline or natural gas. There can be multiple grades within a single fuel type, such as premium gasoline, regular gasoline, or low-level ethanol-gasoline blends.

* * * * *

Handheld means relating to equipment that meets any of the following criteria:

(1) It is carried by the operator throughout the performance of its intended function.

(2) It is designed to operate multi-positionally, such as upside down or sideways, to complete its intended function.

(3) It has a combined engine and equipment dry weight under 16.0 kilograms, has no more than two wheels, and at least one of the following attributes is also present:

(i) The operator provides support or carries the equipment throughout the performance of its intended function. Carry means to completely bear the weight of the equipment, including the engine. Support means to hold a piece of equipment in position to prevent it from falling, slipping, or sinking, without carrying it.

(ii) The operator provides support or attitudinal control for the equipment throughout the performance of its intended function. Attitudinal control involves regulating the horizontal or vertical position of the equipment.

(4) It is an auger with a combined engine and equipment dry weight under 22.0 kilograms.

(5) It is used in a recreational application with a combined total vehicle dry weight under 20.0 kilograms.

(6) It is a hand-supported jackhammer or rammer/compactor. This does not include equipment that can remain upright without operator support, such as a plate compactor.

* * * * *

New nonroad engine means any of the following things:

(1) A freshly manufactured nonroad engine for which the ultimate purchaser has never received the equitable or legal title. This kind of engine might commonly be thought of as "brand new." In the case of this paragraph (1), the engine is new from the time it is produced until the ultimate purchaser receives the title or the product is placed into service, whichever comes first.
(2) An engine originally manufactured as a motor vehicle engine or a stationary engine that is later used or intended to be used in a piece of nonroad equipment. In this case, the engine is no longer a motor vehicle or stationary engine and becomes a "new nonroad engine." The engine is no longer new when it is placed into nonroad service. This paragraph (2) applies if a motor vehicle engine or a stationary engine is installed in nonroad equipment, or if a motor vehicle or a piece of stationary equipment is modified (or moved) to become nonroad equipment.
(3) A nonroad engine that has been previously placed into service in an application we exclude under §1054.5, when that engine is installed in a piece of equipment that is covered by this part 1054. The engine is no longer new when it is placed into nonroad service covered by this part 1054. For example, this would apply to a marine-propulsion engine that is no longer used in a marine vessel but is instead installed in a piece of nonroad equipment subject to the provisions of this part.
(4) An engine not covered by paragraphs (1) through (3) of this definition that is intended to be installed in new nonroad equipment. This generally includes installation of used engines in new equipment. The engine is no longer new when the ultimate purchaser receives a title for the equipment or the product is placed into service, whichever comes first.
(5) An imported nonroad engine, subject to the following provisions:
(i) An imported nonroad engine covered by a certificate of conformity issued under this part that meets the criteria of one or more of paragraphs (1) through (4) of this definition, where the original engine manufacturer holds the certificate, is new as defined by those applicable paragraphs.
(ii) An imported engine that will be covered by a certificate of conformity issued under this part, where someone other than the original engine manufacturer holds the certificate (such as when the engine is modified after its initial assembly), is a new nonroad engine when it is imported. It is no longer new when the ultimate purchaser receives a title for the engine or it is placed into service, whichever comes first.
(iii) An imported nonroad engine that is not covered by a certificate of conformity issued under this part at the time of importation is new. This addresses uncertified engines and equipment initially placed into service that someone seeks to import into the United States. Importation of this kind of engine (or equipment containing such an engine) is generally prohibited by 40 CFR part 1068. However, the importation of such an engine is not prohibited if the engine has a date of manufacture before January 1, 1997, since it is not subject to standards.
New nonroad equipment means either of the following things:
(1) A nonroad piece of equipment for which the ultimate purchaser has never received the equitable or legal title. The product is no longer new when the ultimate purchaser receives this title or the product is placed into service, whichever comes first.
(2) A nonroad piece of equipment with an engine that becomes new while installed in the equipment. For example, a complete piece of equipment that was imported without being covered by a certificate of conformity would be new nonroad equipment because the engine would be considered new at the time of importation.
* * * * *

Nonmethane hydrocarbon has the meaning given in 40 CFR 1065.1001. This generally means the difference between the emitted mass of total hydrocarbon and the emitted mass of methane.
* * * * *
Nonroad engine has the meaning given in 40 CFR 1068.30. In general, this means all internal-combustion engines except motor vehicle engines, stationary engines, engines used solely for competition, or engines used in aircraft.
* * * * *
Phase 1 means relating to the Phase 1 emission standards described in Appendix I of this part.
Phase 2 means relating to the Phase 2 emission standards described in Appendix I of this part.
* * * * *
Placed into service means put into initial use for its intended purpose. Engines and equipment do not qualify as being "placed into service" based on incidental use by a manufacturer or dealer.
* * * * *
Small-volume emission family means one of the following:
(1) For requirements related to exhaust emissions for nonhandheld engines and to exhaust and evaporative emissions for handheld engines, *small-volume emission family* means any emission family whose U.S.-directed production volume in a given model year is projected at the time of certification to be no more than 5,000 engines or pieces of equipment.
(2) For requirements related to evaporative emissions for nonhandheld equipment, *small-volume emission family* means any equipment manufacturer's U.S.-directed production volume for identical fuel tank is projected at the time of certification to be no more than 5,000 units. Tanks are generally considered identical if they are produced under a single part number to conform to a single design or blueprint. Tanks should be considered identical if they differ only with respect to production variability, post-production changes (such as different fittings or grommets), supplier, color, or other extraneous design variables.
* * * * *
Small-volume equipment manufacturer means one of the following:
(1) For handheld equipment, an equipment manufacturer that had a U.S.-directed production volume of no more than 25,000 pieces of handheld equipment in any calendar year. For manufacturers owned by a parent company, this production limit applies to the production of the parent company and all its subsidiaries.
(2) For nonhandheld equipment, an equipment manufacturer with annual U.S.-directed production volumes of no more than 5,000 pieces of nonhandheld equipment in any calendar year. For manufacturers owned by a parent company, this production limit applies to the production of the parent company and all its subsidiaries.
(3) An equipment manufacturer that we designate to be a small-volume equipment manufacturer under §1054.635.
* * * * *
Total hydrocarbon has the meaning given in 40 CFR 1065.1001. This generally means the combined mass of organic compounds measured by the specified procedure for measuring total hydrocarbon, expressed as an atomic hydrocarbon with an atomic hydrogen-to-carbon ratio of 1.85:1.
Total hydrocarbon equivalent has the meaning given in 40 CFR 1065.1001. This generally means the sum of the carbon mass contributions of non-oxygenated hydrocarbon, alcohols and aldehydes, or other organic compounds that are measured separately as contained in a gas

sample, expressed as exhaust hydrocarbon from petroleum-fueled engines. The atomic hydrogen-to-carbon ratio of the equivalent hydrocarbon is 1.85:1.
* * * * *

281. Revise §1054.815 to read as follows:

§1054.815 What provisions apply to confidential information?

The provisions of 40 CFR 1068.10 apply for information you consider confidential.

282. Revise §1054.825 to read as follows:

§1054.825 What reporting and recordkeeping requirements apply under this part?

(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. We may request these records at any time. You must promptly give us organized, written records in English if we ask for them. This applies whether or not you rely on someone else to keep records on your behalf. We may require you to submit written records in an electronic format.

(b) The regulations in §1054.255, 40 CFR 1068.25, and 40 CFR 1068.101 describe your obligation to report truthful and complete information. This includes information not related to certification. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties.

(c) Send all reports and requests for approval to the Designated Compliance Officer (see §1054.801).

(d) Any written information we require you to send to or receive from another company is deemed to be a required record under this section. Such records are also deemed to be submissions to EPA. We may require you to send us these records.

(e) Under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq*.), the Office of Management and Budget approves the reporting and recordkeeping specified in the applicable regulations. The following items illustrate the kind of reporting and recordkeeping we require for engines and equipment regulated under this part:

(1) We specify the following requirements related to engine and equipment certification in this part 1054:

(i) In §1054.20 we require equipment manufacturers to label their equipment if they are relying on component certification.

(ii) In §1054.135 we require engine manufacturers to keep certain records related to duplicate labels sent to equipment manufacturers.

(iii) In §1054.145 we include various reporting and recordkeeping requirements related to interim provisions.

(iv) In subpart C of this part we identify a wide range of information required to certify engines.

(v) In §§1054.345 and 1054.350 we specify certain records related to production-line testing.

(vi) [Reserved]

(vii) In subpart G of this part we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various special compliance provisions.

(viii) In §§1054.725, 1054.730, and 1054.735 we specify certain records related to averaging, banking, and trading.

(2) We specify the following requirements related to component and equipment certification in 40 CFR part 1060:

(i) In 40 CFR 1060.20 we give an overview of principles for reporting information.

(ii) In 40 CFR part 1060, subpart C, we identify a wide range of information required to certify products.

(iii) In 40 CFR 1060.301 we require manufacturers to keep records related to evaluation of production samples for verifying that the products are as specified in the certificate of conformity.

(iv) In 40 CFR 1060.310 we require manufacturers to make components, engines, or equipment available for our testing if we make such a request.

(v) In 40 CFR 1060.505 we specify information needs for establishing various changes to published test procedures.

(3) We specify the following requirements related to testing in 40 CFR part 1065:

(i) In 40 CFR 1065.2 we give an overview of principles for reporting information.

(ii) In 40 CFR 1065.10 and 1065.12 we specify information needs for establishing various changes to published test procedures.

(iii) In 40 CFR 1065.25 we establish basic guidelines for storing test information.

(iv) In 40 CFR 1065.695 we identify the specific information and data items to record when measuring emissions.

(4) We specify the following requirements related to the general compliance provisions in 40 CFR part 1068:

(i) In 40 CFR 1068.5 we establish a process for evaluating good engineering judgment related to testing and certification.

(ii) In 40 CFR 1068.25 we describe general provisions related to sending and keeping information.

(iii) In 40 CFR 1068.27 we require manufacturers to make engines available for our testing or inspection if we make such a request.

(iv) In 40 CFR 1068.105 we require equipment manufacturers to keep certain records related to duplicate labels from engine manufacturers.

(v) In 40 CFR 1068.120 we specify recordkeeping related to rebuilding engines.

(vi) In 40 CFR part 1068, subpart C, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various exemptions.

(vii) In 40 CFR part 1068, subpart D, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to importing engines.

(viii) In 40 CFR 1068.450 and 1068.455 we specify certain records related to testing production-line engines in a selective enforcement audit.

(ix) In 40 CFR 1068.501 we specify certain records related to investigating and reporting emission-related defects.

(x) In 40 CFR 1068.525 and 1068.530 we specify certain records related to recalling nonconforming engines.

(xi) In 40 CFR part 1068, subpart G, we specify certain records for requesting a hearing.

283. Revise Appendix I to part 1054 to read as follows:

Appendix I to Part 1054—Summary of Previous Emission Standards

The following standards, which EPA originally adopted under 40 CFR part 90, apply to nonroad spark-ignition engines produced before the model years specified in §1054.1:

(a) *Handheld engines*. (1) Phase 1 standards apply for handheld engines as summarized in the following table starting with model year 1997:

Table 1 to Appendix I—Phase 1 Emission Standards for Handheld Engines (g/kW-hr)[a]

Engine displacement class	HC	NOx	CO
Class III	295	5.36	805
Class IV	241	5.36	805
Class V	161	5.36	603

[a] Phase 1 standards are based on testing with new engines only.

(2) Phase 2 standards apply for handheld engines as summarized in the following table starting with model year 2002 for Class III and Class IV, and starting in model year 2004 for Class V:

Table 2 to Appendix I—Phase 2 Emission Standards for Handheld Engines (g/kW-hr)

Engine displacement class	HC + NOx	CO
Class III	50[a]	805
Class IV	50[b]	805
Class V	72[c]	603

[a]Class III engines had alternate HC+NOx standards of 238, 175, and 113 for model years 2002, 2003, and 2004, respectively.
[b]Class IV engines had alternate HC+NOx standards of 196, 148, and 99 for model years 2002, 2003, and 2004, respectively.
[c]Class V engines had alternate HC+NOx standards of 143, 119, and 96 for model years 2004, 2005, and 2006, respectively.

(b) *Nonhandheld engines*. (1) Phase 1 standards apply for nonhandheld engines as summarized in the following table starting with model year 1997:

Table 3 to Appendix I—Phase 1 Emission Standards for Nonhandheld Engines (g/kW-hr)[a]

Engine displacement class	HC + NOx	CO
Class I	16.1	519
Class II	13.4	519

[a]Phase 1 standards are based on testing with new engines only.

(2) Phase 2 standards apply for nonhandheld engines as summarized in the following table starting with model year 2001 (except as noted for Class I engines):

Table 4 to Appendix I—Phase 2 Emission Standards for Nonhandheld Engines (g/kW-hr)

Engine displacement class	HC + NOx	NMHC + NOx	CO
Class I-A	50	—	610
Class I-B	40	37	610
Class I[a]	16.1	14.8	610
Class II[b]	12.1	11.3	610

[a]The Phase 2 standards for Class I engines apply for new engines produced starting August 1, 2007, and for any engines belonging to an engine model whose original production date was on or after August 1, 2003.
[b]Class II engines had alternate HC+NOx standards of 18.0, 16.6, 15.0, 13.6 and alternate NMHC+NOx standards of 16.7, 15.3, 14.0, 12.7 for model years 2001 through 2004, respectively.

(3) Note that engines subject to Phase 1 standards were not subject to useful life provisions as specified in §1054.107. In addition, engines subject to Phase 1 standards and engines subject to Phase 2 standards were both not subject to the following provisions:

(i) Evaporative emission standards as specified in §§1054.110 and 1054.112.

(ii) Altitude adjustments as specified in §1054.115(c).

(iii) Warranty assurance provisions as specified in §1054.120(f).

(iv) Emission-related installation instructions as specified in §1054.130.

(v) Bonding requirements as specified in §1054.690.

284. Revise paragraph (b)(2) of Appendix II to part 1054 to read as follows:

Appendix II to Part 1054— Duty Cycles for Laboratory Testing

* * * * *

(b) * * *

(2) The following duty cycle applies for ramped-modal testing:

RMC Mode [a]	Time in mode (seconds)	Torque (percent) [b, c]
1a Steady-state	41	0
1b Transition	20	Linear transition
2a Steady-state	135	100
2b Transition	20	Linear transition
3a Steady-state	112	10
3b Transition	20	Linear transition
4a Steady-state	337	75
4b Transition	20	Linear transition
5a Steady-state	518	25
5b Transition	20	Linear transition
6a Steady-state	494	50
6b Transition	20	Linear transition
7 Steady-state	43	0

[a]Control engine speed as described in §1054.505. Control engine speed for Mode 6 as described in §1054.505(c) for idle operation.

[b]Advance from one mode to the next within a 20-second transition phase. During the transition phase, command a linear progression from the torque setting of the current mode to the torque setting of the next mode.

[c]The percent torque is relative to the value established for full-load torque, as described in §1054.505.

PART 1060—CONTROL OF EVAPORATIVE EMISSIONS FROM NEW AND IN-USE NONROAD AND STATIONARY EQUIPMENT

285. The authority citation for part 1060 continues to read as follows:

Authority: 42 U.S.C. 7401-7671q.

286. Amend §1060.1 by revising paragraphs (a)(8), (c), and (d) to read as follows:

§1060.1 Which products are subject to this part's requirements?

(a) * * *

(8) Portable nonroad fuel tanks are considered portable marine fuel tanks for purposes of this part 1060. Portable nonroad fuel tanks and fuel lines associated with such fuel tanks must therefore meet evaporative emission standards specified in 40 CFR 1045.112, whether or not they are used with marine vessels.

* * * * *

(c) Fuel caps are subject to evaporative emission standards at the point of installation on a fuel tank. When a fuel cap is certified for use with Marine SI engines or Small SI engines under the optional standards of §1060.103, it becomes subject to all the requirements of this part 1060 as if these optional standards were mandatory.
(d) This part 1060 does not apply to any diesel-fueled engine or any other engine that does not use a volatile liquid fuel. In addition, this part does not apply to any engines or equipment in the following categories even if they use a volatile liquid fuel:

(1) Light-duty motor vehicles (see 40 CFR part 86).

(2) Heavy-duty motor vehicles and heavy-duty motor vehicle engines (see 40 CFR part 86). This part 1060 also does not apply to fuel systems for nonroad engines where such fuel systems are subject to part 86 because they are part of a heavy-duty motor vehicle.

(3) Aircraft engines (see 40 CFR part 87).

(4) Locomotives (see 40 CFR part 1033).

* * * * *

287. Amend §1060.5 by revising paragraph (a)(1) to read as follows:

§1060.5 Do the requirements of this part apply to me?

* * * * *

(a) * * *

(1) Each person meeting the definition of manufacturer for a product that is subject to the standards and other requirements of this part must comply with such requirements. However, if one person complies with a specific requirement for a given product, then all manufacturers are deemed to have complied with that specific requirement. For example, if a Small SI equipment manufacturer uses fuel lines manufactured and certified by another company, the equipment manufacturer is not required to obtain its own certificate with respect to the fuel line emission standards. Such an equipment manufacturer remains subject to the standards and other requirements of this part. However, where a provision requires a specific manufacturer to comply with certain provisions, this paragraph (a) does not change or modify such a requirement. For example, this paragraph (a) does not allow you to rely on another company to certify instead of you if we specifically require you to certify.

* * * * *

288. Revise §1060.30 to read as follows:

§1060.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see §1060.801). See §1060.825 for additional reporting and recordkeeping provisions.

289. Amend §1060.104 by revising paragraph (b)(3) to read as follows:

§1060.104 What running loss emission control requirements apply?

* * * * *

(b) * * *

(3) Get an approved Executive Order or other written approval from the California Air Resources Board showing that your system meets applicable running loss standards in California.

* * * * *

290. Amend §1060.105 by revising paragraphs (c)(1) and (e) to read as follows:

§1060.105 What diurnal requirements apply for equipment?

*   *   *   *   *

(c) *   *   *

(1) They must be self-sealing when detached from the engines. The tanks may not vent to the atmosphere when attached to an engine, except as allowed under paragraph (c)(2) of this section. An integrated or external manually activated device may be included in the fuel tank design to temporarily relieve pressure before refueling or connecting the fuel tank to the engine. However, the default setting for such a vent must be consistent with the requirement in paragraph (c)(2) of this section.

*   *   *   *   *

(e) Manufacturers of nonhandheld Small SI equipment may optionally meet the diurnal emission standards adopted by the California Air Resources Board. To meet this requirement, equipment must be certified to the performance standards specified in Title 13 CCR § 2754(a) based on the applicable requirements specified in CP-902 and TP-902, including the requirements related to fuel caps in Title 13 CCR § 2756. Equipment certified under this paragraph (e) does not need to use fuel lines or fuel tanks that have been certified separately. Equipment certified under this paragraph (e) are subject to all the referenced requirements as if these specifications were mandatory.

*   *   *   *   *

291 Amend §1060.120 by revising paragraphs (b) and (c) to read as follows:

§1060.120 What emission-related warranty requirements apply?

*   *   *   *   *

(b) *Warranty period*. Your emission-related warranty must be valid for at least two years from the date the equipment is sold to the ultimate purchaser.

(c) *Components covered*. The emission-related warranty covers all components whose failure would increase the evaporative emissions, including those listed in 40 CFR part 1068, Appendix I, and those from any other system you develop to control emissions. Your emission-related warranty does not need to cover components whose failure would not increase evaporative emissions.

*   *   *   *   *

292 Amend §1060.130 by revising paragraph (b)(3) to read as follows:

§1060.130 What installation instructions must I give to equipment manufacturers?

*   *   *   *   *

(b) *   *   *

(3) Describe how your certification is limited for any type of application. For example:

(i) For fuel tanks sold without fuel caps, you must specify the requirements for the fuel cap, such as the allowable materials, thread pattern, how it must seal, etc. You must also include instructions to tether the fuel cap as described in §1060.101(f)(1) if you do not sell your fuel tanks with tethered fuel caps. The following instructions apply for specifying a certain level of emission control for fuel caps that will be installed on your fuel tanks:

(A) If your testing involves a default emission value for fuel cap permeation as specified in §1060.520(b)(5)(ii)(C), specify in your installation instructions that installed fuel caps must either be certified with a Family Emission Limit at or below 30 g/m2/day, or have gaskets made of certain materials meeting the definition of “low-permeability material” in §1060.801.

(B) If you certify your fuel tanks based on a fuel cap certified with a Family Emission Limit above 30 g/m2/day, specify in your installation instructions that installed fuel caps must either be certified with a Family Emission Limit at or below the level you used for certifying your fuel tanks, or have gaskets made of certain materials meeting the definition of “low-permeability material” in §1060.801.

(ii) If your fuel lines do not meet permeation standards specified in §1060.102 for EPA Low-Emission Fuel Lines, tell equipment manufacturers not to install the fuel lines with Large SI engines that operate on gasoline or another volatile liquid fuel.

* * * * *

293. Amend §1060.135 by revising the introductory text and paragraphs (a), (b) introductory text, (b)(2), (b)(3), and (b)(4) to read as follows:

§1060.135 How must I label and identify the engines and equipment I produce?

The labeling requirements of this section apply for all equipment manufacturers that are required to certify their equipment or use certified fuel-system components. Note that engine manufacturers are also considered equipment manufacturers if they install a complete fuel system on an engine. See §1060.137 for the labeling requirements that apply separately for fuel lines, fuel tanks, and other fuel-system components.

(a) At the time of manufacture, you must affix a permanent and legible label identifying each engine or piece of equipment. The label must be–

(1) Attached in one piece so it is not removable without being destroyed or defaced.

(2) Secured to a part of the engine or equipment needed for normal operation and not normally requiring replacement.

(3) Durable and readable for the equipment’s entire life.

(4) Written in English.

(5) Readily visible in the final installation. It may be under a hinged door or other readily opened cover. It may not be hidden by any cover attached with screws or any similar designs. Labels on marine vessels (except personal watercraft) must be visible from the helm.

(b) If you hold a certificate under this part for your engine or equipment, the engine or equipment label specified in paragraph (a) of this section must–

* * * * *(2) Include your corporate name and trademark. You may identify another company and use its trademark instead of yours if you comply with the branding provisions of 40 CFR 1068.45.

(3) State the date of manufacture [MONTH and YEAR] of the equipment; however, you may omit this from the label if you stamp, engrave, or otherwise permanently identify it elsewhere on the equipment, in which case you must also describe in your application for certification where you will identify the date on the equipment.

(4) State: "THIS [equipment, vehicle, boat, etc.] MEETS U.S. EPA EVAP STANDARDS.”

* * * * *

294. Amend §1060.137 by revising paragraphs (a)(4) and (c)(1) to read as follows:

§1060.137 How must I label and identify the fuel-system components I produce?

* * * * *

(a) * * *

(4) Fuel caps, as described in this paragraph (a)(4). Fuel caps must be labeled if they are separately certified under §1060.103. If the equipment has a diurnal control system that requires the fuel tank to hold pressure, identify the part number on the fuel cap.

* * * * *

(c) * * *

(1) Include your corporate name. You may identify another company instead of yours if you comply with the provisions of 40 CFR 1068.45.

* * * * *

295. Amend §1060.205 by revising paragraphs (a) and (m) to read as follows:

§1060.205 What must I include in my application?

* * * * *

(a) Describe the emission family's specifications and other basic parameters of the emission controls. Describe how you meet the running loss emission control requirements in §1060.104, if applicable. Describe how you meet any applicable equipment-based requirements of §1060.101(e) and (f). State whether you are requesting certification for gasoline or some other fuel type. List each distinguishable configuration in the emission family. For equipment that relies on one or more certified components, identify the EPA-issued emission family name for all the certified components.

* * * * *

(m) Report all valid test results. Also indicate whether there are test results from invalid tests or from any other tests of the emission-data unit, whether or not they were conducted according to the test procedures of subpart F of this part. We may require you to report these additional test results. We may ask you to send other information to confirm that your tests were valid under the requirements of this part.

* * * * *

296. Amend §1060.225 by revising paragraphs (b) and (g) and adding paragraph (h) to read as follows:

§1060.225 How do I amend my application for certification?

* * * * *

(b) To amend your application for certification, send the relevant information to the Designated Compliance Officer.

(1) Describe in detail the addition or change in the configuration you intend to make.

(2) Include engineering evaluations or data showing that the amended emission family complies with all applicable requirements. You may do this by showing that the original emission data are still appropriate for showing that the amended family complies with all applicable requirements.

(3) If the original emission data for the emission family are not appropriate to show compliance for the new or modified configuration, include new test data showing that the new or modified configuration meets the requirements of this part.

(4) Include any other information needed to make your application correct and complete.

* * * * *

(g) You may produce equipment or components as described in your amended application for certification and consider those equipment or components to be in a certified configuration if we approve a new or modified configuration during the model year or production period under paragraph (d) of this section. Similarly, you may modify in-use products as described in your amended application for certification and consider those products to be in a certified configuration if we approve a new or modified configuration at any time under paragraph (d) of this section. Modifying a new or in-use product to be in a certified configuration does not violate the tampering prohibition of 40 CFR 1068.101(b)(1), as long as this does not involve changing to a certified configuration with a higher family emission limit.
(h) Component manufacturers may not change an emission family's FEL under any circumstances. Changing the FEL would require submission of a new application for certification.

297. Amend §1060.230 by revising paragraph (d)(2) to read as follows:

§1060.230 How do I select emission families?

* * * * *

(d) * * *

(2) Type of material (such as type of charcoal used in a carbon canister). This criterion does not apply for materials that are unrelated to emission control performance.

* * * * *

298. Amend §1060.235 by:

a. Revising the section heading;
b. Redesignating paragraph (a) as (h).
c. Redesignating paragraph (b) as paragraph (a) and paragraph (h) as paragraph (b);
c. Revising paragraphs (d) and (e)(1).
The revisions read as follows:

§1060.235 What testing requirements apply for certification?

* * * * *

(d) We may perform confirmatory testing by measuring emissions from any of your products from the emission family, as follows:

(1) You must supply your products to us if we choose to perform confirmatory testing. We may require you to deliver your test articles to a facility we designate for our testing.
(2) If we measure emissions on one of your products, the results of that testing become the official emission results for the emission family. Unless we later invalidate these data, we may decide not to consider your data in determining if your emission family meets applicable requirements.

(e) * * *

(1) The emission family from the previous production period differs from the current emission family only with respect to production period, items identified in §1060.225(a), or other characteristics unrelated to emissions. We may waive this criterion for differences we determine not to be relevant.

* * * * *

299. Amend §1060.240 by revising paragraph (e)(2)(i) to read as follows:

§1060.240 How do I demonstrate that my emission family complies with evaporative emission standards?

* * * * *

(e) * * *

(2) * * *

(i) You may use the measurement procedures specified by the California Air Resources Board in Attachment 1 to TP-902 to show that canister working capacity is least 3.6 grams of vapor storage capacity per gallon of nominal fuel tank capacity (or 1.4 grams of vapor storage capacity per gallon of nominal fuel tank capacity for fuel tanks used in nontrailerable boats).

* * * * *

300. Amend §1060.250 by revising paragraphs (a)(3)(ii) and (b) to read as follows:

§1060.250 What records must I keep?

(a) * * *

(3) * * *

(ii) All your emission tests (valid and invalid), including the date and purpose of each test and documentation of test parameters described in subpart F of this part.

* * * * *

(b) Keep required data from emission tests and all other information specified in this section for eight years after we issue your certificate. If you use the same emission data or other information for a later model year, the eight-year period restarts with each year that you continue to rely on the information.

* * * * *

301. Revise §1060.255 to read as follows:

§1060.255 What decisions may EPA make regarding a certificate of conformity?

(a) If we determine an application is complete and shows that the emission family meets all the requirements of this part and the Clean Air Act, we will issue a certificate of conformity for the emission family for that production period. We may make the approval subject to additional conditions.

(b) We may deny an application for certification if we determine that an emission family fails to comply with emission standards or other requirements of this part or the Clean Air Act. We will base our decision on all available information. If we deny an application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke a certificate of conformity if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.

(3) Cause any test data to become inaccurate.

(4) Deny us from completing authorized activities (see 40 CFR 1068.20). This includes a failure to provide reasonable assistance.

(5) Produce equipment or components for importation into the United States at a location where local law prohibits us from carrying out authorized activities.

(6) Fail to supply requested information or amend an application to include all equipment or components being produced.

(7) Take any action that otherwise circumvents the intent of the Clean Air Act or this part.
(d) We may void a certificate of conformity if you fail to keep records, send reports, or give us information as required under this part or the Clean Air Act. Note that these are also violations of 40 CFR 1068.101(a)(2).
(e) We may void a certificate of conformity if we find that you intentionally submitted false or incomplete information. This includes doing anything after submitting an application that causes submitted information to be false or incomplete.
(f) If we deny an application or suspend, revoke, or void a certificate of conformity, you may ask for a hearing (see §1060.820).

302. Amend §1060.501 by revising paragraph (c) to read as follows:
§1060.501 General testing provisions.
* * * * *
(c) The specification for gasoline to be used for testing is given in 40 CFR 1065.710(b) or (c). Use the grade of gasoline specified for general testing. For testing specified in this part that requires blending gasoline and ethanol, blend this grade of neat gasoline with fuel-grade ethanol meeting the specifications of ASTM D4806 (incorporated by reference in §1060.810). You do not need to measure the ethanol concentration of such blended fuels and may instead calculate the blended composition by assuming that the ethanol is pure and mixes perfectly with the base fuel. For example, if you mix 10.0 liters of fuel-grade ethanol with 90.0 liters of gasoline, you may assume the resulting mixture is 10.0 percent ethanol. You may use more pure or less pure ethanol if you can demonstrate that it will not affect your ability to demonstrate compliance with the applicable emission standards. Note that unless we specify otherwise, any references to gasoline-ethanol mixtures containing a specified ethanol concentration means mixtures meeting the provisions of this paragraph (c). The following table summarizes test fuel requirements for the procedures specified in this subpart:

Procedure	Reference	Test Fuel[a]
Low-Emission Fuel Lines	§1060.510	CE10
Nonroad Fuel Lines	§1060.515	CE10[b]
Cold-Weather Fuel Lines	§1060.515	Splash-blended E10
Fuel tank and fuel cap permeation	§1060.520	Splash-blended E10; manufacturers may instead use CE10
Diurnal	§1060.525	E0

[a]Pre-mixed gasoline blends are specified in 40 CFR 1065.710(b). Splash-blended gasoline blends are a mix of neat gasoline specified in 40 CFR 1065.710(c) and fuel-grade ethanol.
[b]Different fuel specifications apply for fuel lines tested under 40 CFR part 1051 for recreational vehicles, as described in 40 CFR 1051.501.
* * * * *

303. Amend §1060.505 by revising paragraph (c)(3) to read as follows:
§1060.505 Other procedures.
* * * * *
(c) * * *
(3) You may request to use alternate procedures that are equivalent to the specified procedures, or procedures that are more accurate or more precise than the specified procedures. We may perform tests with your equipment using either the approved alternate procedures or the specified

procedures. See 40 CFR 1065.12 for a description of the information that is generally required for such alternate procedures.

* * * * *

304. Amend §1060.515 by revising paragraph (a)(2) to read as follows:

§1060.515 How do I test EPA Nonroad Fuel Lines and EPA Cold-Weather Fuel Lines for permeation emissions?

* * * * *

(a) * * *

(2) For EPA Cold-Weather Fuel Lines, use gasoline blended with ethanol as described in §1060.501(c).

* * * * *

305. Amend §1060.520 by revising paragraphs (a), (b)(1), (b)(4), (d)(3), (d)(6), (d)(8)(ii), (d)(9), and (e) to read as follows:

§1060.520 How do I test fuel tanks for permeation emissions?

* * * * *

(a) *Preconditioning durability testing*. Take the following steps before an emission test, in any order, if your emission control technology involves surface treatment or other post-processing treatments such as an epoxy coating:

(1) *Pressure cycling*. Perform a pressure test by sealing the fuel tank and cycling it between +13.8 and -3.4 kPa (+2.0 and -0.5 psig) for 10,000 cycles at a rate of 60 seconds per cycle. The purpose of this test is to represent environmental wall stresses caused by pressure changes and other factors (such as vibration or thermal expansion). If your fuel tank cannot be tested using the pressure cycles specified by this paragraph (a)(1), you may ask to use special test procedures under §1060.505.

(2) *UV exposure*. Perform a sunlight-exposure test by exposing the fuel tank to an ultraviolet light of at least 24 W/m2 (0.40 W-hr/m2/min) on the fuel tank surface for at least 450 hours. Alternatively, the fuel tank may be exposed to direct natural sunlight for an equivalent period of time as long as you ensure that the fuel tank is exposed to at least 450 daylight hours.

(3) *Slosh testing*. Perform a slosh test by filling the fuel tank to 40-50 percent of its capacity with the fuel specified in paragraph (e) of this section and rocking it at a rate of 15 cycles per minute until you reach one million total cycles. Use an angle deviation of +15° to -15° from level. Take steps to ensure that the fuel remains at 40-50 percent of its capacity throughout the test run.

(4) *Cap testing*. Perform durability cycles on fuel caps intended for use with handheld equipment by putting the fuel cap on and taking it off 300 times. Tighten the fuel cap each time in a way that represents the typical in-use experience.

(b) * * *

(1) Fill the fuel tank to its nominal capacity with the fuel specified in paragraph (e) of this section, seal it, and allow it to soak at 28±5 °C for at least 20 weeks. Alternatively, the fuel tank may be soaked for at least 10 weeks at 43 5 °C. You may count the time of the preconditioning steps in paragraph (a) of this section as part of the preconditioning fuel soak as long as the ambient temperature remains within the specified temperature range and the fuel tank continues to be at least 40 percent full throughout the test; you may add or replace

fuel as needed to conduct the specified durability procedures. Void the test if you determine that the fuel tank has any kind of leak.

* * * * *

(4) Allow the fuel tank and its contents to equilibrate to the temperatures specified in paragraph (d)(7) of this section. Seal the fuel tank as described in paragraph (b)(5) of this section once the fuel temperatures are stabilized at the test temperature. You must seal the fuel tank no more than eight hours after refueling. Until the fuel tank is sealed, take steps to minimize the vapor losses from the fuel tank, such as keeping the fuel cap loose on the fuel inlet or routing vapors through a vent hose.

* * * * *

(d) * * *

(3) Carefully place the test tank within a temperature-controlled room or enclosure. Do not spill or add any fuel.

* * * * *

(6) Leave the test tank in the room or enclosure for the duration of the test run, except that you may remove the tank for up to 30 minutes at a time to meet weighing requirements.

* * * * *

(8) * * *

(ii) If after ten days of testing your r2 value is below 0.95 and your measured value is more than 50 percent of the applicable standard, continue testing for a total of 20 days or until r2 is at or above 0.95. If r2 is not at or above 0.95 within 20 days of testing, discontinue the test and precondition the test tank further until it has stabilized emission levels, then repeat the testing.

(9) Record the difference in mass between the reference tank and the test tank for each measurement. This value is Mi, where i is a counter representing the number of days elapsed. Subtract Mi from Mo and divide the difference by the internal surface area of the fuel tank. Divide this g/m2 value by the number of test days (using at least two decimal places) to calculate the emission rate in g/m2/day. Example: If a fuel tank with an internal surface area of 0.720 m2 weighed 1.31 grams less than the reference tank at the beginning of the test and weighed 9.86 grams less than the reference tank after soaking for 10.03 days, the emission rate would be-

((-1.31 g) - (-9.86 g)) / 0.720 m2 / 10.03 days = 1.1839 g/m2/day

* * * * *

(e) *Fuel specifications*. Use a low-level ethanol-gasoline blend as specified in §1060.501(c). As an alternative, you may use Fuel CE10, as described in §1060.515(a)(1).

* * * * *

306. Amend §1060.525 by revising paragraph (a)(2) to read as follows:

§1060.525 How do I test fuel systems for diurnal emissions?

* * * * *

(a) * *

(2) Fill the fuel tank to 40 percent of nominal capacity with the gasoline specified in 40 CFR 1065.710(c) for general testing.

* * * * *

307. Amend §1060.601 by revising paragraphs (a) and (b)(2) to read as follows:

§1060.601 How do the prohibitions of 40 CFR 1068.101 apply with respect to the requirements of this part?

(a) As described in §1060.1, fuel tanks and fuel lines that are used with or intended to be used with new nonroad engines or equipment are subject to evaporative emission standards under this part 1060. This includes portable marine fuel tanks and fuel lines and other fuel-system components associated with portable marine fuel tanks. Note that §1060.1 specifies an implementation schedule based on the date of manufacture of nonroad equipment, so new fuel tanks and fuel lines are not subject to standards under this part 1060 if they will be installed for use in equipment built before the specified dates for implementing the appropriate standards, subject to the limitations in paragraph (b) of this section. Except as specified in paragraph (f) of this section, fuel-system components that are subject to permeation or diurnal emission standards under this part 1060 must be covered by a valid certificate of conformity before being introduced into U.S. commerce to avoid violating the prohibition of 40 CFR 1068.101(a). To the extent we allow it under the exhaust standard-setting part, fuel-system components may be certified with a family emission limit higher than the specified emission standard.

(b) * * *

(2) *Applicability of standards after January 1, 2020*. Starting January 1, 2020, it is presumed that replacement components will be used with nonroad engines regulated under this part 1060 if they can reasonably be used with such engines. Manufacturers, distributors, retailers, and importers are therefore obligated to take reasonable steps to ensure that any uncertified components are not used to replace certified components. This would require labeling the components and may also require restricting the sales and requiring the ultimate purchaser to agree to not use the components inappropriately. This requirement does not apply for components that are clearly not intended for use with fuels.

* * * * *

308. Add §1060.610 to subpart G to read as follows:

§1060.610 Temporary exemptions for manufacturing and assembling equipment and fuel-system components.

(a) If you are a certificate holder, you may ship components or equipment requiring further assembly between two of your facilities, subject to the provisions of this paragraph (a). Unless we approve otherwise, you must maintain ownership and control of the products until they reach their destination. We may allow for shipment where you do not maintain actual ownership and control of the engines (such as hiring a shipping company to transport the products) but only if you demonstrate that the products will be transported only according to your specifications. Notify us of your intent to use this exemption in your application for certification, if applicable. Your exemption is effective when we grant your certificate. You may alternatively request an exemption in a separate submission; for example, this would be necessary if you will not be the certificate holder for the products in question. We may require you to take specific steps to ensure that such products are in a certified configuration before reaching the ultimate purchaser. Note that since this is a temporary exemption, it does not allow you to sell or otherwise distribute equipment in an uncertified configuration to ultimate purchasers. Note also that the exempted equipment remains new and subject to emission standards until its title is transferred to the ultimate purchaser or it otherwise ceases to be new.

(b) If you certify equipment, you may ask us at the time of certification for an exemption to allow you to ship your equipment without a complete fuel system. We will generally approve this only if you can demonstrate that the exemption is necessary and that you will take steps to ensure that equipment assembly will be properly completed before reaching the ultimate purchaser. We may specify conditions that we determine are needed to ensure that shipping the equipment without such components will not result in the equipment operating with uncertified components or otherwise in an uncertified configuration. For example, we may require that you ship the equipment to manufacturers that are contractually obligated to install certain components. See 40 CFR 1068.261.

§1060.640 [Removed]
309. Remove §1060.640.

310. Amend §1060.801 by revising the definitions for “Configuration”, “Designated Compliance Officer”, “Fuel type”, “Model year”, “Placed into service”, “Portable nonroad fuel tank”, and “Small SI” to read as follows:
§1060.801 What definitions apply to this part?
* * * * *
Configuration means a unique combination of hardware (material, geometry, and size) and calibration within an emission family. Units within a single configuration differ only with respect to normal production variability or factors unrelated to emissions.
* * * * *
Designated Compliance Officer means the Director, Gasoline Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; complianceinfo@epa.gov.
* * * * *
Fuel type means a general category of fuels such as gasoline or natural gas. There can be multiple grades within a single fuel type, such as premium gasoline, regular gasoline, or low-level ethanol-gasoline blends.
* * * * *
Model year means one of the following things:
(1) For equipment defined as "new nonroad equipment" under paragraph (1) of the definition of “new nonroad engine,” model year means one of the following:
(i) Calendar year of production.
(ii) Your annual new model production period if it is different than the calendar year. This must include January 1 of the calendar year for which the model year is named. It may not begin before January 2 of the previous calendar year and it must end by December 31 of the named calendar year.
(2) For other equipment defined as "new nonroad equipment" under paragraph (2) of the definition of “new nonroad engine,” model year has the meaning given in the exhaust standard-setting part.
(3) For other equipment defined as "new nonroad equipment" under paragraph (3) or paragraph (4) of the definition of “new nonroad engine,” model year means the model year of the engine as defined in the exhaust standard-setting part.
* * * * *
Placed into service means put into initial use for its intended purpose. Equipment does not qualify as being “placed into service” based on incidental use by a manufacturer or dealer.
* * * * *

Portable nonroad fuel tank means a fuel tank that meets each of the following criteria:
(1) It has design features indicative of use in portable applications, such as a carrying handle and fuel line fitting that can be readily attached to and detached from a nonroad engine.
(2) It has a nominal fuel capacity of 12 gallons or less.
(3) It is designed to supply fuel to an engine while the engine is operating.
(4) It is not used or intended to be used to supply fuel to a marine engine. Note that portable tanks excluded from this definition of "portable nonroad fuel tank" under this paragraph (4) because of their use with marine engines are portable marine fuel tanks.
* * * * *
Small SI means relating to engines that are subject to emission standards in 40 CFR part 1054.
* * * * *

311. Amend §1060.810 by:
a. Removing and reserving paragraph (d); and
b. Revising paragraph (e) introductory text.
The revision reads as follows:
§1060.810 What materials does this part reference?
* * * * *
(e) *American Boat and Yacht Council Material*. The following documents are available from the American Boat and Yacht Council, 613 Third Street, Suite 10, Annapolis, MD 21403 or (410) 990-4460 or *http://abycinc.org/*:
* * * * *

312. Revise §1060.815 to read as follows:
§1060.815 What provisions apply to confidential information?
The provisions of 40 CFR 1068.10 apply for information you consider confidential.

313. Revise §1060.825 to read as follows:
§1060.825 What reporting and recordkeeping requirements apply under this part?
(a) This part includes various requirements to submit and record data or other information. Unless we specify otherwise, store required records in any format and on any media and keep them readily available for eight years after you send an associated application for certification, or eight years after you generate the data if they do not support an application for certification. We may request these records at any time. You must promptly give us organized, written records in English if we ask for them. This applies whether or not you rely on someone else to keep records on your behalf. We may require you to submit written records in an electronic format.
(b) The regulations in §1045.255, 40 CFR 1068.25, and 40 CFR 1068.101 describe your obligation to report truthful and complete information. This includes information not related to certification. Failing to properly report information and keep the records we specify violates 40 CFR 1068.101(a)(2), which may involve civil or criminal penalties.
(c) Send all reports and requests for approval to the Designated Compliance Officer (see §1060.801).
(d) Any written information we require you to send to or receive from another company is deemed to be a required record under this section. Such records are also deemed to be submissions to EPA. We may require you to send us these records.

(e) Under the Paperwork Reduction Act (44 U.S.C. 3501 *et seq*.), the Office of Management and Budget approves the reporting and recordkeeping specified in the applicable regulations. The following items illustrate the kind of reporting and recordkeeping we require for products regulated under this part:

(1) We specify the following requirements related to component and equipment certification in this part 1060:

(i) In §1060.20 we give an overview of principles for reporting information.

(ii) In subpart C of this part we identify a wide range of information required to certify engines.

(iii) In §1060.301 we require manufacturers to make components, engines, or equipment available for our testing if we make such a request, and to keep records related to evaluation of production samples for verifying that the products are as specified in the certificate of conformity.

(iv) In §1060.505 we specify information needs for establishing various changes to published test procedures.

(2) We specify the following requirements related to the general compliance provisions in 40 CFR part 1068:

(i) In 40 CFR 1068.5 we establish a process for evaluating good engineering judgment related to testing and certification.

(ii) In 40 CFR 1068.25 we describe general provisions related to sending and keeping information.

(iii) In 40 CFR 1068.27 we require manufacturers to make equipment available for our testing or inspection if we make such a request.

(iv) In 40 CFR 1068.105 we require equipment manufacturers to keep certain records related to duplicate labels from engine manufacturers.

(v) [Reserved]

(vi) In 40 CFR part 1068, subpart C, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to various exemptions.

(vii) In 40 CFR part 1068, subpart D, we identify several reporting and recordkeeping items for making demonstrations and getting approval related to importing equipment.

(viii) In 40 CFR 1068.450 and 1068.455 we specify certain records related to testing production-line products in a selective enforcement audit.

(ix) In 40 CFR 1068.501 we specify certain records related to investigating and reporting emission-related defects.

(x) In 40 CFR 1068.525 and 1068.530 we specify certain records related to recalling nonconforming equipment.

(xi) In 40 CFR part 1068, subpart G, we specify certain records for requesting a hearing.

PART 1065—ENGINE-TESTING PROCEDURES

314. The authority citation for part 1065 continues to read as follows:
Authority: 42 U.S.C. 7401 - 7671q.

315. Amend §1065.1 by revising paragraph (g) to read as follows:

§1065.1 Applicability.

* * * * *

(g) For additional information regarding these test procedures, visit our Web site at www.epa.gov, and in particular https://www.epa.gov/vehicle-and-fuel-emissions-testing/engine-testing-regulations.

* * * * *

316. Amend §1065.2 by revising paragraph (c) to read as follows:

§1065.2 Submitting information to EPA under this part.

* * * * *

(c) We may void any certificates or approvals associated with a submission of information if we find that you intentionally submitted false, incomplete, or misleading information. For example, if we find that you intentionally submitted incomplete information to mislead EPA when requesting approval to use alternate test procedures, we may void the certificates for all engine families certified based on emission data collected using the alternate procedures. This would also apply if you ignore data from incomplete tests or from repeat tests with higher emission results.

* * * * *

317. Amend §1065.130 by revising paragraph (e) to read as follows:

§1065.130 Engine exhaust.

* * * * *

(e) Leaks. Minimize leaks sufficiently to ensure your ability to demonstrate compliance with the applicable standards. We recommend performing carbon balance error verification as described in §1065.543 to verify exhaust system integrity.

* * * * *

318. Amend §1065.140 by revising paragraphs (c)(6)(i) and (e)(2) to read as follows:

§1065.140 Dilution for gaseous and PM constituents.

* * * * *

(c) * * *

(6) * * *

(i) Preventing aqueous condensation. To prevent condensation, you must keep the temperature of internal surfaces, excluding any sample probes, above the dewpoint of the dilute exhaust passing through the CVS tunnel. Use good engineering judgment to monitor temperatures in the CVS. For the purposes of this paragraph (c)(6), assume that aqueous condensation is pure water condensate only, even though the definition of "aqueous condensation" in §1065.1001 includes condensation of any constituents that contain water. No specific verification check is required under this paragraph (c)(6)(i), but we may ask you to show how you comply with this requirement. You may use engineering analysis, CVS tunnel design, alarm systems, measurements of wall temperatures, and calculation of water dewpoint to demonstrate compliance with this requirement. For optional CVS heat exchangers, you may use the lowest water temperature at the inlet(s) and outlet(s) to determine the minimum internal surface temperature.

* * * * *

(e) * * *

(2) For any PM dilution system (i.e., CVS or PFD), add dilution air to the raw exhaust such that the minimum overall ratio of diluted exhaust to raw exhaust is within the range of (5:1 to 7:1)

and is at least 2:1 for any primary dilution stage. Base this minimum value on the maximum engine exhaust flow rate during a given duty cycle for discrete-mode testing and on the maximum engine exhaust flow rate during a given test interval for other testing. Either measure the maximum exhaust flow during a practice run of the test interval or estimate it based on good engineering judgment (for example, you might rely on manufacturer-published literature).
* * * * *

319. Amend §1065.145 by revising paragraph (e)(3)(i) to read as follows:

§1065.145 Gaseous and PM probes, transfer lines, and sampling system components.

* * * * *

(e) * * *

(3) * * *

(i) If you use a NO_x sample pump upstream of either an NO_2-to-NO converter that meets §1065.378 or a chiller that meets §1065.376, design the sampling system to prevent aqueous condensation.

* * * * *

320. Amend §1065.170 by revising the introductory text and paragraph (a)(1) to read as follows:

§1065.170 Batch sampling for gaseous and PM constituents.

Batch sampling involves collecting and storing emissions for later analysis. Examples of batch sampling include collecting and storing gaseous emissions in a bag or collecting and storing PM on a filter. You may use batch sampling to store emissions that have been diluted at least once in some way, such as with CVS, PFD, or BMD. You may use batch sampling to store undiluted emissions. You may stop emission sampling anytime the engine is turned off, consistent with good engineering judgment. This is intended to allow for higher concentrations of dilute exhaust gases and more accurate measurements. Account for exhaust transport delay in the sampling system and integrate over the actual sampling duration when determining n_{dexh}. Use good engineering judgment to add dilution air to fill bags up to minimum read volumes, as needed.

(a) * * *

(1) Verify proportional sampling after an emission test as described in §1065.545. You must exclude from the proportional sampling verification any portion of the test where you are not sampling emissions because the engine is turned off and the batch samplers are not sampling, accounting for exhaust transport delay in the sampling system. Use good engineering judgment to select storage media that will not significantly change measured emission levels (either up or down). For example, do not use sample bags for storing emissions if the bags are permeable with respect to emissions or if they off gas emissions to the extent that it affects your ability to demonstrate compliance with the applicable gaseous emission standards. As another example, do not use PM filters that irreversibly absorb or adsorb gases to the extent that it affects your ability to demonstrate compliance with the applicable PM emission standard.

* * * * *

321. Revise §1065.205 to read as follows:

§1065.205 Performance specifications for measurement instruments.

Your test system as a whole must meet all the calibrations, verifications, and test-validation criteria specified outside this section for laboratory testing or field testing, as applicable. We recommend that your instruments meet the specifications in this section for all ranges you use for testing. We also recommend that you keep any documentation you receive from instrument manufacturers showing that your instruments meet the specifications in the following table:

TABLE 1 OF §1065.205–RECOMMENDED PERFORMANCE SPECIFICATIONS FOR MEASUREMENT INSTRUMENTS

Measurement Instrument	Measured quantity symbol	Complete System Rise time ($t_{10\text{-}90}$) and Fall time ($t_{90\text{-}10}$)[a]	Recording update frequency	Accuracy[b]	Repeatability[b]	Noise[b]
Engine speed transducer	f_n	1 s	1 Hz means	2 % of pt. or 0.5 % of max.	1 % of pt. or 0.25 % of max.	0.05 % of max
Engine torque transducer	T	1 s	1 Hz means	2 % of pt. or 1 % of max.	1 % of pt. or 0.5 % of max	0.05 % of max.
Electrical work (active-power meter)	W	1 s	1 Hz means	2 % of pt. or 0.5 % of max.	1 % of pt. or 0.25 % of max.	0.05 % of max
General pressure transducer (not a part of another instrument)	p	5 s	1 Hz	2 % of pt. or 1 % of max.	1 % of pt. or 0.5 % of max.	0.1 % of max
Atmospheric pressure meter for PM-stabilization and balance environments	p_{atmos}	50 s	5 times per hour	50 Pa	25 Pa	5 Pa
General purpose atmospheric pressure meter	p_{atmos}	50 s	5 times per hour	250 Pa	100Pa	50 Pa
Temperature sensor for PM-stabilization and balance environments	T	50 s	0.1 Hz	0.25 K	0.1 K	0.1 K
Other temperature sensor (not a part of another instrument)	T	10 s	0.5 Hz	0.4 % of pt. K or 0.2 % of max. K	0.2 % of pt. K or 0.1 % of max. K	0.1 % of max.
Dewpoint sensor for intake air, PM-stabilization and balance environments	T_{dew}	50 s	0.1 Hz	0.25 K	0.1 K	0.02 K
Other dewpoint sensor	T_{dew}	50 s	0.1 Hz	1 K	0.5 K	0.1 K
Fuel mass flow rate meter[c]	$\dot{m}$	5 s	1 Hz	2 % of pt. or 1.5 % of max.	1 % of pt. or 0.75 % of max.	0.5 % of max.
DEF mass flow rate meter[c]	$\dot{m}$	5 s	1 Hz	5 % of pt. or 4 % of max.	2.5 % of pt. or 2 % of max.	1.25 % of max.
Fuel mass scale[d]	m	5 s	1 Hz	0.36 % · m_{max} + 0.25 % · pt.	1.13 % · m_{max}	4.4 % · m_{max}
DEF mass scale[d]	m	5 s	1 Hz	0.36 % · m_{max} + 0.25 % · pt.	1.13 % · m_{max}	4.4 % · m_{max}
Total diluted exhaust meter (CVS)[c] (With heat exchanger before meter)	$\dot{n}$	1 s (5 s)	1 Hz means (1 Hz)	2 % of pt. or 1.5 % of max.	1 % of pt. or 0.75 % of max.	1 % of max.
Dilution air, inlet air, exhaust, and sample flow meters[c]	$\dot{n}$	1 s	1 Hz means of 5 Hz samples	2.5 % of pt. or 1.5 % of max.	1.25 % of pt. or 0.75 % of max.	1 % of max.
Continuous gas analyzer	x	5 s	1 Hz	2 % of pt. or 2 % of meas.	1 % of pt. or 1 % of meas.	1 % of max.
Batch gas analyzer	x	—	—	2 % of pt. or 2 % of meas.	1 % of pt. or 1 % of meas.	1 % of max.
Gravimetric PM balance	m_{PM}	—	—	See §1065.790	0.5 µg	—
Inertial PM balance	m_{PM}	5 s	1 Hz	2 % of pt. or 2 % of meas.	1 % of pt. or 1 % of meas.	0.2 % of max.

[a]The performance specifications identified in the table apply separately for rise time and fall time.
[b]Accuracy, repeatability, and noise are all determined with the same collected data, as described in §1065.305, and based on absolute values. "pt." refers to the overall flow-weighted mean value expected at the standard; "max." refers to the peak value expected at the standard over any test interval, not the maximum of the instrument's range; "meas" refers to the actual flow-weighted mean measured over any test interval.
[c]The procedure for accuracy, repeatability, and noise measurement described in §1065.305 may be modified for flow meters to allow noise to be measured at the lowest calibrated value instead of zero flow rate.

[d]Base performance specifications for mass scales on differential mass over the test interval as described in §1065.307(e)(9).

322. Amend §1065.220 by revising paragraph (a) introductory text to read as follows:

§1065.220 Fuel flow meter.

(a) Application. You may use fuel flow meters in combination with a chemical balance of fuel, DEF, intake air, and raw exhaust to calculate raw exhaust flow as described in §1065.655(f). You may also use fuel flow meters to determine the mass flow rate of carbon-carrying fuel streams for performing carbon balance error verification in §1065.543 and to calculate the mass of those fuel streams as described in §1065.643. The following provisions apply for using fuel flow meters:

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323. Amend §1065.225 by revising paragraph (a) introductory text to read as follows:

§1065.225 Intake-air flow meter.

(a) Application. You may use intake-air flow meters in combination with a chemical balance of fuel, DEF, intake air, and raw exhaust to calculate raw exhaust flow as described in §1065.655(f) and (g). You may also use intake-air flow meters to determine the amount of intake air input for performing carbon balance error verification in §1065.543 and to calculate the measured amount of intake air, n_{int}, as described in §1065.643. The following provisions apply for using intake air flow meters:

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324. Revise §1065.247 to read as follows:

§1065.247 Diesel exhaust fluid flow rate.

(a) Application. Determine diesel exhaust fluid (DEF) flow rate over a test interval for batch or continuous emission sampling using one of the three methods described in this section.

(b) ECM. Use the ECM signal directly to determine DEF flow rate. You may combine this with a gravimetric scale if that improves measurement quality. Prior to testing, you may characterize the ECM signal using a laboratory measurement and adjust the ECM signal, consistent with good engineering judgment.

(c) Flow meter. Measure DEF flow rate with a flow meter. We recommend that the flow meter that meets the specifications in Table 1 of §1065.205. Note that your overall system for measuring DEF flow must meet the linearity verification in §1065.307. Measure using the following procedure:

(1) Condition the flow of DEF as needed to prevent wakes, eddies, circulating flows, or flow pulsations from affecting the accuracy or repeatability of the meter. You may accomplish this by using a sufficient length of straight tubing (such as a length equal to at least 10 pipe diameters) or by using specially designed tubing bends, straightening fins, or pneumatic pulsation dampeners to establish a steady and predictable velocity profile upstream of the meter. Condition the flow as needed to prevent any gas bubbles in the fluid from affecting the flow meter.

(2) Account for any fluid that bypasses the DEF dosing unit or returns from the dosing unit to the fluid storage tank.

(d) Gravimetric scale. Use a gravimetric scale to determine the mass of DEF the engine uses over a discrete-mode test interval and divide by the time of the test interval.

325. Amend §1065.260 by revising paragraph (e) to read as follows:

§1065.260 Flame-ionization detector.

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(e) NMHC and NMOG. For demonstrating compliance with NMHC standards, you may either measure THC and determine NMHC mass as described in §1065.660(b)(1), or you may measure THC and CH_4 and determine NMHC as described in §1065.660(b)(2) or (3). You may also use the additive method in §1065.660(b)(4) for natural gas-fueled engines as described in §1065.266. See 40 CFR 1066.635 for methods to demonstrate compliance with NMOG standards for vehicle testing.

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326. Amend §1065.266 by revising paragraphs (a) and (b) to read as follows:

§1065.266 Fourier transform infrared analyzer.

(a) Application. For engines that run only on natural gas, you may use a Fourier transform infrared (FTIR) analyzer to measure nonmethane hydrocarbon (NMHC) and nonmethane-nonethane hydrocarbon (NMNEHC) for continuous sampling. You may use an FTIR analyzer with any gaseous-fueled engine, including dual-fuel and flexible-fuel engines, to measure CH_4 and C_2H_6, for either batch or continuous sampling (for subtraction from THC).

(b) Component requirements. We recommend that you use an FTIR analyzer that meets the specifications in Table 1 of §1065.205. Note that your FTIR-based system must meet the linearity verification in §1065.307. Use appropriate analytical procedures for interpretation of infrared spectra. For example, EPA Test Method 320 (see https://www.epa.gov/emc/method-320-vapor-phase-organic-and-inorganic-emissions-extractive-ftir) and ASTM D6348 (incorporated by reference in §1065.1010) are considered valid methods for spectral interpretation. You must use heated FTIR analyzers that maintain all surfaces that are exposed to emissions at a temperature of (110 to 202) °C.

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327. Amend §1065.275 by revising paragraph (b)(2) to read as follows:

§1065.275 N_2O measurement devices.

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(b)　　*　　*　　*

(2) Fourier transform infrared (FTIR) analyzer. Use appropriate analytical procedures for interpretation of infrared spectra. For example, EPA Test Method 320 (see §1065.266(b)) and ASTM D6348 (incorporated by reference in §1065.1010) are considered valid methods for spectral interpretation.

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328. Amend §1065.280 by revising paragraph (a) to read as follows:

§1065.280 Paramagnetic and magnetopneumatic O_2 detection analyzers.

(a) Application. You may use a paramagnetic detection (PMD) or magnetopneumatic detection (MPD) analyzer to measure O_2 concentration in raw or diluted exhaust for batch or continuous sampling. You may use good engineering judgment to develop calculations that use O_2 measurements with a chemical balance of fuel, DEF, intake air, and exhaust to calculate exhaust flow rate.

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329. Revise §1065.303 to read as follows:

§1065.303 Summary of required calibration and verifications.

The following table summarizes the required and recommended calibrations and verifications described in this subpart and indicates when these have to be performed:

TABLE 1 OF §1065.303–SUMMARY OF REQUIRED CALIBRATION AND VERIFICATIONS

Type of calibration or verification	Minimum frequency[a]
§1065.305: Accuracy, repeatability and noise	Accuracy: Not required, but recommended for initial installation. Repeatability: Not required, but recommended for initial installation. Noise: Not required, but recommended for initial installation.
§1065.307: Linearity verification	Speed: Upon initial installation, within 370 days before testing and after major maintenance. Torque: Upon initial installation, within 370 days before testing and after major maintenance. Electrical power, current, and voltage: Upon initial installation, within 370 days before testing and after major maintenance.[b] Fuel mass flow rate: Upon initial installation, within 370 days before testing, and after major maintenance. Fuel mass scale: Upon initial installation, within 370 days before testing, and after major maintenance. DEF mass flow rate: Upon initial installation, within 370 days before testing, and after major maintenance.[c] DEF mass scale: Upon initial installation, within 370 days before testing, and after major maintenance. Intake-air, dilution air, diluted exhaust, and batch sampler flow rates: Upon initial installation, within 370 days before testing and after major maintenance.[d] Raw exhaust flow rate: Upon initial installation, within 185 days before testing and after major maintenance.[d] Gas dividers: Upon initial installation, within 370 days before testing, and after major maintenance. Gas analyzers (unless otherwise noted): Upon initial installation, within 35 days before testing and after major maintenance. FTIR and photoacoustic analyzers: Upon initial installation, within 370 days before testing and after major maintenance. GC-ECD: Upon initial installation and after major maintenance. PM balance: Upon initial installation, within 370 days before testing and after major maintenance. Pressure, temperature, and dewpoint: Upon initial installation, within 370 days before testing and after major maintenance.
§1065.308: Continuous gas analyzer system response and updating-recording verification—for gas analyzers not continuously compensated for other gas species	Upon initial installation or after system modification that would affect response.
§1065.309: Continuous gas analyzer system-response and updating-recording verification—for gas analyzers continuously compensated for other gas species	Upon initial installation or after system modification that would affect response.
§1065.310: Torque	Upon initial installation and after major maintenance.
§1065.315: Pressure, temperature, dewpoint	Upon initial installation and after major maintenance.
§1065.320: Fuel flow	Upon initial installation and after major maintenance.
§1065.325: Intake flow	Upon initial installation and after major maintenance.
§1065.330: Exhaust flow	Upon initial installation and after major maintenance.
§1065.340: Diluted exhaust flow (CVS)	Upon initial installation and after major maintenance.
§1065.341: CVS and PFD flow verification (propane check)	Upon initial installation, within 35 days before testing, and after major maintenance.[e]
§1065.342 Sample dryer verification	For thermal chillers: upon installation and after major maintenance. For osmotic membranes; upon installation, within 35 days of testing, and after major maintenance.

§1065.345: Vacuum leak	For laboratory testing: upon initial installation of the sampling system, within 8 hours before the start of the first test interval of each duty-cycle sequence, and after maintenance such as pre-filter changes. For field testing: after each installation of the sampling system on the vehicle, prior to the start of the field test, and after maintenance such as pre-filter changes.
§1065.350: CO_2 NDIR H_2O interference	Upon initial installation and after major maintenance.
§1065.355: CO NDIR CO_2 and H_2O interference	Upon initial installation and after major maintenance.
§1065.360: FID calibration THC FID optimization, and THC FID verification	Calibrate all FID analyzers: upon initial installation and after major maintenance. Optimize and determine CH_4 response for THC FID analyzers: upon initial installation and after major maintenance. Verify CH_4 response for THC FID analyzers: upon initial installation, within 185 days before testing, and after major maintenance. Verify C_2H_6 response for THC FID analyzers if used for NMNEHC determination: upon initial installation, within 185 days before testing, and after major maintenance.
§1065.362: Raw exhaust FID O_2 interference	For all FID analyzers: upon initial installation, and after major maintenance. For THC FID analyzers: upon initial installation, after major maintenance, and after FID optimization according to §1065.360.
§1065.365: Nonmethane cutter penetration	Upon initial installation, within 185 days before testing, and after major maintenance.
§1065.366: Interference verification for FTIR analyzers	Upon initial installation and after major maintenance.
§1065.369: H_2O, CO, and CO_2 interference verification for ethanol photoacoustic analyzers	Upon initial installation and after major maintenance.
§1065.370: CLD CO_2 and H_2O quench	Upon initial installation and after major maintenance.
§1065.372: NDUV HC and H_2O interference	Upon initial installation and after major maintenance.
§1065.375: N_2O analyzer interference	Upon initial installation and after major maintenance.
§1065.376: Chiller NO_2 penetration	Upon initial installation and after major maintenance.
§1065.378: NO_2-to-NO converter conversion	Upon initial installation, within 35 days before testing, and after major maintenance.
§1065.390: PM balance and weighing	Independent verification: upon initial installation, within 370 days before testing, and after major maintenance. Zero, span, and reference sample verifications: within 12 hours of weighing, and after major maintenance.
§1065.395: Inertial PM balance and weighing	Independent verification: upon initial installation, within 370 days before testing, and after major maintenance. Other verifications: upon initial installation and after major maintenance.

[a]Perform calibrations and verifications more frequently than we specify, according to measurement system manufacturer instructions and good engineering judgment.
[b]Perform linearity verification either for electrical power or for current and voltage.
[c]Linearity verification is not required if DEF flow rate comes directly from the ECM signal as described in §1065.247(b).
[d]Linearity verification is not required if the flow signal's accuracy is verified by carbon balance error verification as described in §1065.307(e)(5) or a propane check as described in §1065.341.
[e]CVS and PFD flow verification (propane check) is not required for measurement systems verified by linearity verification as described in §1065.307 or carbon balance error verification as described in §1065.341(h).

330. Amend §1065.307 by–
a. Revising paragraphs (c)(13), (d)(4), (d)(6)(i), (d)(7), (d)(9), (e)(3), and (e)(5).
b. Adding paragraphs (e)(7)(i)(F) and (G), (f), and (g).
The added and revised paragraphs read as follows:

§1065.307 Linearity verification.

* * * * *

(c) * * * * *

(13) Use the arithmetic means, $\bar{y}_i$, and reference values, y_{refi}, to calculate least-squares linear regression parameters and statistical values to compare to the minimum performance criteria specified in Table 1 of this section. Use the calculations for a floating intercept described in §1065.602. Using good engineering judgment, you may weight the results of individual data pairs (i.e., (y_{refi}, $\bar{y}_i$)), in the linear regression calculations.

(d) * * *

(4) Fuel and DEF mass flow rate. Use a gravimetric reference measurement (such as a scale, balance, or mass comparator) and a container. Use a stopwatch or timer to measure the time intervals over which reference masses of fluid pass through the mass flow rate meter. Use good engineering judgment to correct the reference mass flowing through the mass flow rate meter for buoyancy effects from any tubes, temperature probes, or objects submerged in the fluid in the container that are not attached to the container. If the container has any tubes or wires connected to the container, recalibrate the gravimetric reference measurement device with them connected and at normal operating pressure using calibration weights that meet the requirements in §1065.790. The corrected reference mass that flowed through the mass flow rate meter during a time interval divided by the duration of the time interval is the average reference mass flow rate. For meters that report a different quantity (such as actual volume, standard volume, or moles), convert the reported quantity to mass. For meters that report a cumulative quantity calculate the average measured mass flow rate as the difference in the reported cumulative mass during the time interval divided by the duration of the time interval. For measuring flow rate of gaseous fuel prevent condensation on the fuel container and any attached tubes, fittings, or regulators.

* * * * *

(6) * * *

(i) At the outlet of the gas-division system, connect a gas analyzer that meets the linearity verification described in this section and has not been linearized with the gas divider being verified. For example, verify the linearity of an analyzer using a series of reference analytical gases directly from compressed gas cylinders that meet the specifications of §1065.750. We recommend using a FID analyzer or a PMD or MPD O_2 analyzer because of their inherent linearity. Operate this analyzer consistent with how you would operate it during an emission test. Connect a span gas containing only a single constituent of interest with balance of purified air or purified N_2 to the gas-divider inlet. Use the gas-division system to divide the span gas with purified air or nitrogen. Select gas divisions that you typically use. Use a selected gas division as the measured value. Use the analyzer response divided by the span gas concentration as the reference gas-division value. Because the instrument response is not absolutely constant, sample and record values of x_{refi} for 30 seconds and use the arithmetic mean of the values, $\bar{x}_{ref}$, as the reference value. Refer to §1065.602 for an example of calculating arithmetic mean.

* * * * *

(7) Continuous constituent concentration. For reference values, use a series of gas cylinders of known gas concentration containing only a single constituent of interest with balance of purified air or purified N_2 or use a gas-division system that is known to be linear with a span gas. Gas cylinders, gas-division systems, and span gases that you use for reference values must meet the specifications of §1065.750.

* * * * *

(9) Mass. For linearity verification for gravimetric PM balances, fuel mass scales, and DEF mass scales, use external calibration weights that meet the requirements in §1065.790. Perform

the linearity verification for fuel mass scales and DEF mass scales with the in-use container, installing all objects that interface with the container. For example, this includes all tubes, temperature probes, and objects submerged in the fluid in the container; it also includes tubes, fittings, regulators, and wires, and any other objects attached to the container. We recommend that you develop and apply appropriate buoyancy corrections for the configuration of your mass scale during normal testing, consistent with good engineering judgment. Account for the scale weighing a calibration weight instead of fluid if you calculate buoyancy corrections. You may also correct for the effect of natural convection currents from temperature differences between the container and ambient air. Prepare for linearity verification by taking the following steps for vented and unvented containers:

(i) If the container is vented to ambient, fill the container and tubes with fluid above the minimum level used to trigger a fill operation; drain the fluid down to the minimum level; tare the scale; and perform the linearity verification.

(ii) If the container is rigid and not vented, drain the fluid down to the minimum level; fill all tubes attached to the container to normal operating pressure; tare the scale; and perform the linearity verification.

(e) * * *

(3) The expression "max" generally refers to the absolute value of the reference value used during linearity verification that is furthest from zero. This is the value used to scale the first and third tolerances in Table 1 of this section using a_0 and *SEE*. For example, if the reference values chosen to validate a pressure transducer vary from –10 to –1 kPa, then p_{max} is +10 kPa. If the reference values used to validate a temperature device vary from 290 to 390 K, then T_{max} is 390 K. For gas dividers where "max" is expressed as, x_{max}/x_{span}; x_{max} is the maximum gas concentration used during the verification, x_{span} is the undivided, undiluted, span gas concentration, and the resulting ratio is the maximum divider point reference value used during the verification (typically 1). The following are special cases where "max" refers to a different value:

(i) For linearity verification of a PM balance, m_{max} is the typical mass of a PM filter.

(ii) For linearity verification of a torque measurement system used with the engine's primary output shaft, T_{max} is the manufacturer's specified peak torque of the lowest torque engine expected during testing.

(iii) For linearity verification of a fuel mass scale, m_{max} is determined based on the range of engines and test interval durations expected during testing. It is the minimum, over all engines expected during testing, of the fuel consumption expected over the minimum test interval duration at the engine's maximum fuel rate. If the minimum test interval duration used during testing does not change with engine power or if the minimum test interval duration used during testing increases with engine power, m_{max} is given by Eq. 1065.307-1. Calculate m_{max} using the following equation:

$$m_{\text{max,fuel scale}} = \dot{m}_{\text{max,fuel}} \cdot t_{\text{min}}$$

Eq. 1065.307-1

Where:

$\dot{m}_{\text{max,fuel}}$ = the manufacturer's specified maximum fuel rate on the lowest-power engine expected during testing.

t_{min} = the minimum test interval duration expected during testing. If the minimum test interval duration decreases with engine power, evaluate Eq. 1065.307-1 for the range of engines expected during testing and use the minimum calculated value of $m_{\text{max,fuel scale}}$.

(iv) For linearity verification of a DEF mass scale, m_{max} is 10 % of the value determined for a fuel mass scale in paragraph (e)(3)(iii) of this section. You may determine m_{max} for a DEF mass scale by evaluating m_{max} for a fuel mass scale based only on the DEF-using engines expected during testing.
(v) For linearity verification of a fuel flow rate meter, $\dot{m}_{max}$ is the manufacturer's specified maximum fuel rate of the lowest-power engine expected during testing.
(vi) For linearity verification of a DEF flow rate meter, $\dot{m}_{max}$ is 10 % of the manufacturer's specified maximum fuel rate of the lowest-power DEF-using engine expected during testing.
(vii) For linearity verification of an intake-air flow rate meter, $\dot{n}_{max}$ is the manufacturer's specified maximum intake-air flow rate (converted to molar flow rate) of the lowest-power engine expected during testing.
(viii) For linearity verification of a raw exhaust flow rate meter, $\dot{n}_{max}$ is the manufacturer's specified maximum exhaust flow rate (converted to molar flow rate) of the lowest-power engine expected during testing.
(ix) For linearity verification of an electrical-power measurement system used to determine the engine's primary output shaft torque, P_{max} is the manufacturer's specified maximum power of the lowest-power engine expected during testing.
(x) For linearity verification of an electrical-current measurement system used to determine the engine's primary output shaft torque, I_{max} is the maximum current expected on the lowest-power engine expected during testing.
(xi) For linearity verification of an electrical-voltage measurement system used to determine the engine's primary output shaft torque, V_{max} is the minimum peak voltage expected on the range of engines expected during testing.
* * * * *
(5) Table 2 of this section describes optional verification procedures you may perform instead of linearity verification for certain systems. The following provisions apply for the alternative verification procedures:
(i) Perform the propane check verification described in §1065.341 at the frequency specified in Table 1 of §1065.303.
(ii) Perform the carbon balance error verification described in §1065.543 on all test sequences that use the corresponding system. It must also meet the restrictions listed in Table 2 of this section. You may evaluate the carbon balance error verification multiple ways with different inputs to validate multiple flow-measurement systems.
* * * * *
(7) * * *
(i) * * *
(F) Transmission oil.
(G) Axle gear oil.
* * * * *
(f) Table 1 follows:

TABLE 1 OF §1065.307–MEASUREMENT SYSTEMS THAT REQUIRE LINEARITY VERIFICATION

Measurement system	Quantity	Linearity criteria			
		$\lvert x_{min}(a_1-1)+a_0 \rvert$	a_1	SEE	r^2
Speed	f_n	≤ 0.05 % · f_{nmax}	0.98-1.02	≤ 2 % · f_{nmax}	≥ 0.990
Torque	T	≤ 1 % · T_{max}	0.98-1.02	≤ 2 % · T_{max}	≥ 0.990
Electrical power	P	≤ 1 % · P_{max}	0.98-1.02	≤ 2 % · P_{max}	≥ 0.990
Current	I	≤ 1 % · I_{max}	0.98-1.02	≤ 2 % · I_{max}	≥ 0.990
Voltage	U	≤ 1 % · U_{max}	0.98-1.02	≤ 2 % · U_{max}	≥ 0.990
Fuel flow rate	$\dot{m}$	≤ 1 % · $\dot{m}_{max}$	0.98-1.02	≤ 2 % · $\dot{m}_{max}$	≥ 0.990
Fuel mass scale	m	≤ 0.3 % · m_{max}	0.996-1.004	≤ 0.4 % · m_{max}	≥ 0.999
DEF flow rate	$\dot{m}$	≤ 1 % · $\dot{m}_{max}$	0.98-1.02	≤ 2 % · $\dot{m}_{max}$	≥ 0.990
DEF mass scale	m	≤ 0.3 % · m_{max}	0.996-1.004	≤ 0.4 % · m_{max}	≥ 0.999
Intake-air flow rate[a]	$\dot{n}$	≤ 1 % · $\dot{n}_{max}$	0.98-1.02	≤ 2 % · $\dot{n}_{max}$	≥ 0.990
Dilution air flow rate[a]	$\dot{n}$	≤ 1 % · $\dot{n}_{max}$	0.98-1.02	≤ 2 % · $\dot{n}_{max}$	≥ 0.990
Diluted exhaust flow rate[a]	$\dot{n}$	≤ 1 % · $\dot{n}_{max}$	0.98-1.02	≤ 2 % · $\dot{n}_{max}$	≥ 0.990
Raw exhaust flow rate[a]	$\dot{n}$	≤ 1 % · $\dot{n}_{max}$	0.98-1.02	≤ 2 % · $\dot{n}_{max}$	≥ 0.990
Batch sampler flow rates[a]	$\dot{n}$	≤ 1 % · $\dot{n}_{max}$	0.98-1.02	≤ 2 % · $\dot{n}_{max}$	≥ 0.990
Gas dividers	x/x_{span}	≤ 0.5 % · x_{max}/x_{span}	0.98-1.02	≤ 2 % · x_{max}/x_{span}	≥ 0.990
Gas analyzers for laboratory testing	x	≤ 0.5 % · x_{max}	0.99-1.01	≤ 1 % · x_{max}	≥ 0.998
Gas analyzers for field testing	x	≤ 1 % · x_{max}	0.99-1.01	≤ 1 % · x_{max}	≥ 0.998
PM balance	m	≤ 1 % · m_{max}	0.99-1.01	≤ 1 % · m_{max}	≥ 0.998
Pressures	p	≤ 1 % · p_{max}	0.99-1.01	≤ 1 % · p_{max}	≥ 0.998
Dewpoint for intake air, PM-stabilization and balance environments	T_{dew}	≤ 0.5 % · T_{dewmax}	0.99-1.01	≤ 0.5 % · T_{dewmax}	≥ 0.998
Other dewpoint measurements	T_{dew}	≤ 1 % · T_{dewmax}	0.99-1.01	≤ 1 % · T_{dewmax}	≥ 0.998
Analog-to-digital conversion of temperature signals	T	≤ 1 % · T_{max}	0.99-1.01	≤ 1 % · T_{max}	≥ 0.998

[a]For flow meters that determine volumetric flow rate, $\dot{V}_{std}$, you may substitute $\dot{V}_{std}$ for $\dot{n}$ as the quantity and substitute $\dot{V}_{stdmax}$ for $\dot{n}_{max}$.

(g) Table 2 follows:

TABLE 2 OF §1065.307–OPTIONAL VERIFICATION TO LINEARITY VERIFICATION

Measurement system	§1065.341	§1065.543	Restrictions for §1065.543
Intake-air flow rate	Yes	Yes	Determine raw exhaust flow rate using the intake-air flow rate signal as an input into Eq. 1065.655-24 and determine mass of CO_2 over each test interval input into Eq. 1065.643-6 using samples taken from the raw exhaust (continuous or bag, and with or without a PFD).
Dilution air flow rate for CVS	Yes	No	Not allowed.
Diluted exhaust flow rate for CVS	Yes	Yes	Determine mass of CO_2 over each test interval input into Eq. 1065.643-6 using samples taken from the CVS (continuous or bag, and with or without a PFD).
Raw exhaust flow rate for exhaust stack	Yes	Yes	Determine mass of CO_2 over each test interval input into Eq. 1065.643-6 using samples taken from the raw exhaust (continuous or bag, and with or without a PFD).
Flow measurements in a PFD (usually dilution air and diluted exhaust streams) used to determine the dilution ratio in the PFD	Yes	Yes	Determine mass of CO_2 over each test interval input into Eq. 1065.643-6 using samples taken from the PFD (continuous or bag).
Batch sampler flow rates	Yes	No	Not allowed.
Fuel mass flow rate	No	Yes	Determine mass of a carbon-carrying fluid stream used as an input into Eq. 1065.643-1 using the fuel mass flow rate meter.
Fuel mass scale	No	Yes	Determine mass of a carbon-carrying fluid stream used as an input into Eq. 1065.643-1 using the fuel mass scale.

331. Amend §1065.309 by revising paragraph (d)(2) to read as follows:

§1065.309 Continuous gas analyzer system-response and updating-recording verification—for gas analyzers continuously compensated for other gas species.

* * * * *

(d) * * *

(2) Equipment setup. We recommend using minimal lengths of gas transfer lines between all connections and fast-acting three-way valves (2 inlets, 1 outlet) to control the flow of zero and blended span gases to the sample system's probe inlet or a tee near the outlet of the probe. If you inject the gas at a tee near the outlet of the probe, you may correct the transformation time, t_{50}, for an estimate of the transport time from the probe inlet to the tee. Normally the gas flow rate is higher than the sample flow rate and the excess is overflowed out the inlet of the probe. If the gas flow rate is lower than the sample flow rate, the gas concentrations must be adjusted to account for the dilution from ambient air drawn into the probe. We recommend you use the final, stabilized analyzer reading as the final gas concentration. Select span gases for the species being continuously combined, other than H_2O. Select concentrations of compensating species that will yield concentrations of these species at the analyzer inlet that covers the range of concentrations expected during testing. You may use binary or multi-gas span gases. You may use a gas blending or mixing device to blend span gases. A gas blending or mixing device is recommended when blending span gases diluted in N_2 with span gases diluted in air. You may use a multi-gas span gas, such as NO-CO-CO_2-C_3H_8-CH_4, to verify multiple analyzers at the same time. In designing your experimental setup, avoid pressure pulsations due to stopping the flow through the gas blending device. The change in gas concentration must be at least 20 % of the analyzer's range. If H_2O correction is applicable, then span gases must be humidified before entering the analyzer; however, you may not humidify NO_2 span gas by passing it through a sealed humidification vessel that contains H_2O. You must humidify NO_2 span gas with another

moist gas stream. We recommend humidifying your NO-CO-CO_2-C_3H_8-CH_4, balance N_2, blended gas by bubbling the gas mixture that meets the specifications in §1065.750 through distilled H_2O in a sealed vessel and then mixing the gas with dry NO_2 gas, balance purified air, or by using a device that introduces distilled H_2O as vapor into a controlled span gas flow. If the sample does not pass through a dryer during emission testing, humidify your span gas to an H_2O level at or above the maximum expected during emission testing. If the sample passes through a dryer during emission testing, it must pass the sample dryer verification check in §1065.342, and you must humidify your span gas to an H_2O level at or above the level determined in §1065.145(e)(2) for that dryer. If you are humidifying span gases without NO_2, use good engineering judgment to ensure that the wall temperatures in the transfer lines, fittings, and valves from the humidifying system to the probe are above the dewpoint required for the target H_2O content. If you are humidifying span gases with NO_2, use good engineering judgment to ensure that there is no condensation in the transfer lines, fittings, or valves from the point where humidified gas is mixed with NO_2 span gas to the probe. We recommend that you design your setup so that the wall temperatures in the transfer lines, fittings, and valves from the humidifying system to the probe are at least 5 ºC above the local sample gas dewpoint. Operate the measurement and sample handling system as you do for emission testing. Make no modifications to the sample handling system to reduce the risk of condensation. Flow humidified gas through the sampling system before this check to allow stabilization of the measurement system's sampling handling system to occur, as it would for an emission test.

* * * * *

§1065.320—[Amended]

332. Amend §1065.320 by removing and reserving paragraph (b).

333. Revise §1065.341 to read as follows:

§1065.341 CVS and PFD flow verification (propane check).

This section describes two optional methods, using propane as a tracer gas, to verify CVS and PFD flow streams. You may use good engineering judgment and safe practices to use other tracer gases, such as CO_2 or CO. The first method, described in paragraphs (a) through (e) of this section, applies for the CVS diluted exhaust flow measurement system. It may also apply for other single-flow measurement systems as described in Table 2 of §1065.307. Paragraph (g) of this section describes a second method you may use to verify flow measurements in a PFD for determining the PFD dilution ratio.

(a) A propane check uses either a reference mass or a reference flow rate of C_3H_8 as a tracer gas in a CVS. Note that if you use a reference flow rate, account for any non-ideal gas behavior of C_3H_8 in the reference flow meter. Refer to §1065.640 and §1065.642, which describe how to calibrate and use certain flow meters. Do not use any ideal gas assumptions in §1065.640 and §1065.642. The propane check compares the calculated mass of injected C_3H_8 using HC measurements and CVS flow rate measurements with the reference value.

(b) Prepare for the propane check as follows:

(1) If you use a reference mass of C_3H_8 instead of a reference flow rate, obtain a cylinder charged with C_3H_8. Determine the reference cylinder's mass of C_3H_8 within ±0.5 % of the amount of C_3H_8 that you expect to use. You may substitute a C_3H_8 analytical gas mixture (i.e., a prediluted tracer gas) for pure C_3H_8. This would be most appropriate for lower flow rates. The analytical gas mixture must meet the specifications in §1065.750(a)(3).

(2) Select appropriate flow rates for the CVS and C_3H_8.
(3) Select a C_3H_8 injection port in the CVS. Select the port location to be as close as practical to the location where you introduce engine exhaust into the CVS, or at some point in the laboratory exhaust tubing upstream of this location. Connect the C_3H_8 cylinder to the injection system.
(4) Operate and stabilize the CVS.
(5) Preheat or pre-cool any heat exchangers in the sampling system.
(6) Allow heated and cooled components such as sample lines, filters, chillers, and pumps to stabilize at operating temperature.
(7) You may purge the HC sampling system during stabilization.
(8) If applicable, perform a vacuum side leak verification of the HC sampling system as described in §1065.345.
(9) You may also conduct any other calibrations or verifications on equipment or analyzers.
(c) If you performed the vacuum-side leak verification of the HC sampling system as described in paragraph (b)(8) of this section, you may use the HC contamination procedure in §1065.520(f) to verify HC contamination. Otherwise, zero, span, and verify contamination of the HC sampling system, as follows:
(1) Select the lowest HC analyzer range that can measure the C_3H_8 concentration expected for the CVS and C_3H_8 flow rates.
(2) Zero the HC analyzer using zero air introduced at the analyzer port.
(3) Span the HC analyzer using C_3H_8 span gas introduced at the analyzer port.
(4) Overflow zero air at the HC probe inlet or into a tee near the outlet of the probe.
(5) Measure the stable HC concentration of the HC sampling system as overflow zero air flows. For batch HC measurement, fill the batch container (such as a bag) and measure the HC overflow concentration.
(6) If the overflow HC concentration exceeds 2 μmol/mol, do not proceed until contamination is eliminated. Determine the source of the contamination and take corrective action, such as cleaning the system or replacing contaminated portions.
(7) When the overflow HC concentration does not exceed 2 μmol/mol, record this value as $x_{THCinit}$ and use it to correct for HC contamination as described in §1065.660.
(d) Perform the propane check as follows:
(1) For batch HC sampling, connect clean storage media, such as evacuated bags.
(2) Operate HC measurement instruments according to the instrument manufacturer's instructions.
(3) If you will correct for dilution air background concentrations of HC, measure and record background HC in the dilution air.
(4) Zero any integrating devices.
(5) Begin sampling, and start any flow integrators.
(6) Release the contents of the C_3H_8 reference cylinder at the rate you selected. If you use a reference flow rate of C_3H_8, start integrating this flow rate.
(7) Continue to release the cylinder's contents until at least enough C_3H_8 has been released to ensure accurate quantification of the reference C_3H_8 and the measured C_3H_8.
(8) Shut off the C_3H_8 reference cylinder and continue sampling until you have accounted for time delays due to sample transport and analyzer response.
(9) Stop sampling and stop any integrators.
(e) Perform post-test procedure as follows:
(1) If you used batch sampling, analyze batch samples as soon as practical.

(2) After analyzing HC, correct for contamination and background.
(3) Calculate total C_3H_8 mass based on your CVS and HC data as described in §1065.650 (40 CFR 1066.605 for vehicle testing) and §1065.660, using the molar mass of C_3H_8, M_{C3H8}, instead the effective molar mass of HC, M_{HC}.
(4) If you use a reference mass, determine the cylinder's propane mass within ±0.5 % and determine the C_3H_8 reference mass by subtracting the empty cylinder propane mass from the full cylinder propane mass.
(5) Subtract the reference C_3H_8 mass from the calculated mass. If this difference is within ±2 % of the reference mass, the CVS passes this verification. If not, take corrective action as described in paragraph (f) of this section.
(f) A failed propane check might indicate one or more problems requiring corrective action, as follows:

Problem	Recommended Corrective Action
Incorrect analyzer calibration	Recalibrate, repair, or replace the FID analyzer.
Leaks	Inspect CVS tunnel, connections, fasteners, and HC sampling system. Repair or replace components.
Poor mixing	Perform the verification as described in this section while traversing a sampling probe across the tunnel's diameter, vertically and horizontally. If the analyzer response indicates any deviation exceeding ±2 % of the mean measured concentration, consider operating the CVS at a higher flow rate or installing a mixing plate or orifice to improve mixing.
Hydrocarbon contamination in the sample system	Perform the hydrocarbon-contamination verification as described in §1065.520.
Change in CVS calibration	Perform a calibration of the CVS flow meter as described in §1065.340.
Flow meter entrance effects	Inspect the CVS tunnel to determine whether the entrance effects from the piping configuration upstream of the flow meter adversely affect the flow measurement.
Other problems with the CVS or sampling verification hardware or software	Inspect the CVS system and related verification hardware, and software for discrepancies.

(g) You may verify flow measurements in a PFD (usually dilution air and diluted exhaust streams) for determining the dilution ratio in the PFD using the following method:
(1) Configure the HC sampling system to extract a sample from the PFD's diluted exhaust stream (such as near a PM filter). If the absolute pressure at this location is too low to extract an HC sample, you may sample HC from the PFD's pump exhaust. Use caution when sampling from pump exhaust because an otherwise acceptable pump leak downstream of a PFD diluted exhaust flow meter will cause a false failure of the propane check.
(2) Perform the propane check described in paragraphs (b), (c), and (d) of this section, but sample HC from the PFD's diluted exhaust stream. Inject the propane in the same exhaust stream that the PFD is sampling from (either CVS or raw exhaust stack).
(3) Calculate C_3H_8 mass, taking into account the dilution from the PFD.

(4) Subtract the reference C_3H_8 mass from the calculated mass. If this difference is within ±2 % of the reference mass, all PFD flow measurements for determining PFD dilution ratio pass this verification. If not, take corrective action as described in paragraph (f) of this section. For PFDs sampling only for PM, the allowed difference is ±5 %.
(h) Table 2 of §1065.307 describes optional verification procedures you may perform instead of linearity verification for certain flow-measurement systems. Performing carbon balance error verification also replaces any required propane checks.

334. Amend §1065.342 by revising paragraph (d)(2) to read as follows:
§1065.342 Sample dryer verification.
* * * * *
(d) * * *
(2) Humidify room air, purified N_2, or purified air by bubbling it through distilled H_2O in a sealed vessel or use a device that injects distilled H_2O as vapor into a controlled gas flow to humidify the gas to the highest sample H_2O content that you estimate during emission sampling.
* * * * *

335. Amend §1065.350 by revising paragraph (d)(2) to read as follows:
§1065.350 H_2O interference verification for CO_2 NDIR analyzers.
* * * * *
(d) * * *
(2) Create a humidified test gas by bubbling zero gas that meets the specifications in §1065.750 through distilled H_2O in a sealed vessel or use a device that introduces distilled H_2O as vapor into a controlled gas flow. If the sample does not pass through a dryer during emission testing, humidify your test gas to an H_2O level at or above the maximum expected during emission testing. If the sample passes through a dryer during emission testing, you must humidify your test gas to an H_2O level at or above the level determined in §1065.145(e)(2) for that dryer.
* * * * *

336. Amend §1065.355 by revising paragraph (d)(2) to read as follows:
§1065.355 H_2O and CO_2 interference verification for CO NDIR analyzers.
* * * * *
(d) * * *
(2) Create a humidified CO_2 test gas by bubbling a CO_2 span gas that meets the specifications in §1065.750 through distilled H_2O in a sealed vessel or use a device that introduces distilled H_2O as vapor into a controlled gas flow. If the sample does not pass through a dryer during emission testing, humidify your test gas to an H_2O level at or above the maximum expected during emission testing. If the sample passes through a dryer during emission testing, you must humidify your test gas to an H_2O at or above the level determined in §1065.145(e)(2) for that dryer. Use a CO_2 span gas concentration at least as high as the maximum expected during testing.
* * * * *

337. Amend §1065.360 by adding paragraphs (a)(4) and (d)(12) to read as follows:
§1065.360 FID optimization and verification.
(a) * * *

(4) For any gaseous-fueled engine, including dual-fuel and flexible-fuel engines, you may determine the methane (CH_4) and ethane (C_2H_6) response factors as a function of the molar water concentration in the raw or diluted exhaust. If you choose this option, generate and verify the humidity level (or fraction) as described in §1065.365(d)(11).

* * * * *

(d) * * *

(12) Determine the response factor as a function of molar water concentration and use this response factor to account for the CH_4 response for NMHC determination described in §1065.660(b)(2)(iii). Humidify the CH_4 span gas as described in §1065.365(d)(11) and repeat the steps in paragraphs (d)(7) through (9) of this section until measurements are complete for each setpoint in the selected range. Divide each mean measured CH_4 concentration by the recorded span concentration of the CH_4 calibration gas, adjusted for water content, to determine the FID analyzer's CH_4 response factor, $RF_{CH4[THC\text{-}FID]}$. Use the CH_4 response factors at the different setpoints to create a functional relationship between response factor and molar water concentration, downstream of the last sample dryer if any sample dryers are present. Use this functional relationship to determine the response factor during an emission test.

* * * * *

338. Amend §1065.365 by revising paragraphs (a), (d), (f)(9), and (f)(14) to read as follows:

§1065.365 Nonmethane cutter penetration fractions.

(a) Scope and frequency. If you use a FID analyzer and a nonmethane cutter (NMC) to measure methane (CH_4), determine the nonmethane cutter's penetration fractions of methane, PF_{CH4}, and ethane, PF_{C2H6}. As detailed in this section, these penetration fractions may be determined as a combination of NMC penetration fractions and FID analyzer response factors, depending on your particular NMC and FID analyzer configuration. Perform this verification after installing the nonmethane cutter. Repeat this verification within 185 days of testing to verify that the catalytic activity of the cutter has not deteriorated. Note that because nonmethane cutters can deteriorate rapidly and without warning if they are operated outside of certain ranges of gas concentrations and outside of certain temperature ranges, good engineering judgment may dictate that you determine a nonmethane cutter's penetration fractions more frequently.

* * * * *

(d) Procedure for a FID calibrated with the NMC. The method described in this paragraph (d) is recommended over the procedures specified in paragraphs (e) and (f) of this section and required for any gaseous-fueled engine, including dual-fuel and flexible-fuel engines. If your FID arrangement is such that a FID is always calibrated to measure CH_4 with the NMC, then span that FID with the NMC using a CH_4 span gas, set the product of that FID's CH_4 response factor and CH_4 penetration fraction, $RFPF_{CH4[NMC\text{-}FID]}$, equal to 1.0 for all emission calculations, and determine its combined C_2H_6 response factor and C_2H_6 penetration fraction, $RFPF_{C2H6[NMC\text{-}FID]}$, as follows. For any gaseous-fueled engine, including dual-fuel and flexible-fuel engines, you must determine the CH_4 penetration fraction, $PF_{CH4[NMC\text{-}FID]}$, and C_2H_6 response factor and C_2H_6 penetration fraction, $RFPF_{C2H6[NMC\text{-}FID]}$, as a function of the molar water concentration in the raw or diluted exhaust as described in paragraphs (d)(10) and (12) of this section. Generate and verify the humidity generation as described in §1065.365(d)(11). When using this option, note that the FID's CH_4 penetration fraction, $PF_{CH4[NMC\text{-}FID]}$, is set equal to 1.0 only for 0 % molar water concentration. You are not required to meet the recommended lower limit for PF_{CH4} of

greater than 0.85 for any of the penetration fractions generated as a function of molar water concentration.
(1) Select CH_4 and C_2H_6 analytical gas mixtures and ensure that both mixtures meet the specifications of §1065.750. Select a CH_4 concentration that you would use for spanning the FID during emission testing and select a C_2H_6 concentration that is typical of the peak NMHC concentration expected at the hydrocarbon standard or equal to the THC analyzer's span value. For CH_4 analyzers with multiple ranges, perform this procedure on the highest range used for emission testing.
(2) Start, operate, and optimize the nonmethane cutter according to the manufacturer's instructions, including any temperature optimization.
(3) Confirm that the FID analyzer meets all the specifications of §1065.360.
(4) Start and operate the FID analyzer according to the manufacturer's instructions.
(5) Zero and span the FID with the nonmethane cutter as you would during emission testing. Span the FID through the cutter by using CH_4 span gas.
(6) Introduce the C_2H_6 analytical gas mixture upstream of the nonmethane cutter. Use good engineering judgment to address the effect of hydrocarbon contamination if your point of introduction is vastly different from the point of zero/span gas introduction.
(7) Allow time for the analyzer response to stabilize. Stabilization time may include time to purge the nonmethane cutter and to account for the analyzer's response.
(8) While the analyzer measures a stable concentration, record 30 seconds of sampled data. Calculate the arithmetic mean of these data points.
(9) Divide the mean C_2H_6 concentration by the reference concentration of C_2H_6, converted to a C_1 basis. The result is the C_2H_6 combined response factor and penetration fraction, $RFPF_{C2H6[NMC\text{-}FID]}$. Use this combined C_2H_6 response factor and C_2H_6 penetration fraction and the product of the CH_4 response factor and CH_4 penetration fraction, $RFPF_{CH4[NMC\text{-}FID]}$, set to 1.0 in emission calculations according to §1065.660(b)(2)(i), §1065.660(d)(1)(i), or §1065.665, as applicable.
(10) Determine the combined C_2H_6 response factor and C_2H_6 penetration fraction as a function of molar water concentration and use it to account for C_2H_6 response factor and C_2H_6 penetration fraction for NMHC determination as described in §1065.660(b)(2)(iii) and for CH_4 determination in §1065.660(d)(1)(iii). Humidify the C_2H_6 analytical gas mixture as described in paragraph (d)(11) of this section. Repeat the steps in paragraphs (d)(6) through (8) of this section until measurements are complete for each setpoint in the selected range. Divide each mean measured C_2H_6 concentration by the reference concentration of C_2H_6, converted to a C_1-basis and adjusted for water content to determine the FID analyzer's combined C_2H_6 response factor and C_2H_6 penetration fraction, $RFPF_{C2H6[NMC\text{-}FID]}$. Use $RFPF_{C2H6[NMC\text{-}FID]}$ at the different setpoints to create a functional relationship between the combined response factor and penetration fraction and molar water concentration, downstream of the last sample dryer if any sample dryers are present. Use this functional relationship to determine the combined response factor and penetration fraction during the emission test.
(11) Create a humidified test gas by bubbling the analytical gas mixture that meets the specifications in §1065.750 through distilled H_2O in a sealed vessel or use a device that introduces distilled H_2O as vapor into a controlled gas flow. If the sample does not pass through a dryer during emission testing, generate at least five different H_2O concentrations that cover the range from less than the minimum expected to greater than the maximum expected water concentration during testing. Use good engineering judgment to determine the target

concentrations. For analyzers where the sample passes through a dryer during emission testing, humidify your test gas to an H_2O level at or above the level determined in §1065.145(e)(2) for that dryer and determine a single wet analyzer response to the dehumidified sample. Heat all transfer lines from the water generation system to a temperature at least 5 °C higher than the highest dewpoint generated. Determine H_2O concentration as an average value over intervals of at least 30 seconds. Monitor the humidified sample stream with a dewpoint analyzer, relative humidity sensor, FTIR, NDIR, or other water analyzer during each test or, if the humidity generator achieves humidity levels with controlled flow rates, validate the instrument within 370 days before testing and after major maintenance using one of the following methods:

(i) Determine the linearity of each flow metering device. Use one or more reference flow meters to measure the humidity generator's flow rates and verify the H_2O level value based on the humidity generator manufacturer's recommendations and good engineering judgment. We recommend that you utilize at least 10 flow rates for each flow-metering device.

(ii) Perform validation testing based on monitoring the humidified stream with a dewpoint analyzer, relative humidity sensor, FTIR, NDIR, or other water analyzer as described in this paragraph (d)(11). Compare the measured humidity to the humidity generator's value. Verify overall linearity performance for the generated humidity as described in §1065.307 using the criteria for other dewpoint measurements or confirm all measured values are within ± 2 % of the target mole fraction. In the case of dry gas, the measured value may not exceed 0.002 mole fraction.

(iii) Follow the performance requirements in §1065.307(b) if the humidity generator does not meet validation criteria.

(12) Determine the CH_4 penetration fraction as a function of molar water concentration and use this penetration fraction for NMHC determination in §1065.660(b)(2)(iii) and for CH_4 determination in §1065.660(d)(1)(iii). Repeat the steps in paragraphs (d)(6) through (11) of this section, but with the CH_4 analytical gas mixture instead of C_2H_6. Use this functional relationship to determine the penetration fraction during the emission test.

*   *   *   *   *

(f)   *   *   *

(9) Divide the mean C_2H_6 concentration by the reference concentration of C_2H_6, converted to a C_1 basis. The result is the combined C_2H_6 response factor and C_2H_6 penetration fraction, $RFPF_{C2H6[NMC-FID]}$. Use this combined C_2H_6 response factor and C_2H_6 penetration fraction according to §1065.660(b)(2)(iii), §1065.660(d)(1)(iii), or §1065.665, as applicable.

*   *   *   *   *

(14) Divide the mean CH_4 concentration measured through the nonmethane cutter by the mean CH_4 concentration measured after bypassing the nonmethane cutter. The result is the CH_4 penetration fraction, $PF_{CH4[NMC-FID]}$. Use this CH_4 penetration fraction according to §1065.660(b)(2)(iii), §1065.660(d)(1)(iii), or §1065.665, as applicable.

339. Amend §1065.370 by revising paragraph (e)(5) to read as follows:

§1065.370 CLD CO_2 and H_2O quench verification.

*   *   *   *   *

(e)   *   *   *

(5) Create a humidified NO span gas by bubbling a NO gas that meets the specifications in §1065.750 through distilled H_2O in a sealed vessel or use a device that introduces distilled H_2O as vapor into a controlled gas flow. If the sample does not pass through a dryer during emission

testing, humidify your test gas to an H_2O level approximately equal to the maximum mole fraction of H_2O expected during emission testing. If the humidified NO span gas sample does not pass through a sample dryer, the quench verification calculations in §1065.675 scale the measured H_2O quench to the highest mole fraction of H_2O expected during emission testing. If the sample passes through a dryer during emission testing, you must humidify your test gas to an H_2O level at or above the level determined in §1065.145(e)(2) for that dryer. For this case, the quench verification calculations in §1065.675 do not scale the measured H_2O quench.
* * * * *

340. Amend §1065.375 by revising paragraph (d)(2) to read as follows:

§1065.375 Interference verification for N_2O analyzers.

* * * * *

(d) * * *

(2) Create a humidified test gas by bubbling a multi component span gas that incorporates the target interference species and meets the specifications in §1065.750 through distilled H_2O in a sealed vessel or use a device that introduces distilled H_2O as vapor into a controlled gas flow. If the sample does not pass through a dryer during emission testing, humidify your test gas to an H_2O level at or above the maximum expected during emission testing. If the sample passes through a dryer during emission testing, you must humidify your test gas to an H_2O level at or above the level determined in §1065.145(e)(2) for that dryer. Use interference span gas concentrations that are at least as high as the maximum expected during testing.
* * * * *

341. Amend §1065.410 by revising paragraphs (c) and (d) to read as follows:

§1065.410 Maintenance limits for stabilized test engines.

* * * * *

(c) If you inspect an engine, keep a record of the inspection and update your application for certification to document any changes that result. You may use any kind of equipment, instrument, or tool that is available at dealerships and other service outlets to identify malfunctioning components or perform maintenance.

(d) You may repair defective parts from a test engine if they are unrelated to emission control. You must ask us to approve repairs that might affect the engine's emission controls. If we determine that a part failure, system malfunction, or associated repair makes the engine's emission controls unrepresentative of production engines, you may not use it as an emission-data engine. Also, if your test engine has a major mechanical failure that requires you to take it apart, you may no longer use it as an emission-data engine.

342. Amend §1065.510 by–

a. Revising paragraphs (a) introductory text and (b)(5)(i).

b. Adding paragraph (c)(5).

c. Revising paragraph (f)(4)(i)

The revisions and addition read as follows:

§1065.510 Engine mapping.

(a) Applicability, scope, and frequency. An engine map is a data set that consists of a series of paired data points that represent the maximum brake torque versus engine speed, measured at the engine's primary output shaft. Map your engine if the standard-setting part requires engine mapping to generate a duty cycle for your engine configuration. Map your engine while it is connected to a dynamometer or other device that can absorb work output from the engine's primary output shaft according to §1065.110. Configure any auxiliary work inputs and outputs such as hybrid, turbo-compounding, or thermoelectric systems to represent their in-use configurations, and use the same configuration for emission testing. See Figure 1 of §1065.210. This may involve configuring initial states of charge and rates and times of auxiliary-work inputs and outputs. We recommend that you contact the Designated Compliance Officer before testing to determine how you should configure any auxiliary-work inputs and outputs. Use the most recent engine map to transform a normalized duty cycle from the standard-setting part to a reference duty cycle specific to your engine. Normalized duty cycles are specified in the standard-setting part. You may update an engine map at any time by repeating the engine-mapping procedure. You must map or re-map an engine before a test if any of the following apply:

* * * * *

(b) * * *

(5) * * *

(i) For any engine subject only to steady-state duty cycles, you may perform an engine map by using discrete speeds. Select at least 20 evenly spaced setpoints from 95 % of warm idle speed to the highest speed above maximum power at which 50 % of maximum power occurs. We refer to this 50 % speed as the check point speed as described in paragraph (b)(5)(iii) of this section. At each setpoint, stabilize speed and allow torque to stabilize. We recommend that you stabilize an engine for at least 15 seconds at each setpoint and record the mean feedback speed and torque of the last (4 to 6) seconds. Record the mean speed and torque at each setpoint. Use linear interpolation to determine intermediate speeds and torques. Use this series of speeds and torques to generate the power map as described in paragraph (e) of this section.

* * * * *

(c) * * *

(5) For engines with an electric hybrid system, map the negative torque required to motor the engine by repeating paragraph (b) of this section with minimum operator demand and a fully charged RESS or with the hybrid system disabled, such that it doesn't affect the motoring torque. You may start the negative torque map at either the minimum or maximum speed from paragraph (b) of this section.

* * * * *

(f) * *

(4) * * *

(i) For variable-speed engines, declare a warm idle torque that is representative of in-use operation. For example, if your engine is typically connected to an automatic transmission or a hydrostatic transmission, declare the torque that occurs at the idle speed at which your engine operates when the transmission is engaged. Use this value for cycle generation. You may use multiple warm idle torques and associated idle speeds in cycle generation for representative testing. For example, for cycles that start the engine and begin with idle, you may start a cycle in idle with the transmission in neutral with zero torque and later switch to a different idle with the transmission in drive with the Curb-Idle Transmission Torque (CITT). For variable-speed engines intended primarily for propulsion of a vehicle with an automatic transmission where that engine is subject to a transient duty cycle with idle operation, you must declare a CITT. We recommend that you specify CITT as a function of idle speed for engines with adjustable warm idle or enhanced-idle. You may specify a CITT based on typical applications at the mean of the range of idle speeds you specify at stabilized temperature conditions.

* * * * *

343. Amend §1065.512 by revising paragraphs (b)(1) and (2) to read as follows:

§1065.512 Duty cycle generation.

* * * * *

(b) * * *

(1) Engine speed for variable-speed engines. For variable-speed engines, normalized speed may be expressed as a percentage between warm idle speed, f_{nidle}, and maximum test speed, f_{ntest}, or speed may be expressed by referring to a defined speed by name, such as "warm idle," "intermediate speed," or "A," "B," or "C" speed. Section 1065.610 describes how to transform these normalized values into a sequence of reference speeds, f_{nref}. Running duty cycles with negative or small normalized speed values near warm idle speed may cause low-speed idle governors to activate and the engine torque to exceed the reference torque even though the operator demand is at a minimum. In such cases, we recommend controlling the dynamometer so it gives priority to follow the reference torque instead of the reference speed and let the engine govern the speed. Note that the cycle-validation criteria in §1065.514 allow an engine to govern itself. This allowance permits you to test engines with enhanced-idle devices and to simulate the effects of transmissions such as automatic transmissions. For example, an enhanced-idle device might be an idle speed value that is normally commanded only under cold-start conditions to quickly warm up the engine and aftertreatment devices. In this case, negative and very low normalized speeds will generate reference speeds below this higher enhanced-idle speed. You may do either of the following with when using enhanced-idle devices:

(i) Control the dynamometer so it gives priority to follow the reference torque, controlling the operator demand so it gives priority to follow reference speed and let the engine govern the speed when the operator demand is at minimum.

(ii) While running an engine where the electronic control module broadcasts an enhanced-idle speed that is above the denormalized speed, use the broadcast speed as the reference speed. Use these new reference points for duty-cycle validation. This does not affect how you determine denormalized reference torque in paragraph (b)(2) of this section.

(2) Engine torque for variable-speed engines. For variable-speed engines, normalized torque is expressed as a percentage of the mapped torque at the corresponding reference speed. Section 1065.610 describes how to transform normalized torques into a sequence of reference torques, T_{ref}. Section 1065.610 also describes special requirements for modifying transient duty cycles for variable-speed engines intended primarily for propulsion of a vehicle with an automatic transmission. Section 1065.610 also describes under what conditions you may command T_{ref} greater than the reference torque you calculated from a normalized duty cycle. This provision permits you to command T_{ref} values that are limited by a declared minimum torque. For any negative torque commands, command minimum operator demand and use the dynamometer to control engine speed to the reference speed, but if reference speed is so low that the idle governor activates, we recommend using the dynamometer to control torque to zero, CITT, or a declared minimum torque as appropriate. Note that you may omit power and torque points during motoring from the cycle-validation criteria in §1065.514. Also, use the maximum mapped torque at the minimum mapped speed as the maximum torque for any reference speed at or below the minimum mapped speed.

*   *   *   *   *

344. Amend §1065.514 by revising paragraphs (e) introductory text, (e)(3), and (f)(3) to read as follows:

§1065.514 Cycle-validation criteria for operation over specified duty cycles.

*   *   *   *   *

(e) Statistical parameters. Use the remaining points to calculate regression statistics for a floating intercept as described in §1065.602. Round calculated regression statistics to the same number of significant digits as the criteria to which they are compared. Refer to Table 2 of §1065.514 for the default criteria and refer to the standard-setting part to determine if there are other criteria for your engine. Calculate the following regression statistics:

*   *   *   *   *

(3) Standard error of the estimate for feedback speed, SEE_{fn}, feedback torque, SEE_T, and feedback power SEE_P.

*   *   *   *   *

(f)   *   *   *

(3) For discrete-mode steady-state testing, apply cycle-validation criteria by treating the sampling periods from the series of test modes as a continuous sampling period, analogous to ramped-modal testing and apply statistical criteria as described in paragraph (f)(1) or (f)(2) of this section. Note that if the gaseous and particulate test intervals are different periods of time, separate validations are required for the gaseous and particulate test intervals. Table 2 follows:

TABLE 2 OF §1065.514—DEFAULT STATISTICAL CRITERIA FOR VALIDATING DUTY CYCLES

Parameter	Speed	Torque	Power
Slope, a_1	$0.950 \leq a_1 \leq 1.030$	$0.830 \leq a_1 \leq 1.030$	$0.830 \leq a_1 \leq 1.030$
Absolute value of intercept, $\|a_0\|$	≤ 10 % of warm idle	≤ 2 % of maximum mapped torque	≤ 2 % of maximum mapped power
Standard error of the estimate, *SEE*	≤ 5 % of maximum test speed	≤ 10 % of maximum mapped torque	≤ 10 % of maximum mapped power
Coefficient of determination, r^2	≥ 0.970	≥ 0.850	≥ 0.910

345. Amend §1065.530 by revising paragraphs (a)(2)(iii) and (g)(5) to read as follows:

§1065.530 Emission test sequence.

(a)   *   *   *

(2)   *   *   *

(iii) For testing that involves hot-stabilized emission measurements, bring the engine either to warm idle or the first operating point of the duty cycle. Start the test within 10 min of achieving temperature stability. Determine temperature stability as the point at which the engine thermostat controls engine temperature or as the point at which measured operating temperature has stayed within ±2 % of the mean value for at least 2 min based on the following parameters:

(A) Engine coolant or block or head absolute temperatures for water-cooled engines.

(B) Oil sump absolute temperature for air-cooled engines with an oil sump.

(C) Cylinder head absolute temperature or exhaust gas temperature for air-cooled engines with no oil sump.

*   *   *   *   *

(g)   *   *   *

(5) If you perform carbon balance error verification, verify carbon balance error as specified in the standard-setting part and §1065.543. Calculate and report the three carbon balance error quantities for each test interval; carbon mass absolute error for a test interval (ϵ_{aC}), carbon mass rate absolute error for a test interval (ϵ_{aCrate}), and carbon mass relative error for a test interval (ϵ_{rC}). For duty cycles with multiple test intervals, you may calculate and report the composite carbon mass relative error, ϵ_{rCcomp}, for the whole duty cycle. If you report ϵ_{rCcomp}, you must still calculate and report ϵ_{aC}, ϵ_{aCrate}, and ϵ_{rC} for each test interval.

* * * * *

346. Add §1065.543 to read as follows:

§1065.543 Carbon balance error verification.

(a) Carbon balance error verification compares independently calculated quantities of carbon flowing into and out of an engine system. The engine system includes aftertreatment devices as applicable. Calculating carbon intake considers carbon-carrying streams flowing into the system, including intake air, fuel, and optionally DEF or other fluids. Carbon flow out of the system comes from exhaust emission calculations. Note that this verification is not valid if you calculate exhaust molar flow rate using fuel rate and chemical balance as described in §1065.655(f)(3) because carbon flows into and out of the system are not independent. Use good engineering judgment to ensure that carbon mass in and carbon mass out data signals align.

(b) Perform the carbon balance error verification after emission sampling is complete for a test interval or duty cycle as described in §1065.530(g). Testing must include measured values as needed to determine intake air, fuel flow, and carbon-related gaseous exhaust emissions. You may optionally account for the flow of carbon-carrying fluids other than intake air and fuel into the system.

Perform carbon balance error verification as follows:

(1) Calculate carbon balance error quantities as described in §1065.643. The three quantities for individual test intervals are carbon mass absolute error, ϵ_{aC}, carbon mass rate absolute error, ϵ_{aCrate}, and carbon mass relative error, ϵ_{rC}. Determine ϵ_{aC}, ϵ_{aCrate}, and ϵ_{rC} for all test intervals. You may determine composite carbon mass relative error, ϵ_{rCcomp}, as a fourth quantity that optionally applies for duty cycles with multiple test intervals.

(2) You meet verification criteria for an individual test interval if the absolute values of carbon balance error quantities are at or below the following limit values:

(i) Calculate the carbon mass absolute error limit, $L_{\epsilon aC}$, in grams to three decimal places for comparision to the absolute value of ϵ_{aC}, using the following equation:

$$L_{\epsilon aC} = c \cdot P_{max}$$

Eq. 1065.543-1

Where:

c = power-specific carbon mass absolute error coefficient = 0.007 g/kW.

P_{max} = maximum power from the engine map generated according to §1065.510. If measured P_{max} is not available, use a manufacturer-declared value for P_{max}.

Example:

c = 0.007 g/kW

P_{max} = 230.0 kW

$$L_{\epsilon aC} = 0.007 \cdot 230.0 = 1.610 \text{ g}$$

(ii) Calculate the carbon mass rate absolute error limit, $L_{\epsilon aCrate}$, in grams per hour to three decimal places for comparison to the absolute value of ϵ_{aCrate}, using the following equation:

$$L_{\epsilon aCrate} = d \cdot P_{max}$$

Eq. 1065.543-2

Where:

d = power-specific carbon mass rate absolute error coefficient = 0.31 g/(kW·hr).

P_{max} = maximum power from the engine map generated according to §1065.510. If measured P_{max} is not available, use a manufacturer-declared value for P_{max}.

Example:

d = 0.31 g/(kW·hr)

P_{max} = 230.0 kW

$$L_{\epsilon aCrate} = 0.31 \cdot 230.0 = 71.300 \text{ g/hr}$$

(iii) The carbon mass relative error limit, $L_{\epsilon rC}$, is 0.020 for comparision to the absolute value of ϵ_{rC}, and optionally the absolute value of ϵ_{rCcomp}.

(c) A failed carbon balance error verification might indicate one or more problems requiring corrective action, as follows:

Area of Concern	Problem	Recommended Corrective Action
Gas analyzer system	Incorrect analyzer calibration	Calibrate NDIR and THC analyzers.
	Incorrect time alignment between flow and concentration data	Determine transformation time, t_{50}, for continuous gas analyzers and time-align flow and concentration data as described in §1065.650(c)(2)(i).
	Problems with the sample system	Inspect sample system components such as sample lines, filters, chillers, and pumps for leaks, operating temperature, and contamination.
Fuel flow measurement	Zero shift of fuel flow rate meter	Perform an in-situ zero adjustment.
	Change in fuel flow meter calibration	Calibrate the fuel flow meter as described in §1065.320.
	Incorrect time alignment of fuel flow data	Verify alignment of carbon mass in and carbon mass out data streams.
	Short sampling periods	For test intervals with varying duration, such as discrete-mode steady-state duty cycles, make the test intervals longer to improve accuracy when measuring low fuel flow rates.
	Fluctuations in the fuel conditioning system	Improve stability of the fuel temperature and pressure conditioning system to improve accuracy when measuring low fuel flow rates.
Dilute testing using a CVS system	Leaks	Inspect exhaust system and CVS tunnel, connections, and fasteners. Repair or replace components as needed. A leak in the exhaust transfer tube to the CVS may result in negative values for carbon balance error.
	Poor mixing	Perform the verification related to mixing in §1065.341(f).
	Change in CVS calibration	Calibrate the CVS flow meter as described in §1065.340.
	Flow meter entrance effects	Inspect the CVS tunnel to determine whether entrance effects from the piping configuration upstream of the flow meter adversely affect flow measurement.

	Other problems with the CVS or sampling verification hardware or software	Inspect hardware and software for the CVS system and CVS verification system for discrepancies.
Raw testing using intake air flow measurement or direct exhaust flow measurement	Leaks	Inspect intake air and exhaust systems, connections, fasteners. Repair or replace components as needed.
	Zero shift of intake air flow rate meter	Perform an in-situ zero adjustment.
	Change in intake air flow meter calibration	Calibrate the intake air flow meter as described in §1065.325.
	Zero shift of exhaust flow rate meter	Perform an in-situ zero adjustment.
	Change in exhaust flow meter calibration	Calibrate the exhaust flow meter as described in §1065.330.
	Flow meter entrance effects	Inspect intake air and exhaust systems to determine whether entrance effects from the piping configuration upstream and downstream of the intake air flow meter or the exhaust flow meter adversely affect flow measurement.
	Other problems with the intake air flow and exhaust flow measurement hardware or software	Look for discrepancies in the hardware and software for measuring intake air flow and exhaust flow.
	Poor mixing	Ensure that all streams are well mixed.
Accuracy of fluid properties	Inaccurate fluid properties	If defaults are used, use measured values. If measured values are used, verify fluid property determination.

347. Amend §1065.545 by revising paragraphs (a) and (b) introductory text to read as follows:

§1065.545 Verification of proportional flow control for batch sampling.

* * * * *

(a) For any pair of flow rates, use recorded sample and total flow rates. Total flow rate means the raw exhaust flow rate for raw exhaust sampling and the dilute exhaust flow rate for CVS sampling, or their 1 Hz means with the statistical calculations in §1065.602 forcing the intercept through zero. Determine the standard error of the estimate, *SEE*, of the sample flow rate versus the total flow rate. For each test interval, demonstrate that *SEE* was less than or equal to 3.5 % of the mean sample flow rate.

(b) For any pair of flow rates, use recorded sample and total flow rates. Total flow rate means the raw exhaust flow rate for raw exhaust sampling and the dilute exhaust flow rate for CVS sampling, or their 1 Hz means to demonstrate that each flow rate was constant within ±2.5 % of its respective mean or target flow rate. You may use the following options instead of recording the respective flow rate of each type of meter:

* * * * *

348. Revise §1065.602 to read as follows:

§1065.602 Statistics.

(a) Overview. This section contains equations and example calculations for statistics that are specified in this part. In this section we use the letter "y" to denote a generic measured quantity, the superscript over-bar "‾" to denote an arithmetic mean, and the subscript "$_{ref}$" to denote the reference quantity being measured.

(b) Arithmetic mean. Calculate an arithmetic mean, $\bar{y}$, as follows:

$$\bar{y} = \frac{\sum_{i=1}^{N} y_i}{N}$$

Eq. 1065.602-1

Example:
$N = 3$
$y_1 = 10.60$
$y_2 = 11.91$
$y_N = y_3 = 11.09$

$$\bar{y} = \frac{10.60 + 11.91 + 11.09}{3}$$

$\bar{y} = 11.20$

(c) Standard deviation. Calculate the standard deviation for a non-biased (e.g., N–1) sample, σ, as follows:

$$\sigma_{\mathrm{y}} = \sqrt{\frac{\sum_{i=1}^{N} \left(y_i - \bar{y}\right)^2}{\left(N-1\right)}}$$

Eq. 1065.602-2

Example:
$N = 3$
$y_1 = 10.60$
$y_2 = 11.91$
$y_N = y_3 = 11.09$
$\bar{y} = 11.20$

$$\sigma_{\mathrm{y}} = \sqrt{\frac{\left(10.60 - 11.2\right)^2 + \left(11.91 - 11.2\right)^2 + \left(11.09 - 11.2\right)^2}{2}}$$

$\sigma_{\mathrm{y}} = 0.6619$

(d) Root mean square. Calculate a root mean square, rms_{y}, as follows:

$$rms_{\mathrm{y}} = \sqrt{\frac{1}{N} \sum_{i=1}^{N} y_i^2}$$

Eq. 1065.602-3

Example:
$N = 3$
$y_1 = 10.60$
$y_2 = 11.91$
$y_N = y_3 = 11.09$

$$rms_{\mathrm{y}} = \sqrt{\frac{10.60^2 + 11.91^2 + 11.09^2}{3}}$$

$rms_{\mathrm{y}} = 11.21$

(e) Accuracy. Determine accuracy as described in this paragraph (e). Make multiple measurements of a standard quantity to create a set of observed values, y_i, and compare each observed value to the known value of the standard quantity. The standard quantity may have a single known value, such as a gas standard, or a set of known values of negligible range, such as a known applied pressure produced by a calibration device during repeated applications. The known value of the standard quantity is represented by $y_{\mathrm{ref}i}$. If you use a standard quantity with a single value, y_{ref_i} would be constant. Calculate an accuracy value as follows:

$$accuracy = \left| \frac{1}{N} \sum_{i=1}^{N} \left(y_i - y_{\mathrm{ref}i} \right) \right|$$

Eq. 1065.602-4

Example:

$y_{\mathrm{ref}} = 1800.0$

$N = 3$

$y_1 = 1806.4$

$y_2 = 1803.1$

$y_3 = 1798.9$

$$accuracy = \left| \frac{1}{3} \left((1806.4 - 1800.0) + (1803.1 - 1800.0) + (1798.9 - 1800.0) \right) \right|$$

$$accuracy = \left| \frac{1}{3} \left((6.4) + (3.1) + (-1.1) \right) \right|$$

$accuracy = 2.8$

(f) t-test. Determine if your data passes a t-test by using the following equations and tables:

(1) For an unpaired t-test, calculate the t statistic and its number of degrees of freedom, v, as follows:

$$t = \frac{\left| \bar{y}_{\mathrm{ref}} - \bar{y} \right|}{\sqrt{\frac{\sigma_{\mathrm{ref}}^2}{N_{\mathrm{ref}}} + \frac{\sigma_{\mathrm{y}}^2}{N}}}$$

Eq. 1065.602-5

$$v = \frac{\left(\frac{\sigma_{\mathrm{ref}}^2}{N_{\mathrm{ref}}} + \frac{\sigma_{\mathrm{y}}^2}{N} \right)^2}{\frac{\left(\frac{\sigma_{\mathrm{ref}}^2}{N_{\mathrm{ref}}} \right)^2}{N_{\mathrm{ref}} - 1} + \frac{\left(\frac{\sigma_{\mathrm{y}}^2}{N} \right)^2}{N - 1}}$$

Eq. 1065.602-6

Example:

$\bar{y}_{\mathrm{ref}} = 1205.3$

$\bar{y} = 1123.8$
$\sigma_{ref} = 9.399$
$\sigma_y = 10.583$
$N_{ref} = 11$
$N = 7$

$$t = \frac{|1205.3 - 1123.8|}{\sqrt{\frac{9.399^2}{11} + \frac{10.583^2}{7}}}$$

$t = 16.63$

$\sigma_{ref} = 9.399$
$\sigma_y = 10.583$
$N_{ref} = 11$
$N = 7$

$$v = \frac{\left(\frac{9.399^2}{11} + \frac{10.583^2}{7}\right)^2}{\frac{\left(\frac{9.399^2}{11}\right)^2}{11-1} + \frac{\left(\frac{10.583^2}{7}\right)^2}{7-1}}$$

$v = 11.76$

(2) For a paired *t*-test, calculate the *t* statistic and its number of degrees of freedom, *v*, as follows, noting that the ε_i are the errors (e.g., differences) between each pair of y_{refi} and y_i:

$$t = \frac{|\bar{\varepsilon}| \cdot \sqrt{N}}{\sigma_\varepsilon}$$

Eq. 1065.602-7

Example:
$\bar{\varepsilon} = -0.12580$
$N = 16$
$\sigma_\varepsilon = 0.04837$

$$t = \frac{|-0.12580| \cdot \sqrt{16}}{0.04837}$$

$t = 10.403$
$v = N - 1$
Example:
$N = 16$
$v = 16 - 1$
$v = 15$

(3) Use Table 1 of this section to compare *t* to the t_{crit} values tabulated versus the number of degrees of freedom. If *t* is less than t_{crit}, then *t* passes the *t*-test. The Microsoft Excel software

has a TINV function that returns results equivalent results and may be used in place of Table 1, which follows:

TABLE 1 OF §1065.602–
CRITICAL t VALUES VERSUS NUMBER OF DEGREES OF FREEDOM, ν[a]

ν	Confidence	
	90 %	**95 %**
1	6.314	12.706
2	2.920	4.303
3	2.353	3.182
4	2.132	2.776
5	2.015	2.571
6	1.943	2.447
7	1.895	2.365
8	1.860	2.306
9	1.833	2.262
10	1.812	2.228
11	1.796	2.201
12	1.782	2.179
13	1.771	2.160
14	1.761	2.145
15	1.753	2.131
16	1.746	2.120
18	1.734	2.101
20	1.725	2.086
22	1.717	2.074
24	1.711	2.064
26	1.706	2.056
28	1.701	2.048
30	1.697	2.042
35	1.690	2.030
40	1.684	2.021
50	1.676	2.009
70	1.667	1.994
100	1.660	1.984
1000+	1.645	1.960

[a]Use linear interpolation to establish values not shown here.

(g) *F*-test. Calculate the F statistic as follows:

$$F_{\mathrm{y}} = \frac{\sigma_{\mathrm{y}}^2}{\sigma_{\mathrm{ref}}^2}$$

Eq. 1065.602-8

Example:

$$\sigma_{\mathrm{y}} = \sqrt{\frac{\sum_{i=1}^{N}\left(y_i - \overline{y}\right)^2}{\left(N-1\right)}} = 10.583$$

$$\sigma_{\mathrm{ref}} = \sqrt{\frac{\sum_{i=1}^{N_{\mathrm{ref}}}\left(y_{\mathrm{ref}i} - \overline{y}_{\mathrm{ref}}\right)^2}{\left(N_{\mathrm{ref}}-1\right)}} = 9.399$$

$$F = \frac{10.583^2}{9.399^2}$$

$F = 1.268$

(1) For a 90 % confidence F-test, use the following table to compare F to the F_{crit90} values tabulated versus (N–1) and (N_{ref} –1). If F is less than F_{crit90}, then F passes the F-test at 90 % confidence.

TABLE 2 OF §1065.602–CRITICAL *F* VALUES, F_{crit90}, VERSUS *N*–1 AND N_{ref}–1 AT 90 % CONFIDENCE

N–1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	1000+
N_{ref}–1																			
1	39.86	49.50	53.59	55.83	57.24	58.20	58.90	59.43	59.85	60.19	60.70	61.22	61.74	62.00	62.26	62.52	62.79	63.06	63.32
2	8.526	9.000	9.162	9.243	9.293	9.326	9.349	9.367	9.381	9.392	9.408	9.425	9.441	9.450	9.458	9.466	9.475	9.483	9.491
3	5.538	5.462	5.391	5.343	5.309	5.285	5.266	5.252	5.240	5.230	5.216	5.200	5.184	5.176	5.168	5.160	5.151	5.143	5.134
4	4.545	4.325	4.191	4.107	4.051	4.010	3.979	3.955	3.936	3.920	3.896	3.870	3.844	3.831	3.817	3.804	3.790	3.775	3.761
5	4.060	3.780	3.619	3.520	3.453	3.405	3.368	3.339	3.316	3.297	3.268	3.238	3.207	3.191	3.174	3.157	3.140	3.123	3.105
6	3.776	3.463	3.289	3.181	3.108	3.055	3.014	2.983	2.958	2.937	2.905	2.871	2.836	2.818	2.800	2.781	2.762	2.742	2.722
7	3.589	3.257	3.074	2.961	2.883	2.827	2.785	2.752	2.725	2.703	2.668	2.632	2.595	2.575	2.555	2.535	2.514	2.493	2.471
8	3.458	3.113	2.924	2.806	2.726	2.668	2.624	2.589	2.561	2.538	2.502	2.464	2.425	2.404	2.383	2.361	2.339	2.316	2.293
9	3.360	3.006	2.813	2.693	2.611	2.551	2.505	2.469	2.440	2.416	2.379	2.340	2.298	2.277	2.255	2.232	2.208	2.184	2.159
10	3.285	2.924	2.728	2.605	2.522	2.461	2.414	2.377	2.347	2.323	2.284	2.244	2.201	2.178	2.155	2.132	2.107	2.082	2.055
11	3.225	2.860	2.660	2.536	2.451	2.389	2.342	2.304	2.274	2.248	2.209	2.167	2.123	2.100	2.076	2.052	2.026	2.000	1.972
12	3.177	2.807	2.606	2.480	2.394	2.331	2.283	2.245	2.214	2.188	2.147	2.105	2.060	2.036	2.011	1.986	1.960	1.932	1.904
13	3.136	2.763	2.560	2.434	2.347	2.283	2.234	2.195	2.164	2.138	2.097	2.053	2.007	1.983	1.958	1.931	1.904	1.876	1.846
14	3.102	2.726	2.522	2.395	2.307	2.243	2.193	2.154	2.122	2.095	2.054	2.010	1.962	1.938	1.912	1.885	1.857	1.828	1.797
15	3.073	2.695	2.490	2.361	2.273	2.208	2.158	2.119	2.086	2.059	2.017	1.972	1.924	1.899	1.873	1.845	1.817	1.787	1.755
16	3.048	2.668	2.462	2.333	2.244	2.178	2.128	2.088	2.055	2.028	1.985	1.940	1.891	1.866	1.839	1.811	1.782	1.751	1.718
17	3.026	2.645	2.437	2.308	2.218	2.152	2.102	2.061	2.028	2.001	1.958	1.912	1.862	1.836	1.809	1.781	1.751	1.719	1.686
18	3.007	2.624	2.416	2.286	2.196	2.130	2.079	2.038	2.005	1.977	1.933	1.887	1.837	1.810	1.783	1.754	1.723	1.691	1.657
19	2.990	2.606	2.397	2.266	2.176	2.109	2.058	2.017	1.984	1.956	1.912	1.865	1.814	1.787	1.759	1.730	1.699	1.666	1.631
20	2.975	2.589	2.380	2.249	2.158	2.091	2.040	1.999	1.965	1.937	1.892	1.845	1.794	1.767	1.738	1.708	1.677	1.643	1.607
21	2.961	2.575	2.365	2.233	2.142	2.075	2.023	1.982	1.948	1.920	1.875	1.827	1.776	1.748	1.719	1.689	1.657	1.623	1.586
22	2.949	2.561	2.351	2.219	2.128	2.061	2.008	1.967	1.933	1.904	1.859	1.811	1.759	1.731	1.702	1.671	1.639	1.604	1.567
23	2.937	2.549	2.339	2.207	2.115	2.047	1.995	1.953	1.919	1.890	1.845	1.796	1.744	1.716	1.686	1.655	1.622	1.587	1.549
24	2.927	2.538	2.327	2.195	2.103	2.035	1.983	1.941	1.906	1.877	1.832	1.783	1.730	1.702	1.672	1.641	1.607	1.571	1.533
25	2.918	2.528	2.317	2.184	2.092	2.024	1.971	1.929	1.895	1.866	1.820	1.771	1.718	1.689	1.659	1.627	1.593	1.557	1.518
26	2.909	2.519	2.307	2.174	2.082	2.014	1.961	1.919	1.884	1.855	1.809	1.760	1.706	1.677	1.647	1.615	1.581	1.544	1.504
27	2.901	2.511	2.299	2.165	2.073	2.005	1.952	1.909	1.874	1.845	1.799	1.749	1.695	1.666	1.636	1.603	1.569	1.531	1.491
28	2.894	2.503	2.291	2.157	2.064	1.996	1.943	1.900	1.865	1.836	1.790	1.740	1.685	1.656	1.625	1.593	1.558	1.520	1.478
29	2.887	2.495	2.283	2.149	2.057	1.988	1.935	1.892	1.857	1.827	1.781	1.731	1.676	1.647	1.616	1.583	1.547	1.509	1.467
30	2.881	2.489	2.276	2.142	2.049	1.980	1.927	1.884	1.849	1.819	1.773	1.722	1.667	1.638	1.606	1.573	1.538	1.499	1.456
40	2.835	2.440	2.226	2.091	1.997	1.927	1.873	1.829	1.793	1.763	1.715	1.662	1.605	1.574	1.541	1.506	1.467	1.425	1.377
60	2.791	2.393	2.177	2.041	1.946	1.875	1.819	1.775	1.738	1.707	1.657	1.603	1.543	1.511	1.476	1.437	1.395	1.348	1.291
120	2.748	2.347	2.130	1.992	1.896	1.824	1.767	1.722	1.684	1.652	1.601	1.545	1.482	1.447	1.409	1.368	1.320	1.265	1.193
1000+	2.706	2.303	2.084	1.945	1.847	1.774	1.717	1.670	1.632	1.599	1.546	1.487	1.421	1.383	1.342	1.295	1.240	1.169	1.000

(2) For a 95 % confidence F-test, use the following table to compare F to the F_{crit95} values tabulated versus (N–1) and (N_{ref} –1). If F is less than F_{crit95}, then F passes the F-test at 95 % confidence.

TABLE 3 OF §1065.602–CRITICAL *F* VALUES, F_{crit95}, VERSUS *N*–1 AND N_{ref}–1 AT 95 % CONFIDENCE

N–1	1	2	3	4	5	6	7	8	9	10	12	15	20	24	30	40	60	120	1000+
N_{ref}–1																			
1	161.4	199.5	215.7	224.5	230.1	233.9	236.7	238.8	240.5	241.8	243.9	245.9	248.0	249.0	250.1	251.1	252.2	253.2	254.3
2	18.51	19.00	19.16	19.24	19.29	19.33	19.35	19.37	19.38	19.39	19.41	19.42	19.44	19.45	19.46	19.47	19.47	19.48	19.49
3	10.12	9.552	9.277	9.117	9.014	8.941	8.887	8.845	8.812	8.786	8.745	8.703	8.660	8.639	8.617	8.594	8.572	8.549	8.526
4	7.709	6.944	6.591	6.388	6.256	6.163	6.094	6.041	5.999	5.964	5.912	5.858	5.803	5.774	5.746	5.717	5.688	5.658	5.628
5	6.608	5.786	5.410	5.192	5.050	4.950	4.876	4.818	4.773	4.735	4.678	4.619	4.558	4.527	4.496	4.464	4.431	4.399	4.365
6	5.987	5.143	4.757	4.534	4.387	4.284	4.207	4.147	4.099	4.060	4.000	3.938	3.874	3.842	3.808	3.774	3.740	3.705	3.669
7	5.591	4.737	4.347	4.120	3.972	3.866	3.787	3.726	3.677	3.637	3.575	3.511	3.445	3.411	3.376	3.340	3.304	3.267	3.230
8	5.318	4.459	4.066	3.838	3.688	3.581	3.501	3.438	3.388	3.347	3.284	3.218	3.150	3.115	3.079	3.043	3.005	2.967	2.928
9	5.117	4.257	3.863	3.633	3.482	3.374	3.293	3.230	3.179	3.137	3.073	3.006	2.937	2.901	2.864	2.826	2.787	2.748	2.707
10	4.965	4.103	3.708	3.478	3.326	3.217	3.136	3.072	3.020	2.978	2.913	2.845	2.774	2.737	2.700	2.661	2.621	2.580	2.538
11	4.844	3.982	3.587	3.357	3.204	3.095	3.012	2.948	2.896	2.854	2.788	2.719	2.646	2.609	2.571	2.531	2.490	2.448	2.405
12	4.747	3.885	3.490	3.259	3.106	2.996	2.913	2.849	2.796	2.753	2.687	2.617	2.544	2.506	2.466	2.426	2.384	2.341	2.296
13	4.667	3.806	3.411	3.179	3.025	2.915	2.832	2.767	2.714	2.671	2.604	2.533	2.459	2.420	2.380	2.339	2.297	2.252	2.206
14	4.600	3.739	3.344	3.112	2.958	2.848	2.764	2.699	2.646	2.602	2.534	2.463	2.388	2.349	2.308	2.266	2.223	2.178	2.131
15	4.543	3.682	3.287	3.056	2.901	2.791	2.707	2.641	2.588	2.544	2.475	2.403	2.328	2.288	2.247	2.204	2.160	2.114	2.066
16	4.494	3.634	3.239	3.007	2.852	2.741	2.657	2.591	2.538	2.494	2.425	2.352	2.276	2.235	2.194	2.151	2.106	2.059	2.010
17	4.451	3.592	3.197	2.965	2.810	2.699	2.614	2.548	2.494	2.450	2.381	2.308	2.230	2.190	2.148	2.104	2.058	2.011	1.960
18	4.414	3.555	3.160	2.928	2.773	2.661	2.577	2.510	2.456	2.412	2.342	2.269	2.191	2.150	2.107	2.063	2.017	1.968	1.917
19	4.381	3.522	3.127	2.895	2.740	2.628	2.544	2.477	2.423	2.378	2.308	2.234	2.156	2.114	2.071	2.026	1.980	1.930	1.878
20	4.351	3.493	3.098	2.866	2.711	2.599	2.514	2.447	2.393	2.348	2.278	2.203	2.124	2.083	2.039	1.994	1.946	1.896	1.843
21	4.325	3.467	3.073	2.840	2.685	2.573	2.488	2.421	2.366	2.321	2.250	2.176	2.096	2.054	2.010	1.965	1.917	1.866	1.812
22	4.301	3.443	3.049	2.817	2.661	2.549	2.464	2.397	2.342	2.297	2.226	2.151	2.071	2.028	1.984	1.938	1.889	1.838	1.783
23	4.279	3.422	3.028	2.796	2.640	2.528	2.442	2.375	2.320	2.275	2.204	2.128	2.048	2.005	1.961	1.914	1.865	1.813	1.757
24	4.260	3.403	3.009	2.776	2.621	2.508	2.423	2.355	2.300	2.255	2.183	2.108	2.027	1.984	1.939	1.892	1.842	1.790	1.733
25	4.242	3.385	2.991	2.759	2.603	2.490	2.405	2.337	2.282	2.237	2.165	2.089	2.008	1.964	1.919	1.872	1.822	1.768	1.711
26	4.225	3.369	2.975	2.743	2.587	2.474	2.388	2.321	2.266	2.220	2.148	2.072	1.990	1.946	1.901	1.853	1.803	1.749	1.691
27	4.210	3.354	2.960	2.728	2.572	2.459	2.373	2.305	2.250	2.204	2.132	2.056	1.974	1.930	1.884	1.836	1.785	1.731	1.672
28	4.196	3.340	2.947	2.714	2.558	2.445	2.359	2.291	2.236	2.190	2.118	2.041	1.959	1.915	1.869	1.820	1.769	1.714	1.654
29	4.183	3.328	2.934	2.701	2.545	2.432	2.346	2.278	2.223	2.177	2.105	2.028	1.945	1.901	1.854	1.806	1.754	1.698	1.638
30	4.171	3.316	2.922	2.690	2.534	2.421	2.334	2.266	2.211	2.165	2.092	2.015	1.932	1.887	1.841	1.792	1.740	1.684	1.622
40	4.085	3.232	2.839	2.606	2.450	2.336	2.249	2.180	2.124	2.077	2.004	1.925	1.839	1.793	1.744	1.693	1.637	1.577	1.509
60	4.001	3.150	2.758	2.525	2.368	2.254	2.167	2.097	2.040	1.993	1.917	1.836	1.748	1.700	1.649	1.594	1.534	1.467	1.389
120	3.920	3.072	2.680	2.447	2.290	2.175	2.087	2.016	1.959	1.911	1.834	1.751	1.659	1.608	1.554	1.495	1.429	1.352	1.254
1000+	3.842	2.996	2.605	2.372	2.214	2.099	2.010	1.938	1.880	1.831	1.752	1.666	1.571	1.517	1.459	1.394	1.318	1.221	1.000

(h) Slope. Calculate a least-squares regression slope, a_{1y}, using one of the following two methods:

(1) If the intercept floats, i.e., is not forced through zero:

$$a_{1y} = \frac{\sum_{i=1}^{N}(y_i - \bar{y}) \cdot (y_{\text{ref}i} - \bar{y}_{\text{ref}})}{\sum_{i=1}^{N}(y_{\text{ref}i} - \bar{y}_{\text{ref}})^2}$$

Eq. 1065.602-9

Example:

$N = 6000$

$y_1 = 2045.8$

$\bar{y} = 1050.1$

$y_{\text{ref}1} = 2045.0$

$\bar{y}_{\text{ref}} = 1055.3$

$$a_{1y} = \frac{(2045.8 - 1050.1) \cdot (2045.0 - 1055.3) + ... + (y_{6000} - 1050.1) \cdot (y_{\text{ref}6000} - 1055.3)}{(2045.0 - 1055.3)^2 + ... + (y_{\text{ref}6000} - 1055.3)^2}$$

$a_{1y} = 1.0110$

(2) If the intercept is forced through zero, such as for verifying proportional sampling:

$$a_{1y} = \frac{\sum_{i=1}^{N} y_i \cdot y_{\text{ref}i}}{\sum_{i=1}^{N} y_{\text{ref}i}^2}$$

Eq. 1065.602-10

Example:

$N = 6000$

$y_1 = 2045.8$

$y_{\text{ref}1} = 2045.0$

$$a_{1y} = \frac{2045.8 \cdot 2045.0 + ... + y_{6000} \cdot y_{\text{ref}\,6000}}{2045.0^2 + ... + y_{\text{ref}\,6000}^2}$$

$a_{1y} = 1.0110$

(i) Intercept. For a floating intercept, calculate a least-squares regression intercept, a_{0y}, as follows:

$$a_{0y} = \bar{y} - (a_{1y} \cdot \bar{y}_{\text{ref}})$$

Eq. 1065.602-11

Example:

$\bar{y} = 1050.1$

$a_{1y} = 1.0110$

$\bar{y}_{\text{ref}} = 1055.3$

$a_{0y} = 1050.1 - (1.0110 \cdot 1055.3)$

$a_{0y} = -16.8083$

(j) Standard error of the estimate. Calculate a standard error of the estimate, *SEE*, using one of the following two methods:

(1) For a floating intercept:

$$SEE_{y} = \sqrt{\frac{\sum_{i=1}^{N}\left(y_i - a_{0y} - (a_{1y} \cdot y_{refi})\right)^2}{N-2}}$$

Eq. 1065.602-12

Example:

$N = 6000$

$y_1 = 2045.8$

$a_{0y} = -16.8083$

$a_{1y} = 1.0110$

$y_{ref1} = 2045.0$

$$SEE_{y} = \sqrt{\frac{\left(2045.8 - (-16.8083) - (1.0110 \cdot 2045.0)\right)^2 + ...\left(y_{6000} - (-16.8083) - (1.0110 \cdot y_{ref\,6000})\right)^2}{6000-2}}$$

$SEE_y = 5.348$

(2) If the intercept is forced through zero, such as for verifying proportional sampling:

$$SEE_{y} = \sqrt{\frac{\sum_{i=1}^{N}\left(y_i - a_{1y} \cdot y_{refi}\right)^2}{N-1}}$$

Eq. 1065.602-13

Example:

$N = 6000$

$y_1 = 2045.8$

$a_{1y} = 1.0110$

$y_{ref1} = 2045.0$

$$SEE_{y} = \sqrt{\frac{\left(2045.8 - 1.0110 \cdot 2045.0\right)^2 + ...+\left(y_{6000} - 1.0110 \cdot y_{ref\,6000}\right)^2}{6000-1}}$$

$SEE_y = 5.347$

(k) Coefficient of determination. Calculate a coefficient of determination, r_y^2, as follows:

$$r_y^2 = 1 - \frac{\sum_{i=1}^{N}\left(y_i - a_{0y} - (a_{1y} \cdot y_{refi})\right)^2}{\sum_{i=1}^{N}\left(y_i - \bar{y}\right)^2}$$

Eq. 1065.602-14

Example:

$N = 6000$

$y_1 = 2045.8$

$a_{0y} = -16.8083$

$a_{1y} = 1.0110$

$y_{ref1} = 2045.0$

$\bar{y}$= 1480.5

$$r_y^2 = 1 - \frac{\left(2045.8 - (-16.8083) - (1.0110 \times 2045.0)\right)^2 + ...\left(y_{6000} - (-16.8083) - (1.0110 \cdot y_{\text{ref}6000})\right)^2}{\left(2045.8 - 1480.5\right)^2 + ...\left(y_{6000} - 1480.5\right)^2}$$

$r_y^2 = 0.9859$

(l) Flow-weighted mean concentration. In some sections of this part, you may need to calculate a flow-weighted mean concentration to determine the applicability of certain provisions. A flow-weighted mean is the mean of a quantity after it is weighted proportional to a corresponding flow rate. For example, if a gas concentration is measured continuously from the raw exhaust of an engine, its flow-weighted mean concentration is the sum of the products of each recorded concentration times its respective exhaust molar flow rate, divided by the sum of the recorded flow rate values. As another example, the bag concentration from a CVS system is the same as the flow-weighted mean concentration because the CVS system itself flow-weights the bag concentration. You might already expect a certain flow-weighted mean concentration of an emission at its standard based on previous testing with similar engines or testing with similar equipment and instruments. If you need to estimate your expected flow-weighted mean concentration of an emission at its standard, we recommend using the following examples as a guide for how to estimate the flow-weighted mean concentration expected at the standard. Note that these examples are not exact and that they contain assumptions that are not always valid. Use good engineering judgment to determine if you can use similar assumptions.

(1) To estimate the flow-weighted mean raw exhaust NO_x concentration from a turbocharged heavy-duty compression-ignition engine at a NO_x standard of 2.5 g/(kW·hr), you may do the following:

(i) Based on your engine design, approximate a map of maximum torque versus speed and use it with the applicable normalized duty cycle in the standard-setting part to generate a reference duty cycle as described in §1065.610. Calculate the total reference work, W_{ref}, as described in §1065.650. Divide the reference work by the duty cycle's time interval, $\Delta t_{\text{dutycycle}}$, to determine mean reference power, $\bar{P}_{\text{ref}}$.

(ii) Based on your engine design, estimate maximum power, P_{max}, the design speed at maximum power, f_{nmax}, the design maximum intake manifold boost pressure, p_{inmax}, and temperature, T_{inmax}. Also, estimate a mean fraction of power that is lost due to friction and pumping, $\bar{P}_{\text{frict}}$. Use this information along with the engine displacement volume, V_{disp}, an approximate volumetric efficiency, η_V, and the number of engine strokes per power stroke (two-stroke or four-stroke), N_{stroke}, to estimate the maximum raw exhaust molar flow rate, $\dot{n}_{\text{exhmax}}$.

(iii) Use your estimated values as described in the following example calculation:

$$\bar{x}_{\text{exp}} = \frac{e_{\text{std}} \cdot W_{\text{ref}}}{M \cdot \dot{n}_{\text{exhmax}} \cdot \Delta t_{\text{duty cycle}} \cdot \left(\frac{\bar{P}_{\text{ref}} + \left(\bar{P}_{\text{frict}} \cdot P_{\text{max}}\right)}{P_{\text{max}}}\right)}$$

Eq. 1065.602-15

$$\dot{n}_{\text{exhmax}} = \frac{p_{\text{max}} \cdot V_{\text{disp}} \cdot f_{\text{nmax}} \cdot \frac{2}{N_{\text{stroke}}} \cdot \eta_V}{R \cdot T_{\text{max}}}$$

Eq. 1065.602-16

Example:

e_{NOx} = 2.5 g/(kW·hr)

W_{ref} = 11.883 kW·hr

M_{NOx} = 46.0055 g/mol = 46.0055·10^{-6} g/µmol

$\Delta t_{dutycycle}$ = 20 min = 1200 s

$\bar{P}_{ref}$ = 35.65 kW

$\bar{P}_{frict}$ = 15 %

P_{max} = 125 kW

p_{max} = 300 kPa = 300000 Pa

V_{disp} = 3.0 l = 0.0030 m^3/r

f_{nmax} = 2800 r/min = 46.67 r/s

N_{stroke} = 4

η_V = 0.9

R = 8.314472 J/(mol·K)

T_{max} = 348.15 K

$$\dot{n}_{exhmax} = \frac{300000 \cdot 0.0030 \cdot 46.67 \cdot \frac{2}{4} \cdot 0.9}{8.314472 \cdot 348.15}$$

$\dot{n}_{exhmax}$ = 6.53 mol/s

$$\bar{x}_{exp} = \frac{2.5 \cdot 11.883}{46.0055 \cdot 10^{-6} \cdot 6.53 \cdot 1200 \cdot \left(\frac{35.65 + (0.15 \cdot 125)}{125}\right)}$$

$\bar{x}_{exp}$ = 189.4 µmol/mol

(2) To estimate the flow-weighted mean NMHC concentration in a CVS from a naturally aspirated nonroad spark-ignition engine at an NMHC standard of 0.5 g/(kW·hr), you may do the following:

(i) Based on your engine design, approximate a map of maximum torque versus speed and use it with the applicable normalized duty cycle in the standard-setting part to generate a reference duty cycle as described in §1065.610. Calculate the total reference work, W_{ref}, as described in §1065.650.

(ii) Multiply your CVS total molar flow rate by the time interval of the duty cycle, $\Delta t_{dutycycle}$. The result is the total diluted exhaust flow of the n_{dexh}.

(iii) Use your estimated values as described in the following example calculation:

$$\bar{x}_{NMHC} = \frac{e_{std} \cdot W_{ref}}{M \cdot \dot{n}_{dexh} \cdot \Delta t_{duty\,cycle}}$$

Eq. 1065.602-17

Example:

e_{NMHC} = 1.5 g/(kW·hr)

W_{ref} = 5.389 kW·hr

M_{NMHC} = 13.875389 g/mol = 13.875389·10^{-6} g/µmol

$\dot{n}_{dexh}$ = 6.021 mol/s

$\Delta t_{dutycycle}$= 30 min = 1800 s

$$\bar{x}_{NMHC} = \frac{1.5 \cdot 5.389}{13.875389 \cdot 10^{-6} \cdot 6.021 \cdot 1800}$$

$\bar{x}_{NMHC}$= 53.8 µmol/mol

349. Amend §1065.610 by revising paragraphs (a)(1)(iv), (a)(2) introductory text, and (d)(3) introductory text to read as follows:

§1065.610 Duty cycle generation.

* * * * *

(a) * * *

(1) * * *

(iv) Transform the map into a normalized power-versus-speed map by dividing power terms by P_{max} and dividing speed terms by f_{nPmax}. Use the following equation to calculate a quantity representing the sum of squares from the normalized map:

$$\text{Sum of squares} = f_{nnorm\,i}^{2} + P_{norm\,i}^{2}$$

Eq. 1065.610-1

Where:

i = an indexing variable that represents one recorded value of an engine map.

f_{nnormi} = an engine speed normalized by dividing it by f_{nPmax}.

P_{normi} = an engine power normalized by dividing it by P_{max}.

* * * * *

(2) For engines with a high-speed governor that will be subject to a reference duty cycle that specifies normalized speeds greater than 100 %, calculate an alternate maximum test speed, $f_{ntest,alt}$, as specified in this paragraph (a)(2). If $f_{ntest,alt}$ is less than the measured maximum test speed, f_{ntest}, determined in paragraph (a)(1) of this section, replace f_{ntest} with $f_{ntest,alt}$. In this case, $f_{ntest,alt}$ becomes the "maximum test speed" for that engine for all duty cycles. Note that §1065.510 allows you to apply an optional declared maximum test speed to the final measured maximum test speed determined as an outcome of the comparison between f_{ntest}, and $f_{ntest,alt}$ in this paragraph (a)(2). Determine $f_{ntest,alt}$ as follows:

* * * * *

(d) * * *

(3) Required deviations. We require the following deviations for variable-speed engines intended primarily for propulsion of a vehicle with an automatic transmission where that engine is subject to a transient duty cycle with idle operation. These deviations are intended to produce a more representative transient duty cycle for these applications. For steady-state duty cycles or transient duty cycles with no idle operation, these requirements do not apply. Idle points for steady-state duty cycles of such engines are to be run at conditions simulating neutral or park on the transmission. You may develop different procedures for adjusting CITT as a function of speed, consistent with good engineering judgment.

* * * * *

350. Amend §1065.640 by revising paragraph (a), (b)(3), (d)(1), and (d)(3) to read as follows:

§1065.640 Flow meter calibration calculations.

* * * * *

(a) Reference meter conversions. The calibration equations in this section use molar flow rate, $\dot{n}_{\text{ref}}$, as a reference quantity. If your reference meter outputs a flow rate in a different quantity, such as standard volume rate, $\dot{V}_{\text{stdref}}$, actual volume rate, $\dot{V}_{\text{actref}}$, or mass rate, $\dot{m}_{\text{ref}}$, convert your reference meter output to a molar flow rate using the following equations, noting that while values for volume rate, mass rate, pressure, temperature, and molar mass may change during an emission test, you should ensure that they are as constant as practical for each individual set point during a flow meter calibration:

$$\dot{n}_{\text{ref}} = \frac{\dot{V}_{\text{stdref}} \cdot p_{\text{std}}}{T_{\text{std}} \cdot R} = \frac{\dot{V}_{\text{actref}} \cdot p_{\text{act}}}{T_{\text{act}} \cdot R} = \frac{\dot{m}_{\text{ref}}}{M_{\text{mix}}}$$

Eq. 1065.640-1

Where:

$\dot{n}_{\text{ref}}$ = reference molar flow rate.

$\dot{V}_{\text{stdref}}$ = reference volume flow rate corrected to a standard pressure and a standard temperature.

$\dot{V}_{\text{actref}}$ = reference volume flow rate at the actual pressure and temperature of the flow rate.

$\dot{m}_{\text{ref}}$ = reference mass flow.

p_{std} = standard pressure.

p_{act} = actual pressure of the flow rate.

T_{std} = standard temperature.

T_{act} = actual temperature of the flow rate.

R = molar gas constant.

M_{mix} = molar mass of the flow rate.

Example 1:

$\dot{V}_{\text{stdref}}$ = 1000.00 ft^3/min = 0.471948 m^3/s

p_{std} = 29.9213 in Hg @ 32 °F = 101.325 kPa = 101325 Pa = 101325 kg/(m·s^2)

T_{std} = 68.0 °F = 293.15 K

R = 8.314472 J/(mol·K) = 8.314472 (m^2·kg)/(s^2·mol·K)

$$\dot{n}_{\text{ref}} = \frac{0.471948 \cdot 101325}{293.15 \cdot 8.314472}$$

$\dot{n}_{\text{ref}}$ = 19.619 mol/s

Example 2:

$\dot{m}_{\text{ref}}$ = 17.2683 kg/min = 287.805 g/s

M_{mix} = 28.7805 g/mol

$$\dot{n}_{\text{ref}} = \frac{287.805}{28.7805}$$

$\dot{n}_{\text{ref}}$ = 10.0000 mol/s

(b) * *

(3) Perform a least-squares regression of V_{rev}, versus K_{s}, by calculating slope, a_1, and intercept, a_0, as described for a floating intercept in §1065.602.

*   *   *   *   *

(d)   *   *   *

(1) Calculate the Reynolds number, $Re^{\#}$, for each reference molar flow rate, $\dot{n}_{ref}$, using the throat diameter of the venturi, d_t. Because the dynamic viscosity, μ, is needed to compute $Re^{\#}$, you may use your own fluid viscosity model to determine μ for your calibration gas (usually air), using good engineering judgment. Alternatively, you may use the Sutherland three-coefficient viscosity model to approximate μ, as shown in the following sample calculation for $Re^{\#}$:

$$Re^{\#} = \frac{4 \cdot M_{mix} \cdot \dot{n}_{ref}}{\pi \cdot d_t \cdot \mu}$$

Eq. 1065.640-10

Where, using the Sutherland three-coefficient viscosity model as captured in Table 4 of this section:

$$\mu = \mu_0 \cdot \left(\frac{T_{in}}{T_0}\right)^{\frac{3}{2}} \cdot \left(\frac{T_0 + S}{T_{in} + S}\right)$$

Eq. 1065.640-11

Where:

μ_0 = Sutherland reference viscosity.

T_0 = Sutherland reference temperature.

S = Sutherland constant.

TABLE 4 OF §1065.640–
SUTHERLAND THREE-COEFFICIENT VISCOSITY MODEL PARAMETERS

Gas[a]	μ_0	T_0	S	Temperature range within ±2 % error[b]	Pressure limit[b]
	kg/(m·s)	K	K	K	kPa
Air	$1.716 \cdot 10^{-5}$	273	111	170 to 1900	≤ 1800
CO_2	$1.370 \cdot 10^{-5}$	273	222	190 to 1700	≤ 3600
H_2O	$1.12 \cdot 10^{-5}$	350	1064	360 to 1500	≤ 10000
O_2	$1.919 \cdot 10^{-5}$	273	139	190 to 2000	≤ 2500
N_2	$1.663 \cdot 10^{-5}$	273	107	100 to 1500	≤ 1600

[a]Use tabulated parameters only for the pure gases, as listed. Do not combine parameters in calculations to calculate viscosities of gas mixtures.

[b]The model results are valid only for ambient conditions in the specified ranges.

Example:

$\mu_0 = 1.716 \cdot 10^{-5}$ kg/(m·s)

T_0 = 273 K

S = 111 K

$$\mu = 1.716 \cdot 10^{-5} \cdot \left(\frac{298.15}{273}\right)^{\frac{3}{2}} \cdot \left(\frac{273 + 111}{298.15 + 111}\right)$$

$\mu = 1.838 \cdot 10^{-5}$ kg/(m·s)

M_{mix} = 28.7805 g/mol = 0.0287805 kg/mol

$\dot{n}_{ref}$ = 57.625 mol/s

d_t = 152.4 mm = 0.1524 m

T_{in} = 298.15 K

$$Re^{\#} = \frac{4 \cdot 0.0287805 \cdot 57.625}{3.14159 \cdot 0.1524 \cdot 1.838 \cdot 10^{-5}}$$

$Re^{\#} = 7.538 \cdot 10^5$

* * * * *

(3) Perform a least-squares regression analysis to determine the best-fit coefficients for the equation and calculate *SEE* as described in §1065.602. When using Eq. 1065.640-12, treat C_d as y and the radical term as y_{ref} and use Eq. 1065.602-12 to calculate *SEE*. When using another mathematical expression, use the same approach to substitute that expression into the numerator of Eq. 1065.602-12 and replace the 2 in the denominator with the number of coefficients in the mathematical expression.

* * * * *

351. Amend §1065.642 by revising paragraphs (b) and (c)(1) to read as follows:

§1065.642 PDP, SSV, and CFV molar flow rate calculations.

* * * * *

(b) SSV molar flow rate. Calculate SSV molar flow rate, $\dot{n}$, as follows:

$$\dot{n} = C_d \cdot C_f \cdot \frac{A_t \cdot p_{in}}{\sqrt{Z \cdot M_{mix} \cdot R \cdot T_{in}}}$$

Eq. 1065.642-3

Where:

C_d = discharge coefficient, as determined based on the C_d versus $Re^{\#}$ equation in §1065.640(d)(2).

C_f = flow coefficient, as determined in §1065.640(c)(3)(ii).

A_t = venturi throat cross-sectional area.

p_{in} = static absolute pressure at the venturi inlet.

Z = compressibility factor.

M_{mix} = molar mass of gas mixture.

R = molar gas constant.

T_{in} = absolute temperature at the venturi inlet.

Example:

A_t = 0.01824 m^2

p_{in} = 99.132 kPa = 99132 Pa = 99132 kg/(m·s^2)

Z = 1

M_{mix} = 28.7805 g/mol = 0.0287805 kg/mol

R = 8.314472 J/(mol·K) = 8.314472 (m^2·kg)/(s^2·mol·K)

T_{in} = 298.15 K

$Re^{\#} = 7.232 \cdot 10^5$

γ = 1.399

β = 0.8

Δp = 2.312 kPa

Using Eq. 1065.640-7,
r_{ssv} = 0.997

Using Eq. 1065.640-6,
C_f = 0.274

Using Eq. 1065.640-5,
C_d = 0.990

$$\dot{n} = 0.990 \cdot 0.274 \cdot \frac{0.01824 \cdot 99132}{\sqrt{1 \cdot 0.0287805 \cdot 8.314472 \cdot 298.15}}$$

$\dot{n}$ = 58.173 mol/s

(c) * * *

(1) To calculate $\dot{n}$ through one venturi or one combination of venturis, use its respective mean C_d and other constants you determined according to §1065.640 and calculate $\dot{n}$ as follows:

$$\dot{n} = C_d \cdot C_f \cdot \frac{A_t \cdot p_{in}}{\sqrt{Z \cdot M_{mix} \cdot R \cdot T_{in}}}$$

Eq. 1065.642-4

Where:

C_f = flow coefficient, as determined in §1065.640(c)(3).

Example:

C_d = 0.985
C_f = 0.7219
A_t = 0.00456 m^2
p_{in} = 98.836 kPa = 98836 Pa = 98836 kg/(m·s^2)
Z = 1
M_{mix} = 28.7805 g/mol = 0.0287805 kg/mol
R = 8.314472 J/(mol·K) = 8.314472 (m^2·kg)/(s^2·mol·K)
T_{in} = 378.15 K

$$\dot{n} = 0.985 \cdot 0.7219 \cdot \frac{0.00456 \cdot 98836}{\sqrt{1 \cdot 0.0287805 \cdot 8.314472 \cdot 378.15}}$$

$\dot{n}$ = 33.690 mol/s

* * * * *

352. Add §1065.643 to read as follows:

§1065.643 Carbon balance error verification calculations.

This section describes how to calculate quantities used in the carbon balance error verification described in §1065.543. Paragraphs (a) through (c) of this section describe how to calculate the mass of carbon for a test interval from carbon-carrying fluid streams, intake air into the system, and exhaust emissions, respectively. Paragraph (d) of this section describes how to use these carbon masses to calculate four different quantities for evaluating carbon balance error. Use rectangular or trapezoidal integration methods to calculate masses and amounts over a test interval from continuously measured or calculated mass and molar flow rates.

(a) Fuel and other fluids. Determine the mass of fuel, DEF, and other carbon-carrying fluid streams, other than intake air, flowing into the system, $m_{\text{fluid}j}$, for each test interval. Note that §1065.543 allows you to omit all flows other than fuel. You may determine the mass of DEF based on ECM signals for DEF flow rate. You may determine fuel mass during field testing based on ECM signals for fuel flow rate. Calculate the mass of carbon from the combined carbon-carrying fluid streams flowing into the system as follows:

$$m_{\text{Cfluid}} = \sum_{j=1}^{N} \left(w_{\text{C}j} \cdot m_{\text{fluid}j} \right)$$

Eq. 1065.643-1

Where:

j = an indexing variable that represents one carbon-carrying fluid stream.

N = total number of carbon-carrying fluid streams into the system over the test interval.

w_{C} = carbon mass fraction of the carbon-carrying fluid stream as determined in §1065.655(d).

m_{fluid} = the mass of the carbon-carrying fluid stream determined over the test interval.

Example:

$N = 2$

$w_{\text{Cfuel}} = 0.869$

$w_{\text{CDEF}} = 0.065$

$m_{\text{fuel}} = 1119.6$ g

$m_{\text{DEF}} = 36.8$ g

$$m_{\text{Cfluid}} = 0.869 \cdot 1119.6 + 0.065 \cdot 36.8 = 975.3 \text{ g}$$

(b) Intake air. Calculate the mass of carbon in the intake air, m_{Cair}, for each test interval using one of the methods in this paragraph (b). The methods are listed in order of preference. Use the first method where all the inputs are available for your test configuration. For methods that calculate m_{Cair} based on the amount of CO_2 per mole of intake air, we recommend measuring intake air concentration, but you may calculate x_{CO2int} using Eq. 1065.655-10 and letting $x_{\text{CO2intdry}} = 375$ µmol/mol.

(1) Calculate m_{Cair}, using the following equation if you measure intake air flow:

$$m_{\text{Cair}} = M_{\text{C}} \cdot n_{\text{int}} \cdot x_{\text{CO2int}}$$

Eq. 1065.643-2

Where:

M_{C} = molar mass of carbon.

n_{int} = measured amount of intake air over the test interval.

x_{CO2int} = amount of intake air CO_2 per mole of intake air.

Example:

$M_{\text{C}} = 12.0107$ g/mol

$n_{\text{int}} = 62862$ mol

$x_{\text{CO2int}} = 369$ µmol/mol = 0.000369 mol/mol

$$m_{\text{Cair}} = 12.0107 \cdot 62862 \cdot 0.000369 = 278.6 \text{ g}$$

(2) Calculate m_{Cair}, using the following equation if you measure or calculate raw exhaust flow and you calculate chemical balance terms:

$$m_{\text{Cair}} = M_{\text{C}} \cdot n_{\text{exh}} \cdot \left(1 - x_{\text{H2Oexh}}\right) \cdot x_{\text{CO2int}} \cdot \left(x_{\text{dil/exhdry}} + x_{\text{int/exhdry}} \right)$$

Eq. 1065.643-3

Where:

M_C = molar mass of carbon.
n_{exh} = calculated or measured amount of raw exhaust over the test interval.
x_{H2Oexh} = amount of H_2O in exhaust per mole of exhaust.
x_{CO2int} = amount of intake air CO_2 per mole of intake air.
$x_{dil/exhdry}$ = amount of excess air per mole of dry exhaust. Note that excess air and intake air have the same composition, so $x_{CO2dil} = x_{CO2int}$ and $x_{H2Odil} = x_{H2Oint}$ for the chemical balance calculation for raw exhaust.
$x_{int/exhdry}$ = amount of intake air required to produce actual combustion products per mole of dry exhaust.
Example:
M_C = 12.0107 g/mol
n_{exh} = 62862 mol
x_{H2Oexh} = 0.034 mol/mol
x_{CO2int} = 369 µmol/mol = 0.000369 mol/mol
$x_{dil/exhdry}$ = 0.570 mol/mol
$x_{int/exhdry}$ = 0.465 mol/mol

$$m_{Cair} = 12.0107 \cdot 62862 \cdot (1-0.034) \cdot 0.000369 \cdot (0.570+0.465) = 278.6 \text{ g}$$

(3) Calculate m_{Cair}, using the following equation if you measure raw exhaust flow:

$$m_{Cair} = M_C \cdot n_{exh} \cdot x_{CO2int}$$

Eq. 1065.643-4

Where:
M_C = molar mass of carbon.
n_{exh} = measured amount of raw exhaust over the test interval.
x_{CO2int} = amount of intake air CO_2 per mole of intake air.
Example:
M_C = 12.0107 g/mol
n_{exh} = 62862 mol
x_{CO2int} = 369 µmol/mol = 0.000369 mol/mol

$$m_{Cair} = 12.0107 \cdot 62862 \cdot 0.000369 = 278.6 \text{ g}$$

(4) Calculate m_{Cair}, using the following equation if you measure diluted exhaust flow and dilution air flow:

$$m_{Cair} = M_C \cdot (n_{dexh} - n_{dil}) \cdot x_{CO2int}$$

Eq. 1065.643-5

Where:
M_C = molar mass of carbon.
n_{dexh} = measured amount of diluted exhaust over the test interval as determined in §1065.642.
n_{dil} = measured amount of dilution air over the test interval as determined in §1065.667(b).
x_{CO2int} = amount of intake air CO_2 per mole of intake air.
Example:
M_C = 12.0107 g/mol
n_{dexh} = 942930 mol
n_{dil} = 880068 mol
x_{CO2int} = 369 µmol/mol = 0.000369 mol/mol

$$m_{Cair} = 12.0107 \cdot (942930 - 880068) \cdot 0.000369 = 278.6 \text{ g}$$

(5) Determined m_{Cair} based on ECM signals for intake air flow as described in paragraph (b)(1) of this section.
(6) If you measure diluted exhaust, determine m_{Cair} as described in paragraph (b)(4) of this section using a calculated amount of dilution air over the test interval as determined in §1065.667(d) instead of the measured amount of dilution air.
(c) Exhaust emissions. Calculate the mass of carbon in exhaust emissions, m_{Cexh}, for each test interval as follows:

$$m_{Cexh} = M_C \cdot \left(\frac{m_{CO2}}{M_{CO2}} + \frac{m_{CO}}{M_{CO}} + \frac{m_{THC}}{M_{THC}} \right)$$

Eq. 1065.643-6

Where:
M_C = molar mass of carbon.
m_{CO2} = mass of CO_2 over the test interval as determined in §1065.650(c).
M_{CO2} = molar mass of carbon dioxide.
m_{CO} = mass of CO over the test interval as determined in §1065.650(c).
M_{CO} = molar mass of carbon monoxide.
m_{THC} = mass of THC over the test interval as determined in §1065.650(c).
M_{THC} = effective C_1 molar mass of total hydrocarbon as defined in §1065.1005(f)(2).
Example:
M_C = 12.0107 g/mol
m_{CO2} = 4567 g
M_{CO2} = 44.0095 g/mol
m_{CO} = 0.803 g
M_{CO} = 28.0101 g/mol
m_{THC} = 0.537 g
M_{THC} = 13.875389 g/mol

$$m_{Cexh} = 12.0107 \cdot \left(\frac{4567}{44.0095} + \frac{0.803}{28.0101} + \frac{0.537}{13.875389} \right) = 1247.2 \text{ g}$$

(d) Carbon balance error quantities. Calculate carbon balance error quantities as follows:
(1) Calculate carbon mass absolute error, ϵ_{aC}, for a test interval as follows:

$$\epsilon_{aC} = m_{Cexh} - m_{Cfluid} - m_{Cair}$$

Eq. 1065.643-7

Where:
m_{Cexh} = mass of carbon in exhaust emissions over the test interval as determined in paragraph (d) of this section.
m_{Cfluid} = mass of carbon in all the carbon-carrying fluid streams flowing into the system over the test interval as determined in paragraph (a) of this section.
m_{Cair} = mass of carbon in the intake air flowing into the system over the test interval as determined in paragraph (b) of this section.
Example:
m_{Cexh} = 1247.2 g
m_{Cfluid} = 975.3 g
m_{Cair} = 278.6 g

$$\epsilon_{aC} = 1247.2 - 975.3 - 278.6 = -6.7 \text{ g}$$

(2) Calculate carbon mass rate absolute error, ϵ_{aCrate}, for a test interval as follows:

$$\epsilon_{\text{aCrate}} = \frac{\epsilon_{\text{aC}}}{t}$$

Eq. 1065.643-8

Where:

t = duration of the test interval.

Example:

ϵ_{aC} = –6.7 g

t = 1202.2 s = 0.3339 hr

$$\epsilon_{\text{aCrate}} = \frac{-6.7}{0.3339} = -20.065 \text{ g/hr}$$

(3) Calculate carbon mass relative error, ϵ_{rC}, for a test interval as follows:

$$\epsilon_{\text{rC}} = \frac{\epsilon_{\text{aC}}}{m_{\text{Cfluid}} + m_{\text{Cair}}}$$

Eq. 1065.643-9

Example:

ϵ_{aC} = –6.7 g

m_{Cfliud} = 975.3 g

m_{Cair} = 278.6 g

$$\epsilon_{\text{rC}} = \frac{-6.7}{975.3 + 278.6} = -0.0053$$

(4) Calculate composite carbon mass relative error, ϵ_{rCcomp}, for a duty cycle with multiple test intervals as follows:

(i) Calculate ϵ_{rCcomp} using the following equation:

$$\epsilon_{\text{rCcomp}} = \frac{\sum_{i=1}^{N} WF_i \cdot \frac{\left(m_{\text{Cexh}i} - m_{\text{Cfluid}i} - m_{\text{Cair}i}\right)}{t_i}}{\sum_{i=1}^{N} WF_i \cdot \frac{\left(m_{\text{Cfluid}i} + m_{\text{Cair}i}\right)}{t_i}}$$

Eq. 1065.643-10

Where:

i = an indexing variable that represents one test interval.

N = number of test intervals.

WF = weighting factor for the test interval as defined in the standard-setting part.

m_{Cexh} = mass of carbon in exhaust emissions over the test interval as determined in paragraph (c) of this section.

m_{Cfluid} = mass of carbon in all the carbon-carrying fluid streams that flowed into the system over the test interval as determined in paragraph (a) of this section.

m_{Cair} = mass of carbon in the intake air that flowed into the system over the test interval as determined in paragraph (b) of this section.

t = duration of the test interval. For duty cycles with multiple test intervals of a prescribed duration, such as cold-start and hot-start transient cycles, set t = 1 for all test intervals. For discrete-mode steady-state duty cycles with multiple test intervals of varying duration, set t equal to the actual duration of each test interval.

(ii) The following example illustrates calculation of ϵ_{rCcomp}, for cold-start and hot-start transient cycles:

$N = 2$
$WF_1 = 1/7$
$WF_2 = 6/7$
$m_{\text{Cexh1}} = 1255.3$ g
$m_{\text{Cexh2}} = 1247.2$ g
$m_{\text{Cfluid1}} = 977.8$ g
$m_{\text{Cfluid2}} = 975.3$ g
$m_{\text{Cair1}} = 280.2$ g
$m_{\text{Cair2}} = 278.6$ g

$$\epsilon_{\text{rCcomp}} = \frac{\frac{1}{7}\cdot\frac{(1255.3-977.8-280.2)}{1}+\frac{6}{7}\cdot\frac{(1247.2-975.3-278.6)}{1}}{\frac{1}{7}\cdot\frac{(977.8+280.2)}{1}+\frac{6}{7}\cdot\frac{(975.3+278.6)}{1}} = -0.0049$$

(iii) The following example illustrates calculation of ϵ_{rCcomp} for multiple test intervals with varying duration, such as discrete-mode steady-state duty cycles:

$N = 2$
$WF_1 = 0.85$
$WF_2 = 0.15$
$m_{\text{Cexh1}} = 2.873$ g
$m_{\text{Cexh2}} = 0.125$ g
$m_{\text{Cfluid1}} = 2.864$ g
$m_{\text{Cfluid2}} = 0.095$ g
$m_{\text{Cair1}} = 0.023$ g
$m_{\text{Cair2}} = 0.024$ g
$t_1 = 123$ s
$t_2 = 306$ s

$$\epsilon_{\text{rCcomp}} = \frac{0.85\cdot\left(\frac{2.873-2.864-0.023}{123}\right)+0.15\cdot\left(\frac{0.125-0.095-0.024}{306}\right)}{0.85\cdot\left(\frac{2.864+0.023}{123}\right)+0.15\cdot\left(\frac{0.095+0.024}{306}\right)} = -0.0047$$

353. Amend §1065.650 by revising paragraphs (b)(3) introductory text, (c)(1), (c)(2)(i) introductory text, (c)(3), (d) introductory text, (d)(7), (f)(2) introductory text, and (g) to read as follows:

§1065.650 Emission calculations.

* * * * *

(b) * * *

(3) For field testing, you may calculate the ratio of total mass to total work, where these individual values are determined as described in paragraph (f) of this section. You may also use this approach for laboratory testing, consistent with good engineering judgment. Good engineering judgment dictates that this method not be used if there are any work flow paths described in §1065.210 that cross the system boundary, other than the primary output shaft (crankshaft). This is a special case in which you use a signal linearly proportional to raw exhaust molar flow rate to determine a value proportional to total emissions. You then use the same

linearly proportional signal to determine total work using a chemical balance of fuel, DEF, intake air, and exhaust as described in §1065.655, plus information about your engine's brake-specific fuel consumption. Under this method, flow meters need not meet accuracy specifications, but they must meet the applicable linearity and repeatability specifications in subpart D or subpart J of this part. The result is a brake-specific emission value calculated as follows:

* * * * *

(c) * * *

(1) Concentration corrections. Perform the following sequence of preliminary calculations on recorded concentrations:

(i) Use good engineering judgment to time-align flow and concentration data to match transformation time, t_{50}, to within ±1 s.

(ii) Correct all gaseous emission analyzer concentration readings, including continuous readings, sample bag readings, and dilution air background readings, for drift as described in §1065.672. Note that you must omit this step where brake-specific emissions are calculated without the drift correction for performing the drift validation according to §1065.550(b). When applying the initial THC and CH_4 contamination readings according to §1065.520(f), use the same values for both sets of calculations. You may also use as-measured values in the initial set of calculations and corrected values in the drift-corrected set of calculations as described in §1065.520(f)(7).

(iii) Correct all THC and CH_4 concentrations for initial contamination as described in §1065.660(a), including continuous readings, sample bags readings, and dilution air background readings.

(iv) Correct all concentrations measured on a "dry" basis to a "wet" basis, including dilution air background concentrations, as described in §1065.659.

(v) Calculate all NMHC and CH_4 concentrations, including dilution air background concentrations, as described in §1065.660.

(vi) For emission testing with an oxygenated fuel, calculate any HC concentrations, including dilution air background concentrations, as described in §1065.665. See subpart I of this part for testing with oxygenated fuels.

(vii) Correct all the NO_x concentrations, including dilution air background concentrations, for intake-air humidity as described in §1065.670.

(2) * * *

(i) Varying flow rate. If you continuously sample from a changing exhaust flow rate, time align and then multiply concentration measurements by the flow rate from which you extracted it. We consider the following to be examples of changing flows that require a continuous multiplication of concentration times molar flow rate: raw exhaust, exhaust diluted with a constant flow rate of dilution air, and CVS dilution with a CVS flow meter that does not have an upstream heat exchanger or electronic flow control. This multiplication results in the flow rate of the emission itself. Integrate the emission flow rate over a test interval to determine the total emission. If the total emission is a molar quantity, convert this quantity to a mass by multiplying it by its molar mass, M. The result is the mass of the emission, m. Calculate m for continuous sampling with variable flow using the following equations:

* * * * *

(3) Batch sampling. For batch sampling, the concentration is a single value from a proportionally extracted batch sample (such as a bag, filter, impinger, or cartridge). In this case, multiply the mean concentration of the batch sample by the total flow from which the sample was extracted. You may calculate total flow by integrating a changing flow rate or by

determining the mean of a constant flow rate, as follows:
(i) Varying flow rate. If you collect a batch sample from a changing exhaust flow rate, extract a sample proportional to the changing exhaust flow rate. We consider the following to be examples of changing flows that require proportional sampling: raw exhaust, exhaust diluted with a constant flow rate of dilution air, and CVS dilution with a CVS flow meter that does not have an upstream heat exchanger or electronic flow control. Integrate the flow rate over a test interval to determine the total flow from which you extracted the proportional sample. Multiply the mean concentration of the batch sample by the total flow from which the sample was extracted. If the total emission is a molar quantity, convert this quantity to a mass by multiplying it by its molar mass, M. The result is the mass of the emission, m. In the case of PM emissions, where the mean PM concentration is already in units of mass per mole of sample, $\bar{M}_{PM}$, simply multiply it by the total flow. The result is the total mass of PM, m_{PM}. Calculate m for batch sampling with variable flow using the following equation:

$$m = M \cdot \bar{x} \cdot \sum_{i=1}^{N} \dot{n}_i \cdot \Delta t$$

Eq. 1065.650-6

Example:

$M_{NOx} = 46.0055$ g/mol

$N = 9000$

$\bar{x}_{NOx} = 85.6$ µmol/mol $= 85.6 \cdot 10^{-6}$ mol/mol

$\dot{n}_{dexh1} = 25.534$ mol/s

$\dot{n}_{dexh2} = 26.950$ mol/s

$f_{record} = 5$ Hz

Using Eq. 1065.650-5,

$\Delta t = 1/5 = 0.2$

$$m_{NOx} = 46.0055 \cdot 85.6 \cdot 10^{-6} \cdot (25.534 + 26.950 + ... + \dot{n}_{exh9000}) \cdot 0.2$$

$m_{NOx} = 4.201$ g

(ii) Constant flow rate. If you batch sample from a constant exhaust flow rate, extract a sample at a proportional or constant flow rate. We consider the following to be examples of constant exhaust flows: CVS diluted exhaust with a CVS flow meter that has either an upstream heat exchanger, electronic flow control, or both. Determine the mean molar flow rate from which you extracted the constant flow rate sample. Multiply the mean concentration of the batch sample by the mean molar flow rate of the exhaust from which the sample was extracted, and multiply the result by the time of the test interval. If the total emission is a molar quantity, convert this quantity to a mass by multiplying it by its molar mass, M. The result is the mass of the emission, m. In the case of PM emissions, where the mean PM concentration is already in units of mass per mole of sample, $\bar{M}_{PM}$, simply multiply it by the total flow, and the result is the total mass of PM, m_{PM}. Calculate m for sampling with constant flow using the following equations:

$$m = M \cdot \bar{x} \cdot \bar{\dot{n}} \cdot \Delta t$$

Eq. 1065.650-7

and for PM or any other analysis of a batch sample that yields a mass per mole of sample,

$\bar{M} = M \cdot \bar{x}$

Eq. 1065.650-8

Example:

$\bar{M}_{PM}$ = 144.0 µg/mol = 144.0·10^{-6} g/mol

$\bar{n}_{dexh}$ = 57.692 mol/s

Δt = 1200 s

m_{PM} = 144.0·10^{-6}·57.692·1200

m_{PM} = 9.9692 g

* * * * *

(d) Total work over a test interval. To calculate the total work from the engine over a test interval, add the total work from all the work paths described in §1065.210 that cross the system boundary including electrical energy/work, mechanical shaft work, and fluid pumping work. For all work paths, except the engine's primary output shaft (crankshaft), the total work for the path over the test interval is the integration of the net work flow rate (power) out of the system boundary. When energy/work flows into the system boundary, this work flow rate signal becomes negative; in this case, include these negative work rate values in the integration to calculate total work from that work path. Some work paths may result in a negative total work. Include negative total work values from any work path in the calculated total work from the engine rather than setting the values to zero. The rest of this paragraph (d) describes how to calculate total work from the engine's primary output shaft over a test interval. Before integrating power on the engine's primary output shaft, adjust the speed and torque data for the time alignment used in §1065.514(c). Any advance or delay used on the feedback signals for cycle validation must also be used for calculating work. Account for work of accessories according to §1065.110. Exclude any work during cranking and starting. Exclude work during actual motoring operation (negative feedback torques), unless the engine was connected to one or more energy storage devices. Examples of such energy storage devices include hybrid powertrain batteries and hydraulic accumulators, like the ones illustrated in Figure 1 of §1065.210. Exclude any work during reference zero-load idle periods (0 % speed or idle speed with 0 N·m reference torque). Note, that there must be two consecutive reference zero load idle points to establish a period where this applies. Include work during idle points with simulated minimum torque such as Curb Idle Transmissions Torque (CITT) for automatic transmissions in "drive". The work calculation method described in paragraphs (d)(1) though (7) of this section meets these requirements using rectangular integration. You may use other logic that gives equivalent results. For example, you may use a trapezoidal integration method as described in paragraph (d)(8) of this section.

* * * * *

(7) Integrate the resulting values for power over the test interval. Calculate total work as follows:

$$W = \sum_{i=1}^{N} P_i \cdot \Delta t$$

Eq. 1065.650-10

Where:

W = total work from the primary output shaft

P_i = instantaneous power from the primary output shaft over an interval i.

$P_i = f_{ni} \cdot T_i$

Eq. 1065.650-11

Example:
$N = 9000$
$f_{n1} = 1800.2$ r/min
$f_{n2} = 1805.8$ r/min
$T_1 = 177.23$ N·m
$T_2 = 175.00$ N·m
$C_{rev} = 2\cdot\pi$ rad/r
$C_{t1} = 60$ s/min
$C_p = 1000$ (N·m·rad/s)/kW
$f_{record} = 5$ Hz
$C_{t2} = 3600$ s/hr

$$P_1 = \frac{1800.2 \cdot 177.23 \cdot 2 \cdot 3.14159}{60 \cdot 1000}$$

$P_1 = 33.41$ kW
$P_2 = 33.09$ kW
Using Eq. 1065.650-5,
$\Delta t = 1/5 = 0.2$ s

$$W = \frac{(33.41 + 33.09 + ... + P_{9000}) \cdot 0.2}{3600}$$

$W = 16.875$ kW·hr
*   *   *   *   *
(f)   *   *   *
(2) Total work. To calculate a value proportional to total work over a test interval, integrate a value that is proportional to power. Use information about the brake-specific fuel consumption of your engine, e_{fuel}, to convert a signal proportional to fuel flow rate to a signal proportional to power. To determine a signal proportional to fuel flow rate, divide a signal that is proportional to the mass rate of carbon products by the fraction of carbon in your fuel, w_C.. You may use a measured w_C or you may use default values for a given fuel as described in §1065.655(e). Calculate the mass rate of carbon from the amount of carbon and water in the exhaust, which you determine with a chemical balance of fuel, DEF, intake air, and exhaust as described in §1065.655. In the chemical balance, you must use concentrations from the flow that generated the signal proportional to molar flow rate, $\tilde{n}$, in paragraph (e)(1) of this section. Calculate a value proportional to total work as follows:
*   *   *   *   *
(g) Brake-specific emissions over a duty cycle with multiple test intervals. The standard-setting part may specify a duty cycle with multiple test intervals, such as with discrete-mode steady-state testing. Unless we specify otherwise, calculate composite brake-specific emissions over the duty cycle as described in this paragraph (g). If a measured mass (or mass rate) is negative, set it to zero for calculating composite brake-specific emissions, but leave it unchanged for drift validation. In the case of calculating composite brake-specific emissions relative to a combined emission standard (such as a NO_x + NMHC standard), change any negative mass (or mass rate) values to zero for a particular pollutant before combining the values for the different pollutants.

(1) Use the following equation to calculate composite brake-specific emissions for duty cycles with multiple test intervals all with prescribed durations, such as cold-start and hot-start transient cycles:

$$e_{\text{comp}} = \frac{\sum_{i=1}^{N} WF_i \cdot m_i}{\sum_{i=1}^{N} WF_i \cdot W_i}$$

Eq. 1065.650-17

Where

i = test interval number.

N = number of test intervals.

WF = weighting factor for the test interval as defined in the standard-setting part.

m = mass of emissions over the test interval as determined in paragraph (c) of this section.

W = total work from the engine over the test interval as determined in paragraph (d) of this section.

Example:

$N = 2$

$WF_1 = 0.1428$

$WF_2 = 0.8572$

$m_1 = 70.125$ g

$m_2 = 64.975$ g

$W_1 = 25.783$ kW·hr

$W_2 = 25.783$ kW·hr

$$e_{\text{NO}_x\text{comp}} = \frac{(0.1428 \cdot 70.125) + (0.8572 \cdot 64.975)}{(0.1428 \cdot 25.783) + (0.8572 \cdot 25.783)}$$

$e_{\text{NOxcomp}} = 2.548$ g/kW·hr

(2) Calculate composite brake-specific emissions for duty cycles with multiple test intervals that allow use of varying duration, such as discrete-mode steady-state duty cycles, as follows:

(i) Use the following equation if you calculate brake-specific emissions over test intervals based on total mass and total work as described in paragraph (b)(1) of this section:

$$e_{\text{comp}} = \frac{\sum_{i=1}^{N} WF_i \cdot \frac{m_i}{t_i}}{\sum_{i=1}^{N} WF_i \cdot \frac{W_i}{t_i}}$$

Eq. 1065.650-18

Where

i = test interval number.

N = number of test intervals.

WF = weighting factor for the test interval as defined in the standard-setting part.

m = mass of emissions over the test interval as determined in paragraph (c) of this section.

W = total work from the engine over the test interval as determined in paragraph (d) of this section.

t = duration of the test interval.

Example:

$N = 2$

$WF_1 = 0.85$
$WF_2 = 0.15$
$m_1 = 1.3753$ g
$m_2 = 0.4135$ g
$t_1 = 120$ s
$t_2 = 200$ s
$W_1 = 2.8375$ kW·hr
$W_2 = 0.0$ kW·hr

$$e_{\mathrm{NO}_x\mathrm{comp}} = \frac{\left(0.85 \cdot \frac{1.3753}{120}\right) + \left(0.15 \cdot \frac{0.4135}{200}\right)}{\left(0.85 \cdot \frac{2.8375}{120}\right) + \left(0.15 \cdot \frac{0.0}{200}\right)}$$

$e_{\mathrm{NOxcomp}} = 0.5001$ g/kW·hr

(ii) Use the following equation if you calculate brake-specific emissions over test intervals based on the ratio of mass rate to power as described in paragraph (b)(2) of this section:

$$e_{\mathrm{comp}} = \frac{\sum_{i=1}^{N} WF_i \cdot \bar{\dot{m}}_i}{\sum_{i=1}^{N} WF_i \cdot \bar{P}_i}$$

Eq. 1065.650-19

Where
i = test interval number.
N = number of test intervals.
WF = weighting factor for the test interval as defined in the standard-setting part.
$\bar{\dot{m}}$ = mean steady-state mass rate of emissions over the test interval as determined in paragraph (e) of this section.
$\bar{P}$ = mean steady-state power over the test interval as described in paragraph (e) of this section.

Example:
$N = 2$
$WF_1 = 0.85$
$WF_2 = 0.15$
$\bar{\dot{m}}_1 = 2.25842$ g/hr
$\bar{\dot{m}}_2 = 0.063443$ g/hr
$\bar{P}_1 = 4.5383$ kW
$\bar{P}_2 = 0.0$ kW

$$e_{\mathrm{NO}_x\mathrm{comp}} = \frac{(0.85 \cdot 2.25842) + (0.15 \cdot 0.063443)}{(0.85 \cdot 4.5383) + (0.15 \cdot 0.0)}$$

$e_{\mathrm{NOxcomp}} = 0.5001$ g/kW·hr

* * * * *

354. Amend §1065.655 by revising the section heading and paragraphs (a), (c) introductory text, (c)(3), (d) introductory text, (e), and (f)(3) to read as follows:

§1065.655 Chemical balances of fuel, DEF, intake air, and exhaust.
(a) General. Chemical balances of fuel, intake air, and exhaust may be used to calculate flows, the amount of water in their flows, and the wet concentration of constituents in their flows. With one flow rate of either fuel, intake air, or exhaust, you may use chemical balances to determine the flows of the other two. For example, you may use chemical balances along with either intake air or fuel flow to determine raw exhaust flow. Note that chemical balance calculations allow measured values for the flow rate of diesel exhaust fluid for engines with urea-based selective catalytic reduction.
* * * * *
(c) Chemical balance procedure. The calculations for a chemical balance involve a system of equations that require iteration. We recommend using a computer to solve this system of equations. You must guess the initial values of up to three quantities: the amount of water in the measured flow, x_{H2Oexh}, fraction of dilution air in diluted exhaust, $x_{dil/exh}$, and the amount of products on a C_1 basis per dry mole of dry measured flow, $x_{Ccombdry}$. You may use time-weighted mean values of combustion air humidity and dilution air humidity in the chemical balance; as long as your combustion air and dilution air humidities remain within tolerances of ±0.0025 mol/mol of their respective mean values over the test interval. For each emission concentration, x, and amount of water, x_{H2Oexh}, you must determine their completely dry concentrations, x_{dry} and $x_{H2Oexhdry}$. You must also use your fuel mixture's atomic hydrogen-to-carbon ratio, α, oxygen-to-carbon ratio, β, sulfur-to-carbon ratio, γ, and nitrogen-to-carbon ratio, δ; you may optionally account for diesel exhaust fluid (or other fluids injected into the exhaust), if applicable. You may calculate α, β, γ, and δ based on measured fuel composition or based on measured fuel and diesel exhaust fluid (or other fluids injected into the exhaust) composition together, as described in paragraph (e) of this section. You may alternatively use any combination of default values and measured values as described in paragraph (e) of this section. Use the following steps to complete a chemical balance:
* * * * *
(3) Use the following symbols and subscripts in the equations for performing the chemical balance calculations in this paragraph (c):
$x_{dil/exh}$ = amount of dilution gas or excess air per mole of exhaust.
x_{H2Oexh} = amount of H_2O in exhaust per mole of exhaust.
$x_{Ccombdry}$ = amount of carbon from fuel and any injected fluids in the exhaust per mole of dry exhaust.
x_{H2dry} = amount of H_2 in exhaust per amount of dry exhaust.
K_{H2Ogas} = water-gas reaction equilibrium coefficient. You may use 3.5 or calculate your own value using good engineering judgment.
$x_{H2Oexhdry}$ = amount of H_2O in exhaust per dry mole of dry exhaust.
$x_{prod/intdry}$ = amount of dry stoichiometric products per dry mole of intake air.
$x_{dil/exhdry}$ = amount of dilution gas and/or excess air per mole of dry exhaust.
$x_{int/exhdry}$ = amount of intake air required to produce actual combustion products per mole of dry (raw or diluted) exhaust.
$x_{raw/exhdry}$ = amount of undiluted exhaust, without excess air, per mole of dry (raw or diluted) exhaust.
x_{O2int} = amount of intake air O_2 per mole of intake air.
$x_{CO2intdry}$ = amount of intake air CO_2 per mole of dry intake air. You may use $x_{CO2intdry}$ = 375 µmol/mol, but we recommend measuring the actual concentration in the intake air.

$x_{H2Ointdry}$ = amount of intake air H_2O per mole of dry intake air.
x_{CO2int} = amount of intake air CO_2 per mole of intake air.
x_{CO2dil} = amount of dilution gas CO_2 per mole of dilution gas.
$x_{CO2dildry}$ = amount of dilution gas CO_2 per mole of dry dilution gas. If you use air as diluent, you may use $x_{CO2dildry}$ = 375 µmol/mol, but we recommend measuring the actual concentration in the intake air.
$x_{H2Odildry}$ = amount of dilution gas H_2O per mole of dry dilution gas.
x_{H2Odil} = amount of dilution gas H_2O per mole of dilution gas.
$x_{[emission]meas}$ = amount of measured emission in the sample at the respective gas analyzer.
$x_{[emission]dry}$ = amount of emission per dry mole of dry sample.
$x_{H2O[emission]meas}$ = amount of H_2O in sample at emission-detection location. Measure or estimate these values according to §1065.145(e)(2).
x_{H2Oint} = amount of H_2O in the intake air, based on a humidity measurement of intake air.
α = atomic hydrogen-to-carbon ratio of the fuel (or mixture of test fuels) and any injected fluids.
β = atomic oxygen-to-carbon ratio of the fuel (or mixture of test fuels) and any injected fluids.
γ = atomic sulfur-to-carbon ratio of the fuel (or mixture of test fuels) and any injected fluids.
δ = atomic nitrogen-to-carbon ratio of the fuel (or mixture of test fuels) and any injected fluids.
*   *   *   *   *

(d) Carbon mass fraction of fuel. Determine carbon mass fraction of fuel, w_C, based on the fuel properties as determined in paragraph (e) of this section, optionally accounting for diesel exhaust fluid's contribution to α, β, γ, and δ, or other fluids injected into the exhaust, if applicable (for example, the engine is equipped with an emission control system that utilizes DEF). Calculate w_C using the following equation:
*   *   *   *   *

(e) Fuel and diesel exhaust fluid composition. Determine fuel and diesel exhaust fluid composition represented by α, β, γ, and δ as described in this paragraph (e). When using measured fuel or diesel exhaust fluid properties, you must determine values for α and β in all cases. If you determine compositions based on measured values and the default value listed in Table 1 of this section is zero, you may set γ and δ to zero; otherwise determine γ and δ (along with α and β) based on measured values. Determine elemental mass fractions and values for α, β, γ, and δ as follows:
(1) For liquid fuels, use the default values for α, β, γ, and δ in Table 1 of this section or determine mass fractions of liquid fuels for calculation of α, β, γ, and δ as follows:
(i) Determine the carbon and hydrogen mass fractions according to ASTM D5291 (incorporated by reference in §1065.1010). When using ASTM D5291 to determine carbon and hydrogen mass fractions of gasoline (with or without blended ethanol), use good engineering judgment to adapt the method as appropriate. This may include consulting with the instrument manufacturer on how to test high-volatility fuels. Allow the weight of volatile fuel samples to stabilize for 20 minutes before starting the analysis; if the weight still drifts after 20 minutes, prepare a new sample). Retest the sample if the carbon, hydrogen, oxygen, sulfur, and nitrogen mass fractions do not add up to a total mass of 100 ±0.5 %; if you do not measure oxygen, you may assume it has a zero concentration for this specification. You may also assume that sulfur and nitrogen have a zero concentration for all fuels except residual fuel blends.
(ii) Determine oxygen mass fraction of gasoline (with or without blended ethanol) according to ASTM D5599 (incorporated by reference in §1065.1010). For all other liquid fuels, determine the oxygen mass fraction using good engineering judgment.

(iii) Determine the nitrogen mass fraction according to ASTM D4629 or ASTM D5762 (incorporated by reference in §1065.1010) for all liquid fuels. Select the correct method based on the expected nitrogen content.
(iv) Determine the sulfur mass fraction according to subpart H of this part.
(2) For gaseous fuels and diesel exhaust fluid, use the default values for α, β, γ, and δ in Table 1 of this section, or use good engineering judgment to determine those values based on measurement.
(3) For nonconstant fuel mixtures, you must account for the varying proportions of the different fuels. This generally applies for dual-fuel and flexible-fuel engines, but it also applies if diesel exhaust fluid is injected in a way that is not strictly proportional to fuel flow. Account for these varying concentrations either with a batch measurement that provides averaged values to represent the test interval, or by analyzing data from continuous mass rate measurements. Application of average values from a batch measurement generally applies to situations where one fluid is a minor component of the total fuel mixture, for example dual-fuel and flexible-fuel engines with diesel pilot injection, where the diesel pilot fuel mass is less than 5 % of the total fuel mass and diesel exhaust fluid injection; consistent with good engineering judgment.
(4) Calculate α, β, γ, and δ using the following equations:

$$\alpha = \frac{M_C}{M_H} \cdot \frac{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Hj}}{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Cj}}$$

Eq. 1065.655-20

$$\beta = \frac{M_C}{M_O} \cdot \frac{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Oj}}{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Cj}}$$

Eq. 1065.655-21

$$\gamma = \frac{M_C}{M_S} \cdot \frac{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Sj}}{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Cj}}$$

Eq. 1065.655-22

$$\delta = \frac{M_C}{M_N} \cdot \frac{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Nj}}{\sum_{j=1}^{N} \dot{m}_j \cdot w_{Cj}}$$

Eq. 1065.655-23

Where:
N = total number of fuels and injected fluids over the duty cycle.
j = an indexing variable that represents one fuel or injected fluid, starting with j = 1.
$\dot{m}_j$ = the mass flow rate of the fuel or any injected fluid j. For applications using a single fuel and no DEF fluid, set this value to 1. For batch measurements, divide the total mass of fuel over the test interval duration to determine a mass rate.
w_{Hj} = hydrogen mass fraction of fuel or any injected fluid j.

w_{Cj} = carbon mass fraction of fuel or any injected fluid j.
w_{Oj} = oxygen mass fraction of fuel or any injected fluid j.
w_{Sj} = sulfur mass fraction of fuel or any injected fluid j.
w_{Nj} = nitrogen mass fraction of fuel or any injected fluid j.
Example:
$N = 1$
$j = 1$
$\dot{m}_1 = 1$
$w_{H1} = 0.1239$
$w_{C1} = 0.8206$
$w_{O1} = 0.0547$
$w_{S1} = 0.00066$
$w_{N1} = 0.000095$
$M_C = 12.0107$
$M_H = 1.00794$
$M_O = 15.9994$
$M_S = 32.065$
$M_N = 14.0067$

$$\alpha = \frac{12.0107 \cdot 1 \cdot 0.1239}{1.00794 \cdot 1 \cdot 0.8206}$$

$$\beta = \frac{12.0107 \cdot 1 \cdot 0.0547}{15.9994 \cdot 1 \cdot 0.8206}$$

$$\gamma = \frac{12.0107 \cdot 1 \cdot 0.00066}{32.065 \cdot 1 \cdot 0.8206}$$

$$\delta = \frac{12.0107 \cdot 1 \cdot 0.000095}{14.0067 \cdot 1 \cdot 0.8206}$$

$\alpha = 1.799$
$\beta = 0.05004$
$\gamma = 0.0003012$
$\delta = 0.0001003$
(5) Table 1 follows:

TABLE 1 OF §1065.655–DEFAULT VALUES OF α, β, γ, δ, AND w_C

Fuel or injected fluid	**Atomic hydrogen, oxygen, sulfur, and nitrogen-to-carbon ratios** $CH_{\alpha}O_{\beta}S_{\gamma}N_{\delta}$	**Carbon mass fraction, w_C g/g**
Gasoline	$CH_{1.85}O_0S_0N_0$	0.866
E10 Gasoline	$CH_{1.92}O_{0.03}S_0N_0$	0.833
E15 Gasoline	$CH_{1.95}O_{0.05}S_0N_0$	0.817
E85 Gasoline	$CH_{2.73}O_{0.38}S_0N_0$	0.576
E100 Ethanol	$CH_3O_{0.5}S_0N_0$	0.521
M100 Methanol	$CH_4O_1S_0N_0$	0.375
#1 Diesel	$CH_{1.93}O_0S_0N_0$	0.861
#2 Diesel	$CH_{1.80}O_0S_0N_0$	0.869
Liquefied petroleum gas	$CH_{2.64}O_0S_0N_0$	0.819
Natural gas	$CH_{3.78}O_{0.016}S_0N_0$	0.747
Residual fuel blends	Must be determined by measured fuel properties as described in paragraph (e)(1) of this section.	
Diesel exhaust fluid	$CH_{17.85}O_{7.92}S_0N_2$	0.065

(f) * *

(3) Fluid mass flow rate calculation. This calculation may be used only for steady-state laboratory testing. You may not use this calculation if the standard-setting part requires carbon balance error verification as described in §1065.543. See §1065.915(d)(5)(iv) for application to field testing. Calculate $\dot{n}_{exh}$ based on $\dot{m}_j$ using the following equation:

$$\dot{n}_{exh} = \sum_{j=1}^{N} \dot{m}_j \cdot \frac{w_{C_j} \cdot \left(1 + x_{H2Oexhdry\,j}\right)}{M_C \cdot x_{Ccombdry_j}}$$

Eq. 1065.655-25

Where:

$\dot{n}_{exh}$ = raw exhaust molar flow rate from which you measured emissions.

j = an indexing variable that represents one fuel or injected fluid, starting with j = 1.

N = total number of fuels and injected fluids over the duty cycle.

$\dot{m}_j$ = the mass flow rate of the fuel or any injected fluid j.

w_{Cj} = carbon mass fraction of the fuel and any injected fluid j.

Example:

N = 1

j = 1

$\dot{m}_1$ = 7.559 g/s

w_{C1} = 0.869 g/g

M_C = 12.0107 g/mol

$x_{Ccombdry1}$ = 99.87 mmol/mol = 0.09987 mol/mol

$x_{H20exhdry1}$ = 107.64 mmol/mol = 0.10764 mol/mol

$$\dot{n}_{exh} = 7.559 \cdot \frac{0.869 \cdot (1 + 0.10764)}{12.0107 \cdot 0.09987}$$

$\dot{n}_{exh}$ = 6.066 mol/s

* * * **

355. Amend §1065.659 by revising paragraph (c)(2) and (3) to read as follows:

§1065.659 Removed water correction.

* * * * *

(c) * * *

(2) If the measurement comes from raw exhaust, you may determine the amount of water based on intake-air humidity, plus a chemical balance of fuel, DEF, intake air, and exhaust as described in §1065.655.

(3) If the measurement comes from diluted exhaust, you may determine the amount of water based on intake-air humidity, dilution air humidity, and a chemical balance of fuel, DEF, intake air, and exhaust as described in §1065.655.

* * * * *

356. Amend §1065.660 by adding paragraphs (a)(5) and (6) and revising paragraphs (b)(2) introductory text, (b)(2)(ii) introductory text, (b)(2)(iii) introductory text, (b)(3) introductory text, (b)(4), (c)(2), and (d) introductory text, (d)(1) introductory text, (d)(1)(ii) introductory text, (d)(1)(iii) introductory text, (d)(2), and (e) to read as follows:

§1065.660 THC, NMHC, NMNEHC, CH_4, and C_2H_6 determination.

(a) * * *

(5) You may calculate THC as the sum of NMHC and CH_4 if you determine CH_4 with an FTIR as described in §1065.660(d)(2) and NMHC with an FTIR using the additive method from §1065.660(b)(4).

(6) You may calculate THC as the sum of NMNEHC, C_2H_6, and CH_4 if you determine CH_4 with an FTIR as described in §1065.660(d)(2), C_2H_6 with an FTIR as described in §1065.660(e), and NMNEHC with an FTIR using the additive method from $ 1065.660(c)(3).

(b) * * *

(2) For nonmethane cutters, calculate x_{NMHC} using the nonmethane cutter's methane penetration fraction, $PF_{CH4[NMC-FID]}$, and the ethane response factor penetration fraction, $RFPF_{C2H6[NMC-FID]}$, from §1065.365, the THC FID's methane response factor, $RF_{CH4[THC-FID]}$, from §1065.360, the initial THC contamination and dry-to-wet corrected THC concentration, $x_{THC[THC-FID]cor}$, as determined in paragraph (a) of this section, and the dry-to-wet corrected methane concentration, $x_{THC[NMC-FID]cor}$, optionally corrected for initial THC contamination as determined in paragraph (a) of this section.

* * * * *

(ii) Use the following equation for penetration fractions determined using an NMC configuration as outlined in §1065.365(e):

* * * * *

(iii) Use the following equation for penetration fractions determined using an NMC configuration as outlined in §1065.365(f) or for penetration fractions determined as a function of molar water concentration using an NMC configuration as outlined in §1065.365(d):

* * * * *

(3) For a GC-FID or FTIR, calculate x_{NMHC} using the THC analyzer's methane response factor, $RF_{CH4[THC-FID]}$, from §1065.360, and the initial THC contamination and dry-to-wet corrected THC concentration, $x_{THC[THC-FID]cor}$, as determined in paragraph (a) of this section as follows:

* * * * *

(4) For an FTIR, calculate x_{NMHC} by summing the hydrocarbon species listed in §1065.266(c) as follows:

$$x_{NMHC} = \sum_{i=1}^{N} \left(x_{HCi} - x_{HCi\text{-}init} \right)$$

Eq. 1065.660-6

Where:

x_{NMHC} = concentration of NMHC.

x_{HCi} = the C_1-equivalent concentration of hydrocarbon species i as measured by the FTIR, not corrected for initial contamination.

$x_{HCi\text{-}init}$ = the C_1-equivalent concentration of the initial system contamination (optional) of hydrocarbon species i, dry-to-wet corrected, as measured by the FTIR.

Example:

x_{C2H6} = 4.9 µmol/mol

x_{C2H4} = 0.9 µmol/mol

x_{C2H2} = 0.8 µmol/mol

x_{C3H8} = 0.4 µmol/mol

x_{C3H6} = 0.5 µmol/mol

x_{C4H10} = 0.3 µmol/mol

x_{CH2O} = 0.8 µmol/mol

x_{C2H4O} = 0.3 µmol/mol

x_{CH2O2} = 0.1 µmol/mol

x_{CH4O} = 0.1 µmol/mol

x_{NMHC} = 4.9 + 0.9 + 0.8 + 0.4 + 0.5 + 0.3 + 0.8 + 0.3 + 0.1 + 0.1

x_{NMHC} = 9.1 µmol/mol

(c) * * *

(2) For a GC-FID, NMC FID, or FTIR, calculate x_{NMNEHC} using the THC analyzer's methane response factor, $RF_{CH4[THC-FID]}$, and ethane response factor, $RF_{C2H6[THC-FID]}$, from §1065.360, the initial contamination and dry-to-wet corrected THC concentration, $x_{THC[THC-FID]cor}$, as determined in paragraph (a) of this section, the dry-to-wet corrected methane concentration, x_{CH4}, as determined in paragraph (d) of this section, and the dry-to-wet corrected ethane concentration, x_{C2H6}, as determined in paragraph (e) of this section as follows:

$$x_{NMNEHC} = x_{THC[THC-FID]cor} - RF_{CH4[THC-FID]} \cdot x_{CH4} - RF_{C2H6[THC-FID]} \cdot x_{C2H6}$$

Eq. 1065.660-7

Where:

x_{NMNEHC} = concentration of NMNEHC.

$x_{THC[THC-FID]cor}$ = concentration of THC, initial THC contamination and dry-to-wet corrected, as measured by the THC FID.

$RF_{CH4[THC-FID]}$ = response factor of THC-FID to CH_4.

x_{CH4} = concentration of CH_4, dry-to-wet corrected, as measured by the GC-FID, NMC FID, or FTIR.

$RF_{C2H6[THC-FID]}$ = response factor of THC-FID to C_2H_6.

x_{C2H6} = the C_1-equivalent concentration of C_2H_6, dry-to-wet corrected, as measured by the GC-FID or FTIR.

Example:

$x_{THC[THC-FID]cor}$ = 145.6 µmol/mol

$RF_{CH4[THC-FID]}$ = 0.970

x_{CH4} = 18.9 µmol/mol

$RF_{C2H6[THC-FID]}$ = 1.02

x_{C2H6} = 10.6 µmol/mol

$x_{NMNEHC} = 145.6 - 0.970 \cdot 18.9 - 1.02 \cdot 10.6$

x_{NMNEHC} = 116.5 µmol/mol

* * * * *

(d) CH_4 determination. Use one of the following methods to determine methane concentration, x_{CH4}:

(1) For nonmethane cutters, calculate x_{CH4} using the nonmethane cutter's methane penetration fraction, $PF_{CH4[NMC-FID]}$, and the ethane response factor penetration fraction, $RFPF_{C2H6[NMC-FID}$, from §1065.365, the THC FID's methane response factor, $RF_{CH4[THC-FID]}$, from §1065.360, the initial THC contamination and dry-to-wet corrected THC concentration, $x_{THC[THC-FID]cor}$, as determined in paragraph (a) of this section, and the dry-to-wet corrected methane concentration, $x_{THC[NMC-FID]cor}$, optionally corrected for initial THC contamination as determined in paragraph (a) of this section.

* * * * *

(ii) Use the following equation for penetration fractions determined using an NMC configuration as outlined in §1065.365(e):

* * * * *

(iii) Use the following equation for penetration fractions determined using an NMC configuration as outlined in §1065.365(f) or for penetration fractions determined as a function of molar water concentration using an NMC configuration as outlined in §1065.365(d):

* * * * *

(2) For a GC-FID or FTIR, x_{CH4} is the actual dry-to-wet corrected methane concentration as measured by the analyzer.

(e) C_2H_6 determination. For a GC-FID or FTIR, x_{C2H6} is the C_1-equivalent, dry-to-wet corrected ethane concentration as measured by the analyzer.

357. Amend §1065.665 by revising paragraph (a) to read as follows:

§1065.665 THCE and NMHCE determination.

(a) If you measured an oxygenated hydrocarbon's mass concentration, first calculate its molar concentration in the exhaust sample stream from which the sample was taken (raw or diluted exhaust), and convert this into a C_1-equivalent molar concentration. Add these C_1-equivalent molar concentrations to the molar concentration of non-oxygenated total hydrocarbon (NOTHC). The result is the molar concentration of total hydrocarbon equivalent (THCE). Calculate THCE concentration using the following equations, noting that Eq. 1065.665-3 is required only if you need to convert your oxygenated hydrocarbon (OHC) concentration from mass to moles:

$$x_{THCE} = x_{NOTHC} + \sum_{i=1}^{N} \left(x_{OHCi} - x_{OHCi\text{-}init} \right)$$

Eq. 1065.665-1

$$x_{\text{NOTHC}} = x_{\text{THC[THC-FID]cor}} - \sum_{i=1}^{N}\left(\left(x_{\text{OHCi}} - x_{\text{OHCi-init}}\right) \cdot RF_{\text{OHCi[THC-FID]}}\right)$$

Eq. 1065.665-2

$$x_{\text{OHCi}} = \frac{\dfrac{m_{\text{dexhOHCi}}}{M_{\text{OHCi}}}}{\dfrac{m_{\text{dexh}}}{M_{\text{dexh}}}} = \frac{n_{\text{dexhOHCi}}}{n_{\text{dexh}}}$$

Eq. 1065.665-3

Where:

x_{THCE} = the sum of the C_1-equivalent concentrations of non-oxygenated hydrocarbon, alcohols, and aldehydes.

x_{NOTHC} = the sum of the C_1-equivalent concentrations of NOTHC.

x_{OHCi} = the C_1-equivalent concentration of oxygenated species *i* in diluted exhaust, not corrected for initial contamination.

$x_{\text{OHCi-init}}$ = the C_1-equivalent concentration of the initial system contamination (optional) of oxygenated species *i*, dry-to-wet corrected.

$x_{\text{THC[THC-FID]cor}}$ = the C_1-equivalent response to NOTHC and all OHC in diluted exhaust, HC contamination and dry-to-wet corrected, as measured by the THC-FID.

$RF_{\text{OHCi[THC-FID]}}$ = the response factor of the FID to species *i* relative to propane on a C_1-equivalent basis.

M_{dexh} = the molar mass of diluted exhaust as determine in §1065.340.

m_{dexhOHCi} = the mass of oxygenated species *i* in dilute exhaust.

M_{OHCi} = the C_1-equivalent molecular weight of oxygenated species *i*.

m_{dexh} = the mass of diluted exhaust

n_{dexhOHCi} = the number of moles of oxygenated species *i* in total diluted exhaust flow.

n_{dexh} = the total diluted exhaust flow.

* * * * *

358. Amend §1065.667 by revising paragraph (d) to read as follows:

§1065.667 Dilution air background emission correction.

* * * * *

(d) You may determine the total flow of dilution air from the measured dilute exhaust flow and a chemical balance of the fuel, DEF, intake air, and dilute exhaust as described in §1065.655. For this option, the molar flow of dilution air is calculated by multiplying the dilute exhaust flow by the mole fraction of dilution gas to dilute exhaust, $x_{\text{dil/exh}}$, from the dilute chemical balance. This may be done by totaling continuous calculations or by using batch results. For example, to use batch results, the total flow of dilution air is calculated by multiplying the total flow of diluted exhaust, n_{dexh}, by the flow-weighted mean mole fraction of dilution air in diluted exhaust, $\bar{x}_{\text{dil/exh}}$. Calculate $\bar{x}_{\text{dil/exh}}$ using flow-weighted mean concentrations of emissions in the chemical balance, as described in §1065.655. The chemical balance in §1065.655 assumes that your engine operates stoichiometrically, even if it is a lean-burn engine, such as a compression-ignition engine. Note that for lean-burn engines this assumption could result in an error in emission calculations. This error could occur because the chemical balance in §1065.655 treats excess air passing through a lean-burn engine as if it was dilution air. If an emission concentration expected at the standard is about 100 times its dilution air background concentration, this error is negligible. However, if an emission concentration expected at the standard is similar to its background concentration, this error could be significant. If this error might affect your ability to show that your engines comply with applicable standards, we recommend that you either determine the total flow of dilution air using one of the more accurate methods in paragraph (b) or (c) of this section, or remove background emissions from dilution air by HEPA filtration, chemical adsorption, or catalytic scrubbing. You might also consider using a partial-flow dilution technique such as a bag mini-diluter, which uses purified air as the dilution air.

* * * * *

359. Amend §1065.675 by revising paragraph (d) to read as follows:

§1065.675 CLD quench verification calculations.

* * * * *

(d) Calculate quench as follows:

$$quench = \left(\left(\frac{\dfrac{x_{\text{NOwet}}}{1 - x_{\text{H2Omeas}}}}{x_{\text{NOdry}}} - 1 \right) \cdot \frac{x_{\text{H2Oexp}}}{x_{\text{H2Omeas}}} + \left(\frac{x_{\text{NOmeas}}}{x_{\text{NOact}}} - 1 \right) \cdot \frac{x_{\text{CO2exp}}}{x_{\text{CO2act}}} \right) \cdot 100\ \%$$

Eq. 1065.675-1

Where:

quench = amount of CLD quench.

x_{NOdry} = concentration of NO upstream of a humidity generator, according to §1065.370(e)(4).

x_{NOwet} = measured concentration of NO downstream of a humidity generator, according to §1065.370(e)(9).

x_{H2Oexp} = maximum expected mole fraction of water during emission testing, according to paragraph (b) of this section.

x_{H2Omeas} = measured mole fraction of water during the quench verification, according to §1065.370(e)(7).

x_{NOmeas} = measured concentration of NO when NO span gas is blended with CO_2 span gas, according to §1065.370(d)(10).

x_{NOact} = actual concentration of NO when NO span gas is blended with CO_2 span gas, according to §1065.370(d)(11) and calculated according to Eq. 1065.675-2.

x_{CO2exp} = maximum expected concentration of CO_2 during emission testing, according to paragraph (c) of this section.

x_{CO2act} = actual concentration of CO_2 when NO span gas is blended with CO_2 span gas, according to §1065.370(d)(9).

$$x_{\text{NOact}} = \left(1 - \frac{x_{\text{CO2act}}}{x_{\text{CO2span}}} \right) \cdot x_{\text{NOspan}}$$

Eq. 1065.675-2

Where:

x_{NOspan} = the NO span gas concentration input to the gas divider, according to §1065.370(d)(5).

x_{CO2span} = the CO_2 span gas concentration input to the gas divider, according to §1065.370(d)(4).

Example:

x_{NOdry} = 1800.0 µmol/mol
x_{NOwet} = 1739.6 µmol/mol
x_{H2Oexp} = 0.030 mol/mol
$x_{H2Omeas}$ = 0.030 mol/mol
x_{NOmeas} = 1515.2 µmol/mol
x_{NOspan} = 3001.6 µmol/mol
x_{CO2exp} = 3.2 %
$x_{CO2span}$ = 6.1 %
x_{CO2act} = 2.98 %

$$x_{NOact} = \left(1 - \frac{2.98}{6.1}\right) \cdot 3001.6 = 1535.24459 \text{ µmol/mol}$$

$$quench = \left(\left(\frac{\frac{1739.6}{1-0.030}}{1800.0} - 1 \right) \cdot \frac{0.030}{0.030} + \left(\frac{1515.2}{1535.24459} - 1 \right) \cdot \frac{3.2}{2.98} \right) \cdot 100\ \%$$

quench = (–0.0036655 – 0.014020171) ·100 % = –1.7685671 %

360. Amend §1065.695 by adding paragraph (c)(8)(v) to read as follows:
§1065.695 Data requirements.
* * * * *
(c) * *
(8) * * *
(v) Carbon balance error verification, if performed.
* * * * *

361. Amend §1065.701 by revising paragarphs (b) and (f) to read as follows:
§1065.701 General requirements for test fuels.
* * * * *
(b) Fuels meeting alternate specifications. We may allow you to use a different test fuel (such as California LEV III gasoline) if it does not affect your ability to show that your engines would comply with all applicable emission standards using the specified test fuel.
* * * * *
(f) Service accumulation and field testing fuels. If we do not specify a service-accumulation or field-testing fuel in the standard-setting part, use an appropriate commercially available fuel such as those meeting minimum specifications from the following table:

TABLE 1 OF §1065.701–EXAMPLES OF SERVICE-ACCUMULATION AND FIELD-TESTING FUELS

Fuel category	Subcategory	Reference procedure[a]
Diesel	Light distillate and light blends with residual	ASTM D975
	Middle distillate	ASTM D6985
	Biodiesel (B100)	ASTM D6751
Intermediate and residual fuel	All	See §1065.705
Gasoline	Automotive gasoline	ASTM D4814
	Automotive gasoline with ethanol concentration up to 10 volume %.	ASTM D4814
Alcohol	Ethanol (E51-83)	ASTM D5798
	Methanol (M70-M85)	ASTM D5797
Aviation fuel	Aviation gasoline	ASTM D910
	Gas turbine	ASTM D1655
	Jet B wide cut	ASTM D6615
Gas turbine fuel	General	ASTM D2880

[a]Incorporated by reference; see §1065.1010.

362. Amend §1065.703 by revising paragraph (b) to read as follows:

§1065.703 Distillate diesel fuel.

* * * * *

(b) There are three grades of #2 diesel fuel specified for use as a test fuel. See the standard-setting part to determine which grade to use. If the standard-setting part does not specify which grade to use, use good engineering judgment to select the grade that represents the fuel on which the engines will operate in use. The three grades are specified in Table 1 of this section.

TABLE 1 OF §1065.703–TEST FUEL SPECIFICATIONS FOR DISTILLATE DIESEL FUEL

Property	Unit	Ultra Low Sulfur	Low Sulfur	High Sulfur	Reference Procedure[a]
Cetane Number	—	40-50	40-50	40-50	ASTM D613
Distillation range: Initial boiling point 10 pct. point 50 pct. point 90 pct. point Endpoint	°C	 171-204 204-238 243-282 293-332 321-366	 171-204 204-238 243-282 293-332 321-366	 171-204 204-238 243-282 293-332 321-366	 ASTM D86
Gravity	°API	32-37	32-37	32-37	ASTM D4052
Total sulfur	mg/kg	7-15	300-500	800-2500	ASTM D2622, ASTM D5453, or ASTM D7039
Aromatics, min. (Remainder shall be paraffins, naphthenes, and olefins)	g/kg	100	100	100	ASTM D5186
Flashpoint, min.	°C	54	54	54	ASTM D93
Kinematic Viscosity	mm^2/s	2.0-3.2	2.0-3.2	2.0-3.2	ASTM D445

[a]Incorporated by reference, see §1065.1010. See §1065.701(d) for other allowed procedures.

* * * * *

363. Amend §1065.705 by revising paragraph (c) to read as follows:

§1065.705 Residual and intermediate residual fuel.

* * * * *

(c) The fuel must meet the specifications for one of the categories in the following table:

TABLE 1 OF §1065.705–SERVICE ACCUMULATION AND TEST FUEL SPECIFICATIONS FOR RESIDUAL FUEL

Property	Unit	Category ISO-F-										Reference Procedure[a]
		RMA 30	**RMB 30**	**RMD 80**	**RME 180**	**RMF 180**	**RMG 380**	**RMH 380**	**RMK 380**	**RMH 700**	**RMK 700**	
Density at 15 °C, max.	kg/m³	960.0	975.0	980.0	991.0		991.0		1010.0	991.0	1010.0	ISO 3675 or ISO 12185 (see also ISO 8217)
Kinematic viscosity at 50 °C, max.	mm²/s	30.0		80.0	180.0		380.0		700.0			ISO 3104
Flash point, min.	°C	60		60	60		60		60			ISO 2719 (see also ISO 8217)
Pour point (upper) Winter quality, max. Summer quality, max.	°C	 0 6	 24 24	 30 30	 30 30		 30 30		 30 30			ISO 3016
Carbon residue, max.	(kg/kg) %	10		14	15	20	18	22	22			ISO 10370
Ash, max.	(kg/kg) %	0.10		0.10	0.10	0.15	0.15		0.15			ISO 6245
Water, max.	(m³/m³) %	0.5		0.5	0.5		0.5		0.5			ISO 3733
Sulfur, max.	(kg/kg) %	3.50		4.00	4.50		4.50		4.50			ISO 8754 or ISO 14596 (see also ISO 8217)
Vanadium, max.	mg/kg	150		350	200	500	300	600	600			ISO 14597 or IP-501 or IP-470 (see also ISO 8217)
Total sediment potential, max.	(kg/kg) %	0.10		0.10	0.10		0.10		0.10			ISO 10307-2 (see also ISO 8217)
Aluminium plus silicon, max.	mg/kg	80		80	80		80		80			ISO 10478 or IP 501 or IP 470 (see also ISO 8217)

[a]Incorporated by reference; see §1065.1010. See §1065.701(d) for other allowed procedures.

364. Amend §1065.710 by revising paragraphs (b)(2) and (c) to read as follows:

§1065.710 Gasoline.

* * * * *

(b) * * *

(2) Table 1 of this section identifies limit values consistent with the units in the reference procedure for each fuel property. These values are generally specified in international units. Values presented in parentheses are for information only. Table 1 follows:

TABLE 1 OF §1065.710–TEST FUEL SPECIFICATIONS
FOR A LOW-LEVEL ETHANOL-GASOLINE BLEND

Property	Unit	SPECIFICATION			Reference Procedure[a]
		General Testing	Low-Temperature Testing	High Altitude Testing	
Antiknock Index (R+M)/2	-	87.0-88.4[b]		Minimum, 87.0	ASTM D2699 and ASTM D2700
Sensitivity (R-M)	-	Minimum, 7.5			ASTM D2699 and ASTM D2700
Dry Vapor Pressure Equivalent (*DVPE*)[c,d]	kPa (psi)	60.0-63.4 (8.7-9.2)	77.2-81.4 (11.2-11.8)	52.4-55.2 (7.6-8.0)	ASTM D5191
Distillation[d] 10 % evaporated	°C (°F)	49-60 (120-140)	43-54 (110-130)	49-60 (120-140)	ASTM D86
50 % evaporated	°C (°F)	88-99 (190-210)			
90 % evaporated	°C (°F)	157-168 (315-335)			
Evaporated final boiling point	°C (°F)	193-216 (380-420)			
Residue	milliliter	Maximum, 2.0			
Total Aromatic Hydrocarbons	volume %	21.0-25.0			ASTM D5769
C6 Aromatics (benzene)	volume %	0.5-0.7			
C7 Aromatics (toluene)	volume %	5.2-6.4			
C8 Aromatics	volume %	5.2-6.4			
C9 Aromatics	volume %	5.2-6.4			
C10+ Aromatics	volume %	4.4-5.6			
Olefins[e]	volume %	4.0-10.0			ASTM D6550
Ethanol blended	volume %	9.6-10.0			See paragraph (b)(3) of this section.
Ethanol confirmatory[f]	volume %	9.4-10.2			ASTM D4815 or ASTM D5599
Total Content of Oxygenates Other than Ethanol[f]	volume %	Maximum, 0.1			ASTM D4815 or ASTM D5599
Sulfur	mg/kg	8.0-11.0			ASTM D2622, ASTM D5453 or ASTM D7039
Lead	g/liter	Maximum, 0.0026			ASTM D3237
Phosphorus	g/liter	Maximum, 0.0013			ASTM D3231
Copper Corrosion	-	Maximum, No. 1			ASTM D130
Solvent-Washed Gum Content	mg/100 milliliter	Maximum, 3.0			ASTM D381
Oxidation Stability	minute	Minimum, 1000			ASTM D525

[a]Incorporated by reference; see §1065.1010. See §1065.701(d) for other allowed procedures.
[b]Octane specifications apply only for testing related to exhaust emissions. For engines or vehicles that require the use of premium fuel, as described in paragraph (d) of this section, the adjusted specification for antiknock index is a minimum value of 91.0; no maximum value applies. All other specifications apply for this high-octane fuel.
[c]Calculate dry vapor pressure equivalent, *DVPE*, based on the measured total vapor pressure, p_T, using the following equation: $DVPE$ (kPa) = $0.956 \cdot p_T - 2.39$ or $DVPE$ (psi) = $0.956 \cdot p_T - 0.347$. *DVPE* is intended to be equivalent to Reid Vapor Pressure using a different test method.
[d]Parenthetical values are shown for informational purposes only.
[e]ASTM D6550 prescribes measurement of olefin concentration in mass %. Multiply this result by 0.857 and round to the first decimal place to determine the olefin concentration in volume %.
[f]ASTM D5599 prescribes concentration measurements for ethanol and other oxygenates in mass %. Convert results to volume % as specified in Section 14.3 of ASTM D4815.

* * * * *

(c) The specifications of this paragraph (c) apply for testing with neat gasoline. This is sometimes called indolene or E0 test fuel. Gasoline for testing must have octane values that represent commercially available fuels for the appropriate application. Test fuel specifications apply as follows:

TABLE 2 OF §1065.710–TEST FUEL SPECIFICATIONS FOR NEAT (E0) GASOLINE

Property	Unit	SPECIFICATION		Reference Procedure[a]
		General Testing	Low-Temperature Testing	
Distillation Range:				ASTM D86
Evaporated initial boiling point	°C	24-35[b]	24-36	
10 % evaporated	°C	49-57	37-48	
50 % evaporated	°C	93-110	82-101	
90 % evaporated	°C	149-163	158-174	
Evaporated final boiling point	°C	Maximum, 213	Maximum, 212	
Total Aromatic Hydrocarbons	volume %	Maximum, 35	Maximum, 30.4	ASTM D1319 or ASTM D5769
Olefins[c]	volume %	Maximum, 10	Maximum, 17.5	ASTM D1319 or ASTM D6550
Lead	g/liter	Maximum, 0.013	Maximum, 0.013	ASTM D3237
Phosphorous	g/liter	Maximum, 0.0013	Maximum, 0.005	ASTM D3231
Total sulfur	mg/kg	Maximum, 80	Maximum, 80	ASTM D2622
Dry vapor pressure equivalent[d]	kPa	60.0-63.4[b,e]	77.2-81.4	ASTM D5191

[a]Incorporated by reference; see §1065.1010. See §1065.701(d) for other allowed procedures.
[b]For testing at altitudes above 1219 m, the specified initial boiling point range is (23.9 to 40.6) °C and the specified volatility range is (52.0 to 55.2) kPa.
[c]ASTM D6550 prescribes measurement of olefin concentration in mass %. Multiply this result by 0.857 and round to the first decimal place to determine the olefin concentration in volume %.
[d]Calculate dry vapor pressure equivalent, *DVPE*, based on the measured total vapor pressure, p_T, in kPa using the following equation: $DVPE$ (kPa) = $0.956 \cdot p_T - 2.39$ or $DVPE$ (psi) = $0.956 \cdot p_T - 0.347$. *DVPE* is intended to be equivalent to Reid Vapor Pressure using a different test method.
[e]For testing unrelated to evaporative emissions, the specified range is (55.2 to 63.4) kPa.

* * * * *

365. Amend §1065.715 by revising paragraph (a) to read as follows:

§1065.715 Natural gas.

(a) Except as specified in paragraph (b) of this section, natural gas for testing must meet the specifications in the following table:

TABLE 1 OF §1065.715–TEST FUEL SPECIFICATIONS FOR NATURAL GAS

Property	Value[a]
Methane, CH_4	Minimum, 0.87 mol/mol
Ethane, C_2H_6	Maximum, 0.055 mol/mol
Propane, C_3H_8	Maximum, 0.012 mol/mol
Butane, C_4H_{10}	Maximum, 0.0035 mol/mol
Pentane, C_5H_{12}	Maximum, 0.0013 mol/mol
C_6 and higher	Maximum, 0.001 mol/mol
Oxygen	Maximum, 0.001 mol/mol
Inert gases (sum of CO_2 and N_2)	Maximum, 0.051 mol/mol

[a]Demonstrate compliance with fuel specifications based on the reference procedures in ASTM D1945 (incorporated by reference in §1065.1010), or on other measurement procedures using good engineering judgment. See §1065.701(d) for other allowed procedures.

*   *   *   *   *

366. Amend §1065.720 by revising paragraph (a) to read as follows:

§1065.720 Liquefied petroleum gas.

(a) Except as specified in paragraph (b) of this section, liquefied petroleum gas for testing must meet the specifications in the following table:

TABLE 1 OF §1065.720(a)–TEST FUEL SPECIFICATIONS FOR LIQUEFIED PETROLEUM GAS

Property	Value	Reference Procedure[a]
Propane, C_3H_8	Minimum, 0.85 m^3/m^3	ASTM D2163
Vapor pressure at 38 °C	Maximum, 1400 kPa	ASTM D1267 or ASTM D2598[b]
Volatility residue (evaporated temperature, 35 °C)	Maximum, –38 °C	ASTM D1837
Butanes	Maximum, 0.05 m^3/m^3	ASTM D2163
Butenes	Maximum, 0.02 m^3/m^3	ASTM D2163
Pentenes and heavier	Maximum, 0.005 m^3/m^3	ASTM D2163
Propene	Maximum, 0.1 m^3/m^3	ASTM D2163
Residual matter (residue on evaporation of 100 ml oil stain observation)	Maximum, 0.05 ml pass[c]	ASTM D2158
Corrosion, copper strip	Maximum, No. 1	ASTM D1838
Sulfur	Maximum, 80 mg/kg	ASTM D6667
Moisture content	pass	ASTM D2713

[a]Incorporated by reference; see §1065.1010. See §1065.701(d) for other allowed procedures.
[b]If these two test methods yield different results, use the results from ASTM D1267.
[c]The test fuel must not yield a persistent oil ring when you add 0.3 ml of solvent residue mixture to a filter paper in 0.1 ml increments and examine it in daylight after two minutes.

*   *   *   *   *

367. Amend §1065.750 by revising paragraph (a)(1)(ii) to read as follows:

§1065.750 Analytical gases.

(a)   *   *   *

(1)   *   *   *

(ii) Contamination as specified in the following table:

TABLE 1 OF §1065.750–GENERAL SPECIFICATIONS FOR PURIFIED GASES[a]

Constituent	Purified Air	Purified N_2
THC (C_1-equivalent)	≤ 0.05 μmol/mol	≤ 0.05 μmol/mol
CO	≤ 1 μmol/mol	≤ 1 μmol/mol
CO_2	≤ 10 μmol/mol	≤ 10 μmol/mol
O_2	0.205 to 0.215 mol/mol	≤ 2 μmol/mol
NO_x	≤ 0.02 μmol/mol	≤ 0.02 μmol/mol
N_2O[b]	≤ 0.02 μmol/mol	≤ 0.02 μmol/mol

[a]We do not require these levels of purity to be NIST-traceable.
[b]The N_2O limit applies only if the standard-setting part requires you to report N_2O or certify to an N_2O standard.

* * * * *

368. Amend §1065.790 by revising paragraph (b) to read as follows:

§1065.790 Mass standards.

* * * * *

(b) Dynamometer, fuel mass scale, and DEF mass scale calibration weights. Use dynamometer and mass scale calibration weights that are certified as NIST-traceable within 0.1 % uncertainty. Calibration weights may be certified by any calibration lab that maintains NIST-traceability.

369. Amend §1065.905 by revising paragraph (f) to read as follows:

§1065.905 General provisions.

* * * * *

(f) Summary. The following table summarizes the requirements of paragraphs (d) and (e) of this section:

TABLE 1 OF §1065.905–SUMMARY OF TESTING REQUIREMENTS SPECIFIED OUTSIDE OF THIS SUBPART J

Subpart	**Applicability for field testing**[a]	**Applicability for laboratory or similar testing with PEMS without restriction**[a]	**Applicability for laboratory or similar testing with PEMS with restrictions**[a]
A: Applicability and general provisions	Use all.	Use all.	Use all.
B: Equipment for testing	Use §1065.101 and §1065.140 through the end of subpart B, except §1065.140(e)(1) and (4), §1065.170(c)(1)(vi), and §1065.195(c). §1065.910 specifies equipment specific to field testing.	Use all.	Use all. §1065.910 specifies equipment specific to laboratory testing with PEMS.
C: Measurement instruments	Use all. §1065.915 allows deviations.	Use all except §1065.295(c).	Use all except §1065.295(c). §1065.915 allows deviations.
D: Calibrations and verifications	Use all except §1065.308 and §1065.309. §1065.920 allows deviations, but also has additional specifications.	Use all.	Use all. §1065.920 allows deviations, but also has additional specifications.
E: Test engine selection, maintenance, and durability	Do not use. Use standard-setting part.	Use all.	Use all.
F: Running an emission test in the laboratory	Use §§1065.590 and 1065.595 for PM §1065.930 and §1065.935 to start and run a field test.	Use all.	Use all.
G: Calculations and data requirements	Use all. §1065.940 has additional calculation instructions	Use all.	Use all. §1065.940 has additional calculation instructions
H: Fuels, engine fluids, analytical gases, and other calibration materials	Use all.	Use all.	Use all.
I: Testing with oxygenated fuels	Use all.	Use all.	Use all.
K: Definitions and reference materials	Use all.	Use all.	Use all.

[a]Refer to paragraphs (d) and (e) of this section for complete specifications.

370. Amend §1065.910 by revising paragraph (a)(2) to read as follows:
§1065.910 PEMS auxiliary equipment for field testing.
*   *   *   *   *
(a)   *   *   *
(2) Tubing. We recommend using rigid 300 series stainless steel tubing to connect between flexible connectors. Tubing may be straight or bent to accommodate vehicle geometry. You may use "T" or "Y" fittings to join multiple connections, or you may cap or plug redundant flow paths if the engine manufacturer recommends it.
*   *   *   *   *

371. Amend §1065.915 by revising paragraph (a) to read as follows:
§1065.915 PEMS instruments.
(a) Instrument specifications. We recommend that you use PEMS that meet the specifications of subpart C of this part. For unrestricted use of PEMS in a laboratory or similar environment, use a PEMS that meets the same specifications as each lab instrument it replaces. For field testing or for testing with PEMS in a laboratory or similar environment, under the provisions of §1065.905(b), the specifications in the following table apply instead of the specifications in Table 1 of §1065.205:

TABLE 1 OF §1065.915–RECOMMENDED MINIMUM PEMS MEASUREMENT INSTRUMENT PERFORMANCE

Measurement	**Measured quantity symbol**	**Rise time, $t_{10\text{-}90}$, and Fall time, $t_{90\text{-}10}$**	**Recording update frequency**	**Accuracy**[a]	**Repeatability**[a]	**Noise**[a]
Engine speed transducer	f_n	1 s	1 Hz means	5 % of pt. or 1 % of max.	2 % of pt. or 1 % of max.	0.5 % of max
Engine torque estimator, BSFC (This is a signal from an engine's ECM)	T or BSFC	1 s	1 Hz means	8 % of pt. or 5 % of max.	2 % of pt. or 1 % of max.	1 % of max.
General pressure transducer (not a part of another instrument)	p	5 s	1 Hz	5 % of pt. or 5 % of max.	2 % of pt. or 0.5 % of max.	1 % of max
Atmospheric pressure meter	p_{atmos}	50 s	0.1 Hz	250 Pa	200 Pa	100 Pa
General temperature sensor (not a part of another instrument)	T	5 s	1 Hz	1 % of pt. K or 5 K	0.5 % of pt. K or 2 K	0.5 % of max 0.5 K
General dewpoint sensor	T_{dew}	50 s	0.1 Hz	3 K	1 K	1 K
Exhaust flow meter	$\dot{n}$	1 s	1 Hz means	5 % of pt. or 3 % of max.	2 % of pt.	2 % of max.
Dilution air, inlet air, exhaust, and sample flow meters	$\dot{n}$	1 s	1 Hz means	2.5 % of pt. or 1.5 % of max.	1.25 % of pt. or 0.75 % of max.	1 % of max.
Continuous gas analyzer	x	5 s	1 Hz	4 % of pt. or 4 % of meas.	2 % of pt. or 2 % of meas.	1 % of max.
Gravimetric PM balance	m_{PM}	—	—	See §1065.790	0.5 µg	—
Inertial PM balance	m_{PM}	—	—	4 % of pt. or 4 % of meas.	2 % of pt. or 2 % of meas.	1 % of max

[a]Accuracy, repeatability, and noise are all determined with the same collected data, as described in §1065.305, and based on absolute values. "pt." refers to the overall flow-weighted mean value expected at the standard; "max." refers to the peak value expected at the standard over any test interval, not the maximum of the instrument's range; "meas" refers to the actual flow-weighted mean measured over any test interval.

*	*	*	*	*

372. Amend §1065.1001 by adding a definition for "Enhanced-idle" in alphabetical order and revising the definition for "Test interval" to read as follows:

§1065.1001 Definitions.

*	*	*	*	*

Enhanced-idle means a mode of engine idle operation where idle speed is elevated above warm idle speed as determined by the electronic control module, for example during engine warm-up or to increase exhaust temperature.

*	*	*	*	*

Test interval means a duration of time over which you determine mass of emissions. For example, the standard-setting part may specify a complete laboratory duty cycle as a cold-start test interval, plus a hot-start test interval. As another example, a standard-setting part may specify a field-test interval, such as a "not-to-exceed" (NTE) event, as a duration of time over which an engine operates within a certain range of speed and torque. In cases where multiple test intervals occur over a duty cycle, the standard-setting part may specify additional calculations that weight and combine results to arrive at composite values for comparison against the applicable standards.

*	*	*	*	*

373. Amend §1065.1005 by revising paragraphs (a), (c), (d), (e), (f)(2), and (g) to read as follows:

§1065.1005 Symbols, abbreviations, acronyms, and units of measure.

*	*	*	*	*

(a) Symbols for quantities. This part uses the following symbols and units of measure for various quantities:

SYMBOL	QUANTITY	UNIT	UNIT SYMBOL	UNITS IN TERMS OF SI BASE UNITS
α	atomic hydrogen-to-carbon ratio	mole per mole	mol/mol	1
A	area	square meter	m^2	m^2
a_0	intercept of least squares regression			
a_1	slope of least squares regression			
a_g	acceleration of Earth's gravity	meter per square second	m/s^2	$m \cdot s^{-2}$
β	ratio of diameters	meter per meter	m/m	1
β	atomic oxygen-to-carbon ratio	mole per mole	mol/mol	1
$C_\#$	number of carbon atoms in a molecule			
c	power-specific carbon mass error coefficient	gram per kilowatt-hour	g/(kW·hr)	$3.6^{-1} \cdot 10^{-9} \cdot m^{-2} \cdot s^2$
C_d	discharge coefficient			
C_f	flow coefficient			
δ	atomic nitrogen-to-carbon ratio	mole per mole	mol/mol	1
d	diameter	meter	m	m
d	power-specific carbon mass rate absolute error coefficent	gram per kilowatt-hour	g/(kW·hr)	$3.6^{-1} \cdot 10^{-9} \cdot m^{-2} \cdot s^2$
DR	dilution ratio	mole per mole	mol/mol	1
ε	error between a quantity and its reference			
ϵ	difference or error quantity			
e	brake-specific emission or fuel consumption	gram per kilowatt hour	g/(kW·hr)	$3.6^{-1} \cdot 10^{-9} \cdot m^{-2} \cdot s^2$
F	F-test statistic			
f	frequency	hertz	Hz	s^{-1}

f_n	angular speed (shaft)	revolutions per minute	r/min	$\pi\cdot30^{-1}\cdot s^{-1}$
γ	ratio of specific heats	(joule per kilogram kelvin) per (joule per kilogram kelvin)	(J/(kg·K))/(J/(kg·K))	1
γ	atomic sulfur-to-carbon ratio	mole per mole	mol/mol	1
K	correction factor			1
K_v	calibration coefficient		$m^4\cdot s\cdot K^{0.5}/kg$	$m^4\cdot kg^{-1}\cdot s\cdot K^{0.5}$
l	length	meter	m	m
L	limit			
μ	viscosity, dynamic	pascal second	Pa·s	$m^{-1}\cdot kg\cdot s^{-1}$
M	molar mass[a]	gram per mole	g/mol	$10^{-3}\cdot kg\cdot mol^{-1}$
m	mass	kilogram	kg	kg
$\dot{m}$	mass rate	kilogram per second	kg/s	$kg\cdot s^{-1}$
v	viscosity, kinematic	meter squared per second	m^2/s	$m^2\cdot s^{-1}$
N	total number in series			
n	amount of substance	mole	mol	mol
$\dot{n}$	amount of substance rate	mole per second	mol/s	$mol\cdot s^{-1}$
P	power	kilowatt	kW	$10^3\cdot m^2\cdot kg\cdot s^{-3}$
PF	penetration fraction			
p	pressure	pascal	Pa	$m^{-1}\cdot kg\cdot s^{-2}$
ρ	mass density	kilogram per cubic meter	kg/m^3	$m^{-3}\cdot kg$
Δp	differential static pressure	pascal	Pa	$m^{-1}\cdot kg\cdot s^{-2}$
r	ratio of pressures	pascal per pascal	Pa/Pa	1
r^2	coefficient of determination			
Ra	average surface roughness	micrometer	µm	$10^{-6}\cdot m$
$Re^{\#}$	Reynolds number			
RF	response factor			
RH	relative humidity			
σ	non-biased standard deviation			
S	Sutherland constant	kelvin	K	K
SEE	standard error of the estimate			
T	absolute temperature	kelvin	K	K
T	Celsius temperature	degree Celsius	°C	K – 273.15
T	torque (moment of force)	newton meter	N·m	$m^2\cdot kg\cdot s^{-2}$
Θ	plane angle	degrees	°	rad
t	time	second	s	s
Δt	time interval, period, 1/frequency	second	s	s
V	volume	cubic meter	m^3	m^3
$\dot{V}$	volume rate	cubic meter per second	m^3/s	$m^3\cdot s^{-1}$
W	work	kilowatt-hour	kW·hr	$3.6\cdot10^6\cdot m^2\cdot kg\cdot s^{-2}$
w_C	carbon mass fraction	gram per gram	g/g	1
x	amount of substance mole fraction[b]	mole per mole	mol/mol	1
$\bar{x}$	flow-weighted mean concentration	mole per mole	mol/mol	1
y	generic variable			
Z	compressibility factor			

aSee paragraph (f)(2) of this section for the values to use for molar masses. Note that in the cases of NO_x and HC, the regulations specify effective molar masses based on assumed speciation rather than actual speciation.
[b]Note that mole fractions for THC, THCE, NMHC, NMHCE, and NOTHC are expressed on a C_1-equivalent basis.

*   *   *   *   *

(c) Prefixes. This part uses the following prefixes for units and unit symbols:

SYMBOL	PREFIX NAME	FACTOR
µ	micro	10^{-6}
m	milli	10^{-3}
c	centi	10^{-2}
k	kilo	10^{3}
M	mega	10^{6}

(d) Superscripts. This part uses the following superscripts for modifying quantity symbols:

SUPERSCRIPT	MEANING
overbar (such as $\overline{y}$)	arithmetic mean
overdot (such as $\dot{y}$)	quantity per unit time

(e) Subscripts. This part uses the following subscripts for modifying quantity symbols:

SUBSCRIPT	MEANING
a	absolute (e.g., absolute difference or error)
abs	absolute quantity
act	actual condition
air	air, dry
amb	ambient
atmos	atmospheric
bkgnd	background
C	carbon mass
cal	calibration quantity
CFV	critical flow venturi
comb	combined
comp	composite value
cor	corrected quantity
dil	dilution air
dew	dewpoint
dexh	diluted exhaust
dry	dry condition
dutycycle	duty cycle
ϵ	related to a difference or error quantity
exh	raw exhaust
exp	expected quantity
fluid	fluid stream
fn	feedback speed
frict	friction
fuel	fuel consumption
hi,idle	condition at high-idle
i	an individual of a series
idle	condition at idle
in	quantity in
init	initial quantity, typically before an emission test
int	intake air
j	an individual of a series
mapped	conditions over which an engine can operate
max	the maximum (i.e., peak) value expected at the standard over a test interval; not the maximum of an instrument range
meas	measured quantity
media	PM sample media
mix	mixture of diluted exhaust and air
norm	normalized
out	quantity out

P	power
part	partial quantity
PDP	positive-displacement pump
post	after the test interval
pre	before the test interval
prod	stoichiometric product
r	relative (e.g., relative difference or error)
rate	rate (divided by time)
record	record rate
ref	reference quantity
rev	revolution
sat	saturated condition
s	slip
span	span quantity
SSV	subsonic venturi
std	standard condition
stroke	engine strokes per power stroke
T	torque
test	test quantity
test,alt	alternate test quantity
uncor	uncorrected quantity
vac	vacuum side of the sampling system
weight	calibration weight
zero	zero quantity

(f) * *

(2) This part uses the following molar masses or effective molar masses of chemical species:

SYMBOL	QUANTITY	g/mol ($10^{-3}\cdot kg\cdot mol^{-1}$)
M_{air}	molar mass of dry air[a]	28.96559
M_{Ar}	molar mass of argon	39.948
M_{C}	molar mass of carbon	12.0107
M_{CH3OH}	molar mass of methanol	32.04186
M_{C2H5OH}	molar mass of ethanol	46.06844
M_{C2H4O}	molar mass of acetaldehyde	44.05256
M_{CH4N2O}	molar mass of urea	60.05526
M_{C2H6}	molar mass of ethane	30.06904
M_{C3H8}	molar mass of propane	44.09562
M_{C3H7OH}	molar mass of propanol	60.09502
M_{CO}	molar mass of carbon monoxide	28.0101
M_{CH4}	molar mass of methane	16.0425
M_{CO2}	molar mass of carbon dioxide	44.0095
M_{H}	molar mass of atomic hydrogen	1.00794
M_{H2}	molar mass of molecular hydrogen	2.01588
M_{H2O}	molar mass of water	18.01528
M_{CH2O}	molar mass of formaldehyde	30.02598
M_{He}	molar mass of helium	4.002602
M_{N}	molar mass of atomic nitrogen	14.0067
M_{N2}	molar mass of molecular nitrogen	28.0134
M_{NH3}	molar mass of ammonia	17.03052
M_{NMHC}	effective C_1 molar mass of nonmethane hydrocarbon[b]	13.875389
M_{NMHCE}	effective C_1 molar mass of nonmethane hydrocarbon equivalent[b]	13.875389
M_{NMNEHC}	effective C_1 molar mass of nonmethane-nonethane hydrocarbon[b]	13.875389
M_{NOx}	effective molar mass of oxides of nitrogen[c]	46.0055
M_{N2O}	molar mass of nitrous oxide	44.0128

M_O	molar mass of atomic oxygen	15.9994
M_{O2}	molar mass of molecular oxygen	31.9988
M_S	molar mass of sulfur	32.065
M_{THC}	effective C_1 molar mass of total hydrocarbon[b]	13.875389
M_{THCE}	effective C_1 molar mass of total hydrocarbon equivalent[b]	13.875389

[a]See paragraph (f)(1) of this section for the composition of dry air.
[b]The effective molar masses of THC, THCE, NMHC, NMHCE, and NMNEHC are defined on a C_1 basis and are based on an atomic hydrogen-to-carbon ratio, α, of 1.85 (with β, γ, and δ equal to zero).
[c]The effective molar mass of NO_x is defined by the molar mass of nitrogen dioxide, NO_2.

* * * * *

(g) Other acronyms and abbreviations. This part uses the following additional abbreviations and acronyms:

ACRONYM	MEANING
ABS	acrylonitrile-butadiene-styrene
ASTM	ASTM International
BMD	bag mini-diluter
BSFC	brake-specific fuel consumption
CARB	California Air Resources Board
CFR	Code of Federal Regulations
CFV	critical-flow venturi
CI	compression-ignition
CITT	Curb Idle Transmission Torque
CLD	chemiluminescent detector
CVS	constant-volume sampler
DEF	diesel exhaust fluid
DF	deterioration factor
ECM	electronic control module
EFC	electronic flow control
e.g.	exempli gratia, for example
EGR	exhaust gas recirculation
EPA	Environmental Protection Agency
FEL	Family Emission Limit
FID	flame-ionization detector
FTIR	Fourier transform infrared
GC	gas chromatograph
GC-ECD	gas chromatograph with an electron-capture detector
GC-FID	gas chromatograph with a flame ionization detector
HEPA	high-efficiency particulate air
IBP	initial boiling point
IBR	incorporated by reference
i.e.	id est, in other words
ISO	International Organization for Standardization
LPG	liquefied petroleum gas
MPD	magnetopneumatic detection
NDIR	nondispersive infrared
NDUV	nondispersive ultraviolet
NIST	National Institute for Standards and Technology
NMC	nonmethane cutter
PDP	positive-displacement pump
PEMS	portable emission measurement system
PFD	partial-flow dilution
PLOT	porous layer open tubular
PMD	paramagnetic detection
PMP	Polymethylpentene
pt.	a single point at the mean value expected at the standard.

psi	pounds per square inch
PTFE	polytetrafluoroethylene (commonly known as Teflon™)
RE	rounding error
RESS	rechargeable energy storage system
RFPF	response factor penetration fraction
RMC	ramped-modal cycle
rms	root-mean square
RTD	resistive temperature detector
SAW	surface acoustic wave
SEE	standard error of the estimate
SSV	subsonic venturi
SI	spark-ignition
THC-FID	total hydrocarbon flame ionization detector
TINV	inverse student *t*-test function in Microsoft Excel
UCL	upper confidence limit
UFM	ultrasonic flow meter
U.S.C.	United States Code

374. Amend §1065.1010 by revising paragraph (b) to read as follows:

§1065.1010 Incorporation by reference.

* * * * *

(b) *ASTM material*. The following standards are available from ASTM International, 100 Barr Harbor Dr., P.O. Box C700, West Conshohocken, PA 19428–2959, (877) 909–ASTM, or *http://www.astm.org*:

(1) ASTM D86-12, Standard Test Method for Distillation of Petroleum Products at Atmospheric Pressure, approved December 1, 2012 ("ASTM D86"), IBR approved for §§1065.703(b) and 1065.710(b) and (c).

(2) ASTM D93-13, Standard Test Methods for Flash Point by Pensky- Martens Closed Cup Tester, approved July 15, 2013 ("ASTM D93"), IBR approved for §1065.703(b).

(3) ASTM D130-12, Standard Test Method for Corrosiveness to Copper from Petroleum Products by Copper Strip Test, approved November 1, 2012 ("ASTM D130"), IBR approved for §1065.710(b).

(4) ASTM D381-12, Standard Test Method for Gum Content in Fuels by Jet Evaporation, approved April 15, 2012 ("ASTM D381"), IBR approved for §1065.710(b).

(5) ASTM D445-12, Standard Test Method for Kinematic Viscosity of Transparent and Opaque Liquids (and Calculation of Dynamic Viscosity), approved April 15, 2012 ("ASTM D445"), IBR approved for §1065.703(b).

(6) ASTM D525-12a, Standard Test Method for Oxidation Stability of Gasoline (Induction Period Method), approved September 1, 2012 ("ASTM D525"), IBR approved for §1065.710(b).

(7) ASTM D613-13, Standard Test Method for Cetane Number of Diesel Fuel Oil, approved December 1, 2013 ("ASTM D613"), IBR approved for §1065.703(b).

(8) ASTM D910-13a, Standard Specification for Aviation Gasolines, approved December 1, 2013 ("ASTM D910"), IBR approved for §1065.701(f).

(9) ASTM D975-13a, Standard Specification for Diesel Fuel Oils, approved December 1, 2013 ("ASTM D975"), IBR approved for §1065.701(f).

(10) ASTM D1267-12, Standard Test Method for Gage Vapor Pressure of Liquefied Petroleum (LP) Gases (LP-Gas Method), approved November 1, 2012 ("ASTM D1267"), IBR approved for §1065.720(a).

(11) ASTM D1319-13, Standard Test Method for Hydrocarbon Types in Liquid Petroleum Products by Fluorescent Indicator Adsorption, approved May 1, 2013 ("ASTM D1319"), IBR approved for §1065.710(c).
(12) ASTM D1655-13a, Standard Specification for Aviation Turbine Fuels, approved December 1, 2013 ("ASTM D1655"), IBR approved for §1065.701(f).
(13) ASTM D1837-11, Standard Test Method for Volatility of Liquefied Petroleum (LP) Gases, approved October 1, 2011 ("ASTM D1837"), IBR approved for §1065.720(a).
(14) ASTM D1838-12a, Standard Test Method for Copper Strip Corrosion by Liquefied Petroleum (LP) Gases, approved December 1, 2012 ("ASTM D1838"), IBR approved for §1065.720(a).
(15) ASTM D1945-03 (Reapproved 2010), Standard Test Method for Analysis of Natural Gas by Gas Chromatography, approved January 1, 2010 ("ASTM D1945"), IBR approved for §1065.715(a).
(16) ASTM D2158-11, Standard Test Method for Residues in Liquefied Petroleum (LP) Gases, approved January 1, 2011 ("ASTM D2158"), IBR approved for §1065.720(a).
(17) ASTM D2163-07, Standard Test Method for Determination of Hydrocarbons in Liquefied Petroleum (LP) Gases and Propane/Propene Mixtures by Gas Chromatography, approved December 1, 2007 ("ASTM D2163"), IBR approved for §1065.720(a).
(18) ASTM D2598-12, Standard Practice for Calculation of Certain Physical Properties of Liquefied Petroleum (LP) Gases from Compositional Analysis, approved November 1, 2012 ("ASTM D2598"), IBR approved for §1065.720(a).
(19) ASTM D2622-16, Standard Test Method for Sulfur in Petroleum Products by Wavelength Dispersive X-ray Fluorescence Spectrometry, approved January 1, 2016 ("ASTM D2622"), IBR approved for §§1065.703(b) and 1065.710(b) and (c).
(20) ASTM D2699-13b, Standard Test Method for Research Octane Number of Spark-Ignition Engine Fuel, approved October 1, 2013 ("ASTM D2699"), IBR approved for §1065.710(b).
(21) ASTM D2700-13b, Standard Test Method for Motor Octane Number of Spark-Ignition Engine Fuel, approved October 1, 2013 ("ASTM D2700"), IBR approved for §1065.710(b).
(22) ASTM D2713-13, Standard Test Method for Dryness of Propane (Valve Freeze Method), approved October 1, 2013 ("ASTM D2713"), IBR approved for §1065.720(a).
(23) ASTM D2880-13b, Standard Specification for Gas Turbine Fuel Oils, approved November 15, 2013 ("ASTM D2880"), IBR approved for §1065.701(f).
(24) ASTM D2986-95a, Standard Practice for Evaluation of Air Assay Media by the Monodisperse DOP (Dioctyl Phthalate) Smoke Test, approved September 10, 1995 ("ASTM D2986"), IBR approved for §1065.170(c). (Note: This standard was withdrawn by ASTM.)
(25) ASTM D3231-13, Standard Test Method for Phosphorus in Gasoline, approved June 15, 2013 ("ASTM D3231"), IBR approved for §1065.710(b) and (c).
(26) ASTM D3237-12, Standard Test Method for Lead in Gasoline By Atomic Absorption Spectroscopy, approved June 1, 2012 ("ASTM D3237"), IBR approved for §1065.710(b) and (c).
(27) ASTM D4052-11, Standard Test Method for Density, Relative Density, and API Gravity of Liquids by Digital Density Meter, approved October 15, 2011 ("ASTM D4052"), IBR approved for §1065.703(b).
(28) ASTM D4629-12, Standard Test Method for Trace Nitrogen in Liquid Petroleum Hydrocarbons by Syringe/Inlet Oxidative Combustion and Chemiluminescence Detection, approved April 15, 2012 ("ASTM D4629"), IBR approved for §1065.655(e).

(29) ASTM D4814-13b, Standard Specification for Automotive Spark-Ignition Engine Fuel, approved December 1, 2013 ("ASTM D4814"), IBR approved for §1065.701(f).
(30) ASTM D4815-13, Standard Test Method for Determination of MTBE, ETBE, TAME, DIPE, tertiary-Amyl Alcohol and C_1 to C_4 Alcohols in Gasoline by Gas Chromatography, approved October 1, 2013 ("ASTM D4815"), IBR approved for §1065.710(b).
(31) ASTM D5186-03 (Reapproved 2009), Standard Test Method for Determination of the Aromatic Content and Polynuclear Aromatic Content of Diesel Fuels and Aviation Turbine Fuels By Supercritical Fluid Chromatography, approved April 15, 2009 ("ASTM D5186"), IBR approved for §1065.703(b).
(32) ASTM D5191-13, Standard Test Method for Vapor Pressure of Petroleum Products (Mini Method), approved December 1, 2013 ("ASTM D5191"), IBR approved for §1065.710(b) and (c).
(33) ASTM D5291-10, Standard Test Methods for Instrumental Determination of Carbon, Hydrogen, and Nitrogen in Petroleum Products and Lubricants, approved May 1, 2010 ("ASTM D5291"), IBR approved for §1065.655(e).
(34) ASTM D5453-19a , Standard Test Method for Determination of Total Sulfur in Light Hydrocarbons, Spark Ignition Engine Fuel, Diesel Engine Fuel, and Engine Oil by Ultraviolet Fluorescence, approved July 1, 2019 ("ASTM D5453"), IBR approved for §§1065.703(b) and 1065.710(b).
(35) ASTM D5599-00 (Reapproved 2010), Standard Test Method for Determination of Oxygenates in Gasoline by Gas Chromatography and Oxygen Selective Flame Ionization Detection, approved October 1, 2010 ("ASTM D5599"), IBR approved for §§1065.655(e) and 1065.710(b).
(36) ASTM D5762-12 Standard Test Method for Nitrogen in Petroleum and Petroleum Products by Boat-Inlet Chemiluminescence, approved April 15, 2012 ("ASTM D5762"), IBR approved for §1065.655(e).
(37) ASTM D5769-10, Standard Test Method for Determination of Benzene, Toluene, and Total Aromatics in Finished Gasolines by Gas Chromatography/Mass Spectrometry, approved May 1, 2010 ("ASTM D5769"), IBR approved for §1065.710(b).
(38) ASTM D5797-13, Standard Specification for Fuel Methanol (M70- M85) for Automotive Spark-Ignition Engines, approved June 15, 2013 ("ASTM D5797"), IBR approved for §1065.701(f).
(39) ASTM D5798-13a, Standard Specification for Ethanol Fuel Blends for Flexible Fuel Automotive Spark-Ignition Engines, approved June 15, 2013 ("ASTM D5798"), IBR approved for §1065.701(f).
(40) ASTM D6348-12$^{\varepsilon1}$, Standard Test Method for Determination of Gaseous Compounds by Extractive Direct Interface Fourier Transform Infrared (FTIR) Spectroscopy, approved February 1, 2012 ("ASTM D6348"), IBR approved for §§1065.266(b) and 1065.275(b).
(41) ASTM D6550-10, Standard Test Method for Determination of Olefin Content of Gasolines by Supercritical-Fluid Chromatography, approved October 1, 2010 ("ASTM D6550"), IBR approved for §1065.710(b).
(42) ASTM D6615-11a, Standard Specification for Jet B Wide-Cut Aviation Turbine Fuel, approved October 1, 2011 ("ASTM D6615"), IBR approved for §1065.701(f).
(43) ASTM D6667-14 (Reapproved 2019), Standard Test Method for Determination of Total Volatile Sulfur in Gaseous Hydrocarbons and Liquefied Petroleum Gases by Ultraviolet Fluorescence, approved May 1, 2019 ("ASTM D6667"), IBR approved for §1065.720(a).

(44) ASTM D6751-12, Standard Specification for Biodiesel Fuel Blend Stock (B100) for Middle Distillate Fuels, approved August 1, 2012 (“ASTM D6751”), IBR approved for §1065.701(f).
(45) ASTM D6985-04a, Standard Specification for Middle Distillate Fuel Oil—Military Marine Applications, approved November 1, 2004 (“ASTM D6985”), IBR approved for §1065.701(f). (Note: This standard was withdrawn by ASTM.)
(46) ASTM D7039-15a (Reapproved 2020), Standard Test Method for Sulfur in Gasoline, Diesel Fuel, Jet Fuel, Kerosine, Biodiesel, Biodiesel Blends, and Gasoline-Ethanol Blends by Monochromatic Wavelength Dispersive X-ray Fluorescence Spectrometry, approved May 1, 2020 (“ASTM D7039”), IBR approved for §§1065.703(b) and 1065.710(b).
(47) ASTM F1471-09, Standard Test Method for Air Cleaning Performance of a High-Efficiency Particulate Air Filter System, approved March 1, 2009 (“ASTM F1471”), IBR approved for §1065.1001.
*   *   *   *   *

Part 1066—VEHICLE-TESTING PROCEDURES

375. The authority citation for part 1066 continues to read as follows:
Authority: 42 U.S.C. 7401 - 7671q.

376. Amend §1066.1 by revising paragraph (g) to read as follows:

§1066.1 Applicability.

*   *   *   *   *

(g) For additional information regarding these test procedures, visit our Web site at www.epa.gov, and in particular https://www.epa.gov/vehicle-and-fuel-emissions-testing/vehicle-testing-regulations.

377. Amend §1066.135 by revising paragraph (a)(1) to read as follows:

§1066.135 Linearity verification.

*   *   *   *   *

(a)   *   *   *

(1) Use instrument manufacturer recommendations and good engineering judgment to select at least ten reference values, $y_{\mathrm{ref}i}$, that cover the range of values that you expect during testing (to prevent extrapolation beyond the verified range during emission testing). We recommend selecting zero as one of your reference values. For each range calibrated, if the deviation from a least-squares best-fit straight line is 2 % or less of the value at each data point, concentration values may be calculated by use of a straight-line curve fit for that range. If the deviation exceeds 2 % at any point, use the best-fit nonlinear equation that represents the data to within 2 % of each test point to determine concentration. If you use a gas divider to blend calibration gases, you may verify that the calibration curve produced names a calibration gas within 2 % of its certified concentration. Perform this verification between 10 and 60 % of the full-scale analyzer range.

*   *   *   *   *

378. Amend §1066.210 by revising paragraph (d)(3) to read as follows:

§1066.210 Dynamometers.

*   *   *   *   *

(d)   *   *   *

(3) The load applied by the dynamometer simulates forces acting on the vehicle during normal driving according to the following equation:

$$FR_i = A \cdot \cos\left(\text{atan}\left(G_{i-1}\right)\right) + B \cdot v_i + C \cdot v_i^2 + M_e \cdot \frac{v_i - v_{i-1}}{t_i - t_{i-1}} + M \cdot a_g \cdot \sin\left(\text{atan}\left(G_{i-1}\right)\right)$$

Eq. 1066.210-1

Where:

FR = total road-load force to be applied at the surface of the roll. The total force is the sum of the individual tractive forces applied at each roll surface.

i = a counter to indicate a point in time over the driving schedule. For a dynamometer operating at 10-Hz intervals over a 600-second driving schedule, the maximum value of *i* should be 6,000.

A = a vehicle-specific constant value representing the vehicle's frictional load in lbf or newtons. See subpart D of this part.

G_i = instantaneous road grade, in percent. If your duty cycle is not subject to road grade, set this value to 0.

B = a vehicle-specific coefficient representing load from drag and rolling resistance, which are a function of vehicle speed, in lbf/(mi/hr) or N·s/m. See subpart D of this part.

v = instantaneous linear speed at the roll surfaces as measured by the dynamometer, in mi/hr or m/s. Let $v_{i-1} = 0$ for $i = 0$.

C = a vehicle-specific coefficient representing aerodynamic effects, which are a function of vehicle speed squared, in lbf/(mi/hr)^2 or N·s^2/m^2. See subpart D of this part.

M_e = the vehicle's effective mass in lbm or kg, including the effect of rotating axles as specified in §1066.310(b)(7).

t = elapsed time in the driving schedule as measured by the dynamometer, in seconds. Let t_{i-1} = 0 for $i = 0$.

M = the measured vehicle mass, in lbm or kg.

a_g = acceleration of Earth's gravity = 9.80665 m/s^2.

*   *   *   *   *

379. Amend §1066.255 by revising paragraph (c) to read as follows:

§1066.255 Parasitic loss verification.

*   *   *   *   *

(c) Procedure. Perform this verification by following the dynamometer manufacturer's specifications to establish a parasitic loss curve, taking data at fixed speed intervals to cover the range of vehicle speeds that will occur during testing. You may zero the load cell at a selected speed if that improves your ability to determine the parasitic loss. Parasitic loss forces may never be negative. Note that the torque transducers must be mathematically zeroed and spanned prior to performing this procedure.

*   *   *   *   *

380. Amend §1066.260 by revising paragraph (c)(4) to read as follows:

§1066.260 Parasitic friction compensation evaluation.

*   *   *   *   *

(c)   *   *   *

(4) Calculate the power equivalent of friction compensation error, FC_{error}, using the following equation:

$$FC_{\text{error}} = \frac{I}{2 \cdot t} \cdot \left(v_{\text{init}}^2 - v_{\text{final}}^2\right)$$

Eq. 1066.260-1

Where:

I = dynamometer inertia setting.

t = duration of the measurement interval, accurate to at least 0.01 s.

v_{init} = the roll speed corresponding to the start of the measurement interval, accurate to at least 0.05 mi/hr.

v_{final} = the roll speed corresponding to the end of the measurement interval, accurate to at least 0.05 mi/hr.

Example:

I = 2000 lbm = 62.16 lbf·s^2/ft

t = 60.0 s

v_{init} = 9.2 mi/hr = 13.5 ft/s

v_{final} = 10.0 mi/hr = 14.7 ft/s

$$FC_{\text{error}} = \frac{62.16}{2 \cdot 60.00} \cdot \left(13.5^2 - 14.7^2\right)$$

FC_{error} = –17.5 ft·lbf/s = –0.032 hp

*   *   *   *   *

381. Amend §1066.265 by revising paragraph (d)(1) to read as follows:

§1066.265 Acceleration and deceleration verification.

*   *   *   *   *

(d)   *   *   *

(1) Calculate the force setting, F, using the following equation:

$$F = I_{\text{b}} \cdot |a|$$

Eq. 1066.265-4

Where:

I_{b} = the dynamometer manufacturer's stated base inertia, in lbf·s^2/ft.

a = nominal acceleration rate, in ft/s^2.

Example:

I_{b} = 2967 lbm = 92.217 lbf·s^2/ft

a = 1 (mi/hr)/s = 1.4667 ft/s^2

$$F = 92.217 \cdot |1.4667|$$

F = 135.25 lbf

*   *   *   *   *

382. Amend §1066.270 by revising paragraphs (c)(4) and (d)(2) to read as follows:

§1066.270 Unloaded coastdown verification.

*   *   *   *   *

(c)   *   *   *

(4) Determine the mean coastdown force, $\overline{F}$, for each speed and inertia setting for each of the coastdowns performed using the following equation:

$$\bar{F} = \frac{I \cdot (v_{\text{init}} - v_{\text{final}})}{t}$$

Eq. 1066.270-1

Where:

$\bar{F}$ = the mean force measured during the coastdown for each speed interval and inertia setting, expressed in lbf and rounded to four significant figures.

I = the dynamometer's inertia setting, in lbf·s²/ft.

v_{init} = the speed at the start of the coastdown interval, expressed in ft/s to at least four significant figures.

v_{final} = the speed at the end of the coastdown interval, expressed in ft/s to at least four significant figures.

t = coastdown time for each speed interval and inertia setting, accurate to at least 0.01 s.

Example:

I = 2000 lbm = 62.16 lbf·s²/ft

v_{init} = 25 mi/hr = 36.66 ft/s

v_{final} = 15 mi/hr = 22.0 ft/s

t = 5.00 s

$$\bar{F} = \frac{62.16 \cdot (36.66 - 22.0)}{5.00}$$

$\bar{F}$ = 182.3 lbf

* * * * *

(d) * * *

(2) For vehicles above 20,000 pounds GVWR, the maximum allowable error, F_{errormax}, for all speed intervals and inertia settings is 1.0 % or the value determined from Eq. 1066.270-3 (substituting 8.8 lbf for 2.2 lbf in the numerator), whichever is greater.

* * * * *

383. Amend §1066.275 by revising paragraphs (b) and (d) to read as follows:

§1066.275 Daily dynamometer readiness verification.

* * * * *

(b) Scope and frequency. Perform this verification upon initial installation, within 1 day before testing, and after major maintenance. You may run this within 7 days before testing if you accumulate data to support a less frequent verification interval.

* * * * *

(d) Performance evaluation. The coastdown force error determined in paragraph (c) of this section may not exceed the following:

(1) For vehicles at or below 20,000 pounds GVWR, 1.0 % or the value determined from Eq. 1066.270-3, whichever is greater.

(2) For vehicles above 20,000 pounds GVWR, 1.0 % or the value determined from Eq. 1066.270-3 (substituting 8.8 lbf for 2.2 lbf), whichever is greater.

* * * * *

384. Revise §1066.405 to read as follows:

§1066.405 Vehicle preparation, preconditioning, and maintenance.

(a) Prepare the vehicle for testing (including measurement of evaporative and refueling emissions if appropriate), as described in the standard-setting part.
(b) If you inspect a vehicle, keep a record of the inspection and update your application for certification to document any changes that result. You may use any kind of equipment, instrument, or tool that is available at dealerships and other service outlets to identify malfunctioning components or perform maintenance.
(c) You may repair defective parts from a test vehicle if they are unrelated to emission control. You must ask us to approve repairs that might affect the vehicle's emission controls. If we determine that a part failure, system malfunction, or associated repair makes the vehicle's emission controls unrepresentative of production engines, you may not use it as an emission-data vehicle. Also, if the engine installed in the test vehicle has a major mechanical failure that requires you to take the vehicle apart, you may no longer use the vehicle as an emission-data vehicle for exhaust measurements.

385. Amend §1066.420 by revising paragraph (d) to read as follows:
§1066.420 Test preparation.
* * * * *
(d) Control test cell ambient air humidity as follows:
(1) For vehicles at or below 14,000 pounds GVWR, follow the humidity requirements in Table 1 of this section, unless the standard-setting part specifies otherwise. When complying with humidity requirements in the table, where no tolerance is specified, use good engineering judgment to maintain the humidity level near the specified value within the limitations of your test facility.
(2) For vehicles above 14,000 pounds GVWR, you may test vehicles at any humidity.
(3) Table 1 follows:

TABLE 1 OF §1066.420–TEST CELL HUMIDITY REQUIREMENTS

Test cycle	Humidity requirement (grains H_2O per pound dry air)	Tolerance (grains H_2O per pound dry air)
AC17	69	± 5 average, ± 10 instantaneous
FTP[a] and LA-92	50	
HFET	50	
SC03	100	± 5 average
US06	50	

[a]FTP humidity requirement does not apply for cold (–7°C), intermediate (10 °C), and hot (35 °C) temperature testing.

* * * * *
386. Amend §1066.605 by revising paragraphs (c)(4) and (h)(2)(i) to read as follows:
§1066.605 Mass-based and molar-based exhaust emission calculations.
* * * * *
(c) * * *
(4) For vehicles at or below 14,000 pounds GVWR, calculate HC concentrations, including dilution air background concentrations, as described in this section, and as described in §1066.635 for NMOG. For emission testing of vehicles above 14,000 pounds GVWR, with fuels that contain 25 % or more oxygenated compounds by volume, calculate THCE and NMHCE

concentrations, including dilution air background concentrations, as described in 40 CFR part 1065, subpart I.

* * * * *

(h) * * *

(2) * * *

(i) Varying flow rate. If you continuously sample from a varying exhaust flow rate, calculate $V_{[flow]}$ using the following equation:

$$V_{[flow]} = \sum_{i=1}^{N} \dot{Q}_i \cdot \Delta t$$

Eq. 1066.605-10

Where:

$\Delta t = 1/f_{record}$

Eq. 1066.605-11

Example:

$N = 505$

$\dot{Q}_{CVS1} = 0.276\ m^3/s$

$\dot{Q}_{CVS2} = 0.294\ m^3/s$

$f_{record} = 1\ Hz$

Using Eq. 1066.605-11,

$\Delta t = 1/1 = 1\ s$

$V_{CVS} = (0.276 + 0.294 + ... + \dot{Q}_{CVS505}) \cdot 1$

$V_{CVS} = 170.721\ m^3$

* * * * *

387. Amend §1066.610 by revising paragraph (d) to read as follows:

§1066.610 Dilution air background correction.

* * * * *

(d) Determine the time-weighted dilution factor, DF_w, over the duty cycle using the following equation:

$$DF_w = \frac{\sum_{i=1}^{N} t_i}{\sum_{i=1}^{N} \frac{1}{DF_i} \cdot t_i}$$

Eq. 1066.610-4

Where:

N = number of test intervals.

i = test interval number

t = duration of the test interval.

DF = dilution factor over the test interval.

Example:

$N = 3$

$DF_1 = 14.40$

$t_1 = 505\ s$

$DF_2 = 24.48$

$t_2 = 867$ s
$DF_3 = 17.28$
$t_3 = 505$ s

$$DF_w = \frac{505+867+505}{\left(\frac{1}{14.40}\cdot 505\right)+\left(\frac{1}{24.48}\cdot 867\right)+\left(\frac{1}{17.28}\cdot 505\right)} = 18.82$$

388. Amend §1066.710 by revising paragraph (c) to read as follows:

§1066.710 Cold temperature testing procedures for measuring CO and NMHC emissions and determining fuel economy**.**

* * * * *

(c) Heater and defroster. During the test, operate the vehicle's interior climate control system with the heat on and air conditioning off. You may not use any supplemental auxiliary heat during this testing. You may set the heater to any temperature and fan setting during vehicle preconditioning.

(1) Manual and automatic temperature control. Unless you rely on full automatic control as specified in paragraph (c)(2) of this section, take the following steps to control heater settings:

(i) Set the climate control system as follows before the first acceleration (t = 20 s), or before starting the vehicle if the climate control system allows it:

(A) Temperature. Set controls to maximum heat. For automatic temperature control systems that allow the operator to select a specific temperature, set the heater control to 72 °F or higher.

(B) Fan speed. Set the fan speed to full off or the lowest available speed if a full off position is not available.

(C) Airflow direction. Direct airflow to the front window (window defrost mode).

(D) Air source. If independently controllable, set the system to draw in outside air.

(ii) At the second idle of the test cycle, which occurs 125 seconds after the start of the test, set the fan speed to maximum. Complete by 130 seconds after the start of the test. Leave temperature and air source settings unchanged

(iii) At the sixth idle of the test interval, which occurs at the deceleration to zero miles per hour 505 seconds after the start of the test, set the fan speed to the lowest setting that maintains air flow. Complete these changes by 510 seconds after the start of the test. You may use different vent and fan speed settings for the remainder of the test. Leave the temperature and air source settings unchanged.

(2) Full automatic control. Vehicles with full automatic control systems may instead operate as described in this paragraph (c)(2). Set the temperature to 72 °F in full automatic control for the whole test, allowing the vehicle to adjust the air temperature and direction of the airflow.

(3) Multiple-zone systems. For vehicles that have separate driver and passenger controls or separate front and rear controls, you must set all temperature and fan controls as described in paragraphs (c)(1) and (2) of this section, except that rear controls need not be set to defrost the front window.

(4) Alternative test procedures. We may approve the use of other settings under 40 CFR 86.1840 if a vehicle's climate control system is not compatible with the provisions of this section.

* * * * *

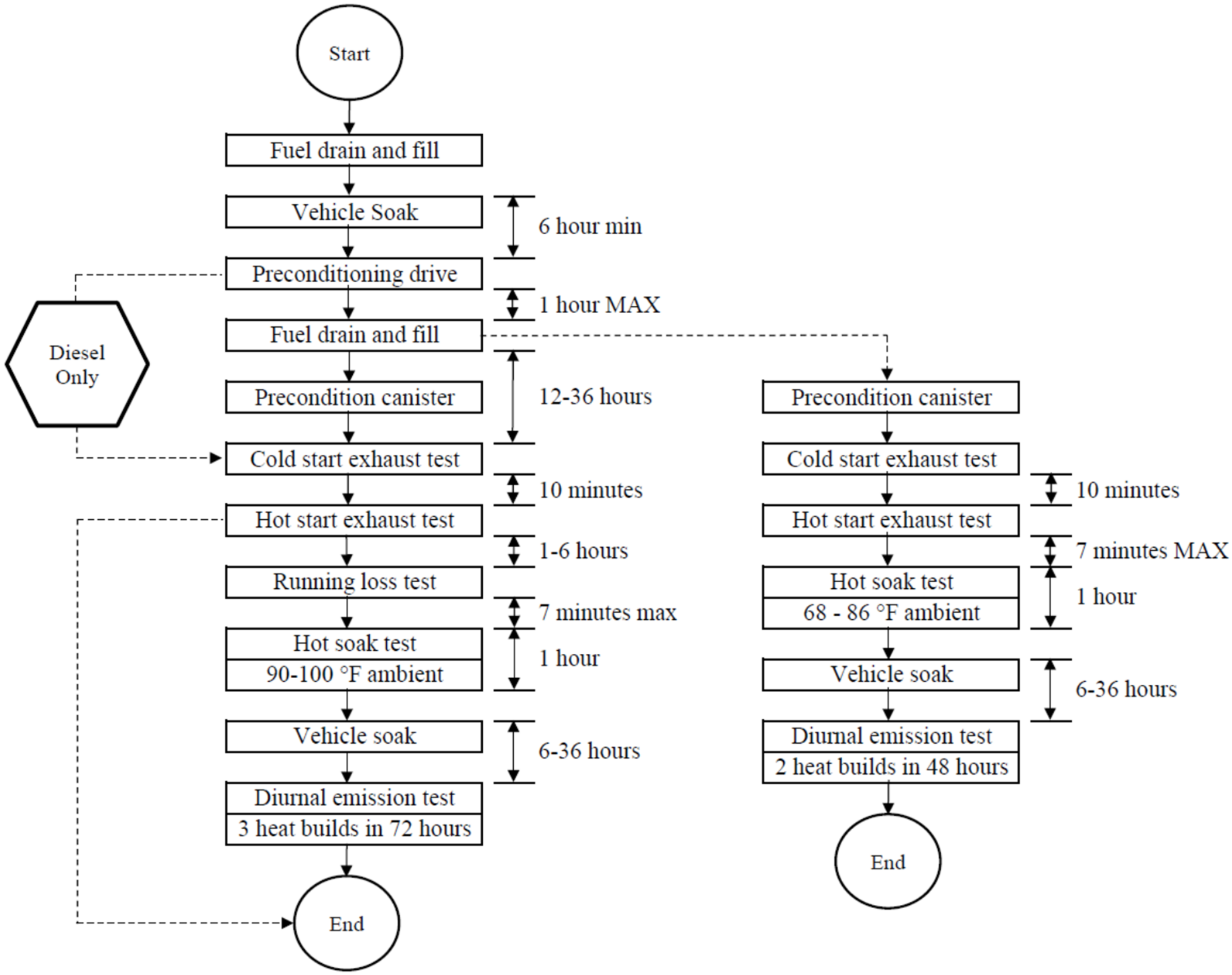
389. Amend §1066.801 by revising paragraph (e) to read as follows:

§1066.801 Applicability and general provisions.

*   *   *   *   *

(e) The following figure illustrates the FTP test sequence for measuring exhaust and evaporative emissions:

Figure 1 of §1066.801–FTP test sequence



390. Amend §1066.835 by revising paragraphs (a) and (f)(2) to read as follows:
§1066.835 Exhaust emission test procedure for SC03 emissions.
* * * * *
(a) Drain and refill the vehicle's fuel tank(s) if testing starts more than 72 hours after the most recent FTP or HFET measurement (with or without evaporative emission measurements).
* * * * *
(f) * * *
(2) Conditions before and after testing. Use good engineering judgment to demonstrate that you meet the specified temperature and humidity tolerances in paragraph (f)(1) of this section at all times before and between emission measurements.
* * * * *

391. Revise §1066.930 to read as follows:
§1066.930 Equipment for point-source measurement of running losses.
For point-source measurement of running loss emissions, use equipment meeting the specifications in 40 CFR 86.107-96(i).

392. Amend §1066.1005 by revising paragraphs (a), (c), (d), (e), and (f) to read as follows:
§1066.1005 Symbols, abbreviations, acronyms, and units of measure.
* * * * *
(a) Symbols for quantities. This part uses the following symbols and units of measure for various quantities:

SYMBOL	QUANTITY	UNIT	UNIT SYMBOL	UNIT IN TERMS OF SI BASE UNITS
α	atomic hydrogen to carbon ratio	mole per mole	mol/mol	1
A	area	square meter	m^2	m^2
A	vehicle frictional load	pound force or newton	lbf or N	$m\cdot kg\cdot s^{-2}$
a_g	acceleration of Earth's gravity	meters per second squared	m/s^2	$m\cdot s^{-2}$
A_m	calculated vehicle frictional load	pound force or newton	lbf or N	$m\cdot kg\cdot s^{-2}$
a_0	intercept of least squares regression			
a_1	slope of least squares regression			
a	acceleration	feet per second squared or meters per second squared	ft/s^2 or m/s^2	$m\cdot s^{-2}$
B	vehicle load from drag and rolling resistance	pound force per mile per hour or newton second per meter	lbf/(mi/hr) or N·s/m	$kg\cdot s^{-1}$
β	ratio of diameters	meter per meter	m/m	1
β	atomic oxygen to carbon ratio	mole per mole	mol/mol	1
c	conversion factor			
C	vehicle-specific aerodynamic effects	pound force per mile per hour squared or newton-second squared per meter squared	$lbf/(mi/hr)^2$ or $N\cdot s^2/m^2$	$m^{-1}\cdot kg$
$C_\#$	number of carbon atoms in a molecule	$C_\#$	number of carbon atoms in a molecule	$C_\#$
C_d	discharge coefficient			
C_dA	drag area	meter squared	m^2	m^2
C_f	flow coefficient			
C_p	heat capacity at constant pressure	joule per kelvin	J/K	$m^2\cdot kg\cdot s^{-2}\cdot K^{-1}$

C_v	heat capacity at constant volume	joule per kelvin	J/K	$m^2 \cdot kg \cdot s^{-2} \cdot K^{-1}$
d	diameter	meters	m	m
D	distance	miles or meters	mi or m	m
D	slope correlation	pound force per mile per hour squared or newton second squared per meter squared	$lbf/(mi/hr)^2$ or $N \cdot s^2/m^2$	$m^{-2} \cdot kg$
DF	dilution factor			1
e	mass weighted emission result	grams/mile	g/mi	
F	force	pound force or newton	lbf or N	$kg \cdot s^{-2}$
f	frequency	hertz	Hz	s^{-1}
f_n	angular speed (shaft)	revolutions per minute	r/min	$\pi \cdot 30 \cdot s^{-1}$
FC	friction compensation error	horsepower or watt	W	$m^2 \cdot kg \cdot s^{-3}$
FR	road-load force	pound force or newton	lbf or N	$kg \cdot s^{-2}$
γ	ratio of specific heats	(joule per kilogram kelvin) per (joule per kilogram kelvin)	(J/(kg·K))/(J/(kg·K))	1
H	ambient humidity	grams water vapor per kilogram dry air	g H_2O vapor/kg dry air	g H_2O vapor/kg dry air
Δh	change in height	meters	m	m
I	inertia	pound mass or kilogram	lbm or kg	kg
I	current	ampere	A	A
i	indexing variable			
IR	inertia work rating			
K	correction factor			1
K_v	calibration coefficient		$m^4 \cdot s \cdot K^{0.5}/kg$	$m^4 \cdot kg^{-1} \cdot s \cdot K^{0.5}$
μ	viscosity, dynamic	pascal second	Pa·s	$m^{-1} \cdot kg \cdot s^{-1}$
M	molar mass	gram per mole	g/mol	$10^{-3} \cdot kg \cdot mol^{-1}$
M_e	effective mass	kilogram	kg	kg
m	mass	pound mass or kilogram	lbm or kg	kg
N	total number in series			
n	total number of pulses in a series			
p	pressure	pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$
Δp	differential static pressure	pascal	Pa	$m^{-1} \cdot kg \cdot s^{-2}$
p_d	saturated vapor pressure at ambient dry bulb temperature	kilopascal	kPa	$m^{-1} \cdot kg \cdot s^{-2}$
PF	penetration fraction			
ρ	mass density	kilogram per cubic meter	kg/m^3	$m^{-3} \cdot kg$
R	dynamometer roll revolutions	revolutions per minute	rpm	$\pi \cdot 30^{-1} \cdot s^{-1}$
r	ratio of pressures	pascal per pascal	Pa/Pa	1
r^2	coefficient of determination			
$Re^{\#}$	Reynolds number			
RF	response factor			
RH	relative humidity			
S	Sutherland constant	kelvin	K	K
SEE	standard error of the estimate			
SG	specific gravity			
Δs	distance traveled during measurement interval	meters	m	m
T	absolute temperature	kelvin	K	K

T	Celsius temperature	degree Celsius	°C	K − 273.15
T	torque (moment of force)	newton meter	N·m	$m^2·kg·s^{-2}$
t	time	hour or second	hr or s	s
Δt	time interval, period, 1/frequency	second	s	s
U	voltage	volt	V	$m^2·kg·s^{-3}·A^{-1}$
v	speed	miles per hour or meters per second	mi/hr or m/s	$m·s^{-1}$
V	volume	cubic meter	m^3	m^3
$\dot{V}$	flow volume rate	cubic feet per minute or cubic meter per second	ft^3/min or m^3/s	$m^3·/s^{-1}$
VP	volume percent			
x	concentration of emission over a test interval	part per million	ppm	
y	generic variable			
Z	compressibility factor			

*   *   *   *   *

(c) Superscripts. This part uses the following superscripts for modifying quantity symbols:

SUPERSCRIPT	MEANING
overbar (such as $\bar{y}$)	arithmetic mean
overdot (such as $\dot{y}$)	quantity per unit time

(d) Subscripts. This part uses the following subscripts for modifying quantity symbols:

SUBSCRIPT	MEANING
0	reference
abs	absolute quantity
AC17	air conditioning 2017 test interval
act	actual or measured condition
actint	actual or measured condition over the speed interval
adj	adjusted
air	air, dry
atmos	atmospheric
b	base
bkgnd	background
c	cold
comp	composite
cor	corrected
cs	cold stabilized
ct	cold transient
cUDDS	cold-start UDDS
D	driven
dew	dewpoint
dexh	dilute exhaust quantity
dil	dilute
e	effective
emission	emission specie
error	error

EtOH	ethanol
exh	raw exhaust quantity
exp	expected quantity
fil	filter
final	final
flow	flow measurement device type
gas	gaseous
h	hot
HFET	highway fuel economy test
hs	hot stabilized
ht	hot transient
hUDDS	hot-start UDDS
i	an individual of a series
ID	driven inertia
in	inlet
int	intake
init	initial quantity, typically before an emission test
IT	target inertia
liq	liquid
max	the maximum (i.e., peak) value expected at the standard over a test interval; not the maximum of an instrument range
meas	measured quantity
mix	dilute exhaust gas mixture
out	outlet
PM	particulate matter
record	record
ref	reference quantity
rev	revolution
roll	dynamometer roll
s	settling
s	slip
s	stabilized
sat	saturated condition
SC03	air conditioning driving schedule
span	span quantity
sda	secondary dilution air
std	standard conditions
T	target
t	throat
test	test quantity
uncor	uncorrected quantity
w	weighted
zero	zero quantity

(e) Other acronyms and abbreviations. This part uses the following additional abbreviations and acronyms:

ACRONYM	MEANING

A/C	air conditioning
AC17	air conditioning 2017 test interval
ALVW	adjusted loaded vehicle weight
ASME	American Society of Mechanical Engineers
CFR	Code of Federal Regulations
CFV	critical-flow venturi
CNG	compressed natural gas
CVS	constant-volume sampler
EPA	Environmental Protection Agency
ETW	equivalent test weight
EV	electric vehicle
FID	flame-ionization detector
FTP	Federal test procedure
GC	gas chromatograph
GEM	greenhouse gas emissions model
GHG	greenhouse gas (including CO_2, N_2O, and CH_4)
GPS	global positioning system
GVWR	gross vehicle weight rating
HEV	hybrid electric vehicle, including plug-in hybrid electric vehicles
HFET	highway fuel economy test
HLDT	heavy light-duty truck
HPLC	high pressure liquid chromatography
IBR	incorporated by reference
LA-92	Los Angeles 1992 driving schedule
MDPV	medium-duty passenger vehicle
NIST	National Institute for Standards and Technology
NMC	nonmethane cutter
PDP	positive-displacement pump
PHEV	plug-in hybrid electric vehicle
PM	particulate matter
RESS	rechargeable energy storage system
ppm	parts per million
SAE	Society of Automotive Engineers
SC03	air conditioning driving schedule
SEA	selective enforcement audit
SFTP	supplemental federal test procedure
SI	International System of Units
SSV	subsonic venturi
UDDS	urban dynamometer driving schedule
US06	aggressive driving schedule
U.S.C.	United States Code
WWV	NIST radio station call sign

(f) This part uses the following densities of chemical species:

SYMBOL	QUANTITY[A,B]	g/m^3	g/ft^3
ρ_{CH4}	density of methane	666.905	18.8847
ρ_{CH3OH}	density of methanol	1332.02	37.7185
ρ_{C2H5OH}	C_1-equivalent density of ethanol	957.559	27.1151
ρ_{C2H4O}	C_1-equivalent density of acetaldehyde	915.658	25.9285
ρ_{C3H8}	density of propane	611.035	17.3026
ρ_{C3H7OH}	C_1-equivalent density of propanol	832.74	23.5806
ρ_{CO}	density of carbon monoxide	1164.41	32.9725
ρ_{CO2}	density of carbon dioxide	1829.53	51.8064
$\rho_{HC\text{-}gas}$	effective density of hydrocarbon - gaseous fuel[c]	(see 3)	(see 3)
ρ_{CH2O}	density of formaldehyde	1248.21	35.3455
$\rho_{HC\text{-}liq}$	effective density of hydrocarbon - liquid fuel[d]	576.816	16.3336
$\rho_{NMHC\text{-}gas}$	effective density of nonmethane hydrocarbon - gaseous fuel[c]	(see 3)	(see 3)
$\rho_{NMHC\text{-}liq}$	effective density of nonmethane hydrocarbon - liquid fuel[d]	576.816	16.3336
$\rho_{NMHCE\text{-}gas}$	effective density of nonmethane equivalent hydrocarbon - gaseous fuel[c]	(see 3)	(see 3)
$\rho_{NMHCE\text{-}liq}$	effective density of nonmethane equivalent hydrocarbon - liquid fuel[d]	576.816	16.3336
ρ_{NOx}	effective density of oxides of nitrogen[e]	1912.5	54.156
ρ_{N2O}	density of nitrous oxide	1829.66	51.8103
$\rho_{THC\text{-}liq}$	effective density of total hydrocarbon - liquid fuel[d]	576.816	16.3336
$\rho_{THCE\text{-}liq}$	effective density of total equivalent hydrocarbon - liquid fuel[d]	576.816	16.3336

[a]Densities are given at 20 °C and 101.325 kPa.
[b]Densities for all hydrocarbon containing quantities are given in g/m^3-carbon atom and g/ft^3-carbon atom.
[c]The effective density for natural gas fuel and liquefied petroleum gas fuel are defined by an atomic hydrogen-to-carbon ratio, α, of the hydrocarbon components of the test fuel. $\rho_{HCgas} = 41.57 \cdot (12.011 + (\alpha \cdot 1.008))$.
[d]The effective density for gasoline and diesel fuel are defined by an atomic hydrogen-to-carbon ratio, α, of 1.85.
[e]The effective density of NO_x is defined by the molar mass of nitrogen dioxide, NO_2.

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PART 1068—GENERAL COMPLIANCE PROVISIONS FOR HIGHWAY, STATIONARY, AND NONROAD PROGRAMS

393. The authority statement for part 1068 continues to read as follows:
Authority: 42 U.S.C. 7401-7671q.

394. Amend §1068.1 by revising paragraph (a) and removing and reserving paragraph (d)(2) to n reads as follows:

§1068.1 Does this part apply to me?

(a) The provisions of this part apply to everyone with respect to the engine and equipment categories as described in this paragraph (a). They apply to everyone, including owners, operators, parts manufacturers, and persons performing maintenance. Where we identify an engine category, the provisions of this part also apply with respect to the equipment using such engines. This part 1068 applies to different engine and equipment categories as follows:

(1) This part 1068 applies to motor vehicles we regulate under 40 CFR part 86, subpart S, to the extent and in the manner specified in 40 CFR parts 85 and 86.

(2) This part 1068 applies for heavy-duty motor vehicles we regulate under 40 CFR part 1037, subject to the provisions of 40 CFR parts 85 and 1037. This includes trailers. This part

1068 applies to other heavy-duty motor vehicles and motor vehicle engines to the extent and in the manner specified in 40 CFR parts 85, 86, and 1036.

(3) This part 1068 applies to highway motorcycles we regulate under 40 CFR part 86, subparts E and F, to the extent and in the manner specified in 40 CFR parts 85 and 86.

(4) This part 1068 applies to aircraft we regulate under 40 CFR part 87 to the extent and in the manner specified in 40 CFR part 87.

(5) This part 1068 applies for locomotives that are subject to the provisions of 40 CFR part 1033. This part 1068 does not apply for locomotives or locomotive engines that were originally manufactured before July 7, 2008, and that have not been remanufactured on or after July 7, 2008.

(6) This part 1068 applies for land-based nonroad compression-ignition engines that are subject to the provisions of 40 CFR part 1039.

(7) This part 1068 applies for stationary compression-ignition engines certified using the provisions of 40 CFR parts 1039 and 1042 as described in 40 CFR part 60, subpart IIII.

(8) This part 1068 applies for marine compression-ignition engines that are subject to the provisions of 40 CFR part 1042.

(9) This part 1068 applies for marine spark-ignition engines that are subject to the provisions of 40 CFR part 1045.

(10) This part 1068 applies for large nonroad spark-ignition engines that are subject to the provisions of 40 CFR part 1048.

(11) This part 1068 applies for stationary spark-ignition engines certified using the provisions of 40 CFR part 1048 or part 1054, as described in 40 CFR part 60, subpart JJJJ.

(12) This part 1068 applies for recreational engines and vehicles, including snowmobiles, off-highway motorcycles, and all-terrain vehicles that are subject to the provisions of 40 CFR part 1051.

(13) This part applies for small nonroad spark-ignition engines that are subject to the provisions of 40 CFR part 1054.

(14) This part applies for fuel-system components installed in nonroad equipment powered by volatile liquid fuels that are subject to the provisions of 40 CFR part 1060.

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395. Amend §1068.10 by revising the section heading and paragraphs (b) and (c) to read as follows:

§1068.10 Confidential business information.

* * * * *

(b) We will store your confidential business information as described in 40 CFR part 2. Also, we will disclose it only as specified in 40 CFR part 2. This applies both to any information you send us and to any information we collect from inspections, audits, or other site visits.

(c) If you send us a second copy without the confidential business information, we will assume it contains nothing confidential whenever we need to release information from it.

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396. Amend §1068.240 by revising paragraphs (b)(6), (c)(1), and (c)(3) to read as follows:

§1068.240 Exempting new replacement engines.

* * * * *

(b) * * *

(6) Engines exempt under this paragraph (b) may not be introduced into U.S. commerce before you make the determinations under paragraph (b)(2) of this section, except as specified in this paragraph (b)(6). We may waive this restriction for engines identified under paragraph (c)(5) of this section that you ship to a distributor. Where we waive this restriction, you must take steps to ensure that the engine is installed consistent with the requirements of this paragraph (b). For example, at a minimum you must report to us annually whether engines we allowed you to ship to a distributor under this paragraph (b)(6) have been placed into service or remain in inventory. After an engine is placed into service, your report must describe how the engine was installed consistent with the requirements of this paragraph (b). Send these reports to the Designated Compliance Officer by the deadlines we specify.
(c) * * *
(1) You may produce a limited number of replacement engines under this paragraph (c) representing 0.5 percent of your annual production volumes for each category and subcategory of engines identified in Table 1 to this section or five engines for each category and subcategory, whichever is greater. Calculate this number by multiplying your annual U.S.-directed production volume by 0.005 (or 0.01 through 2013) and rounding to the nearest whole number. Determine the appropriate production volume by identifying the highest total annual U.S.-directed production volume of engines from the previous three model years for all your certified engines from each category or subcategory identified in Table 1 to this section, as applicable. In unusual circumstances, you may ask us to base your production limits on U.S.-directed production volume for a model year more than three years prior. You may include stationary engines and exempted engines as part of your U.S.-directed production volume. Include U.S.-directed engines produced by any affiliated companies and those from any other companies you license to produce engines for you.
* * * * *
(3) Send the Designated Compliance Officer a report by September 30 of the year following any year in which you produced exempted replacement engines under this paragraph (c).
(i) In your report include the total number of replacement engines you produce under this paragraph (c) for each category or subcategory, as appropriate, and the corresponding total production volumes determined under paragraph (c)(1) of this section. If you send us a report under this paragraph (c)(3), you must also include the total number of complete and partially complete replacement engines you produced under paragraphs (b) and (e) of this section (including any replacement marine engines subject to reporting under 40 CFR 1042.615).
(ii) Count exempt engines as tracked under paragraph (b) of this section only if you meet all the requirements and conditions that apply under paragraph (b)(2) of this section by the due date for the annual report. In the annual report you must identify any replaced engines from the previous year that you were not able to recover by the due date for the annual report. Continue to report those engines in later reports until you recover the replaced engines. If any replaced engine is not recovered for the fifth annual report following the production report, treat this as an untracked replacement in the fifth annual report for the preceding year.
(iii) You may include the information required under this paragraph (c)(3) in production reports required under the standard-setting part.
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PART 1074—PREEMPTION OF STATE STANDARDS AND PROCEDURES FOR WAIVER OF FEDERAL PREEMPTION FOR NONROAD ENGINES AND NONROAD VEHICLES

397. The authority statement for part 1074 continues to read as follows:
Authority: 42 U.S.C. 7401-7671q.

398. Add Appendix I to subpart A to read as follows:

Appendix I to subpart A of part 1074—State Regulation of the Use and Operation of Nonroad Internal Combustion Engines.

(a) This appendix describes EPA's interpretation of the Clean Air Act regarding the authority of states to regulate the use and operation of nonroad engines.

(b) EPA believes that states are not precluded under 42 U.S.C. 7543 from regulating the use and operation of nonroad engines, such as regulations on hours of usage, daily mass emission limits, or sulfur limits on fuel; nor are permits regulating such operations precluded, once the engine is no longer new. EPA believes that states are precluded from requiring retrofitting of used nonroad engines except that states are permitted to adopt and enforce any such retrofitting requirements identical to California requirements which have been authorized by EPA under 42 U.S.C. 7543.