Type of standard	Year of original manufacture	Tier	Standards (g/bhp-hr)		
			NO_X	PM–primary	PM–alternate [1]
	2005–2011	Tier 2	8.1	0.24	0.12

[1] Locomotives certified to the alternate PM standards are also subject to alternate CO standards of 10.0 for the line-haul cycle and 12.0 for the switch cycle.

(b) The original Tier 0, Tier 1, and Tier 2 standards for HC and CO emissions and smoke are the same standards identified in §1033.101.

[81 FR 74011, Oct. 25, 2016]

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

Subpart A—Overview and Applicability

Sec.

Subpart B—Emission Standards and Related Requirements

Subpart C—Certifying Engine Families

Subpart D—Testing Production Engines

Subpart E—In-use Testing

Subpart F—Test Procedures

Subpart G—Special Compliance Provisions

Subpart H—Averaging, Banking, and Trading for Certification

AUTHORITY: 42 U.S.C. 7401—7671q.

SOURCE: 81 FR 74011, Oct. 25, 2016, unless otherwise noted.

§ 1036.1 Does this part apply for my engines?

(a) Except as specified in § 1036.5, the provisions of this part apply for engines that will be installed in heavy-duty vehicles (including glider vehicles) above 14,000 pounds GVWR for propulsion. These provisions also apply for engines that will be installed in incomplete heavy-duty vehicles at or below 14,000 pounds GVWR unless the engine is installed in a vehicle that is covered by a certificate of conformity under 40 CFR part 86, subpart S.

(b) This part does not apply with respect to exhaust emission standards for HC, CO, NO_X, or PM except as follows:

(1) The provisions of § 1036.601 apply.

(2) 40 CFR parts 85 and/or 86 may specify that certain provisions apply.

(c) The provisions of this part also apply for fuel conversions of all engines described in paragraph (a) of this section as described in 40 CFR 85.502.

(d) Gas turbine heavy-duty engines and other heavy-duty engines not meeting the definition *compression-ignition* or *spark-ignition* are deemed to be compression-ignition engines for purposes of this part.

§ 1036.2 Who is responsible for compliance?

The regulations in this part 1036 contain provisions that affect both engine manufacturers and others. However, the requirements of this part are generally addressed to the engine manufacturer(s). The term ''you'' generally means the engine manufacturer(s), especially for issues related to certification. Additional requirements and prohibitions apply to other persons as specified in subpart G of this part and 40 CFR part 1068.

§ 1036.5 Which engines are excluded from this part's requirements?

(a) The provisions of this part do not apply to engines used in medium-duty passenger vehicles or other heavy-duty vehicles that are subject to regulation under 40 CFR part 86, subpart S, except as specified in 40 CFR part 86, subpart S, and § 1036.150(j). For example, this exclusion applies for engines used in vehicles certified to the standards of 40 CFR 86.1819.

(b) An engine installed in a heavy-duty vehicle that is not used to propel the vehicle is not a heavy-duty engine. The provisions of this part therefore do not apply to these engines. Note that engines used to indirectly propel the vehicle (such as electrical generator engines that provide power to batteries for propulsion) are subject to this part. See 40 CFR part 1039, 1048, or 1054 for other requirements that apply for these auxiliary engines. See 40 CFR part 1037 for requirements that may apply for vehicles using these engines, such as the evaporative emission requirements of 40 CFR 1037.103.

(c) The provisions of this part do not apply to aircraft or aircraft engines. Standards apply separately to certain aircraft engines, as described in 40 CFR part 87.

(d) The provisions of this part do not apply to engines that are not internal combustion engines. For example, the provisions of this part do not apply to fuel cells. Note that gas turbine engines are internal combustion engines.

(e) The provisions of this part do not apply for model year 2013 and earlier heavy-duty engines unless they were:

(1) Voluntarily certified to this part.

(2) Installed in a glider vehicle subject to 40 CFR part 1037.

§ 1036.10 How is this part organized?

This part 1036 is divided into the following subparts:

(a) Subpart A of this part defines the applicability of this part 1036 and gives an overview of regulatory requirements.

(b) Subpart B of this part describes the emission standards and other requirements that must be met to certify engines under this part. Note that §1036.150 describes certain interim requirements and compliance provisions that apply only for a limited time.

(c) Subpart C of this part describes how to apply for a certificate of conformity.

(d) Subpart D of this part addresses testing of production engines.

(e) Subpart E of this part describes provisions for testing in-use engines.

(f) Subpart F of this part describes how to test your engines (including references to other parts of the Code of Federal Regulations).

(g) Subpart G of this part describes requirements, prohibitions, and other provisions that apply to engine manufacturers, vehicle manufacturers, owners, operators, rebuilders, and all others.

(h) Subpart H of this part describes how you may generate and use emission credits to certify your engines.

(i) Subpart I of this part contains definitions and other reference information.

§1036.15 Do any other regulation parts apply to me?

(a) Part 86 of this chapter describes additional requirements that apply to engines that are subject to this part 1036. This part extensively references portions of 40 CFR part 86. For example, the regulations of part 86 specify emission standards and certification procedures related to criteria pollutants.

(b) Part 1037 of this chapter describes requirements for controlling evaporative emissions and greenhouse gas emissions from heavy-duty vehicles, whether or not they use engines certified under this part. It also includes standards and requirements that apply instead of the standards and requirements of this part in some cases.

(c) Part 1065 of this chapter describes procedures and equipment specifications for testing engines to measure exhaust emissions. Subpart F of this part 1036 describes how to apply the provisions of part 1065 of this chapter to determine whether engines meet the exhaust emission standards in this part.

(d) Certain provisions of part 1068 of this chapter apply as specified in §1036.601 to everyone, including anyone who manufactures, imports, installs, owns, operates, or rebuilds any of the engines subject to this part 1036, or vehicles containing these engines. Part 1068 of this chapter describes general provisions that apply broadly, but do not necessarily apply for all engines or all persons. See §1036.601 to determine how to apply the part 1068 regulations for heavy-duty engines. The issues addressed by these provisions include these seven areas:

(1) Prohibited acts and penalties for engine manufacturers, vehicle manufacturers, and others.

(2) Rebuilding and other aftermarket changes.

(3) Exclusions and exemptions for certain engines.

(4) Importing engines.

(5) Selective enforcement audits of your production.

(6) Recall.

(7) Procedures for hearings.

(e) Other parts of this chapter apply if referenced in this part.

§1036.30 Submission of information.

Unless we specify otherwise, send all reports and requests for approval to the Designated Compliance Officer (see §1036.801). See §1036.825 for additional reporting and recordkeeping provisions.

Subpart B—Emission Standards and Related Requirements

§1036.100 Overview of exhaust emission standards.

Engines used in vehicles certified to the applicable chassis standards for greenhouse gases described in 40 CFR 86.1819 are not subject to the standards specified in this part. All other engines subject to this part must meet the greenhouse gas standards in §1036.108 in addition to the criteria pollutant standards of 40 CFR part 86.

§1036.108 Greenhouse gas emission standards.

This section contains standards and other regulations applicable to the emission of the air pollutant defined as the aggregate group of six greenhouse

gases: Carbon dioxide, nitrous oxide, methane, hydrofluorocarbons, perfluorocarbons, and sulfur hexafluoride. This section describes the applicable CO_2, N_2O, and CH_4 standards for engines. These standards do not apply for engines used in vehicles subject to (or voluntarily certified to) the CO_2, N_2O, and CH_4 standards for vehicles specified in 40 CFR 86.1819.

(a) *Emission standards.* Emission standards apply for engines 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 40 CFR 86.1362 (referred to as the ramped-modal cycle, or RMC, 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 RMC-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), both of which are specified in 40 CFR part 86, subpart N. 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 40 CFR part 86, subpart N.

(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):

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):

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.

(b) *Family Certification Levels.* You must specify a CO_2 Family Certification Level (FCL) for each engine family. The FCL may not be less than the certified emission level for the engine family. The CO_2 Family Emission Limit (FEL) for the engine family is equal to the FCL multiplied by 1.03.

(c) *Averaging, banking, and trading.* You may generate or use emission credits under the averaging, banking, and trading (ABT) program described in subpart H of this part for demonstrating compliance with CO_2 emission standards. Credits (positive and negative) are calculated from the difference between the FCL and the applicable emission standard. As described in §1036.705, you may use CO_2 credits to certify your engine families to FELs for N_2O and/or CH_4, instead of the N_2O/CH_4 standards of this section that otherwise apply. Except as specified in §§1036.150 and 1036.705, you may not generate or use credits for N_2O or CH_4 emissions.

(d) *Useful life.* The exhaust emission standards of this section apply for the full useful life, expressed in service miles, operating hours, or calendar years, whichever comes first. The useful life values applicable to the criteria pollutant standards of 40 CFR part 86 apply for the standards of this section, except that the spark-ignition standards and the standards for model year 2021 and later light heavy-duty compression-ignition engines apply over a useful life of 15 years or 150,000 miles, whichever comes first.

(e) *Applicability for testing.* The emission standards in this subpart apply as specified in this paragraph (e) to all duty-cycle testing (according to the applicable test cycles) of testable configurations, including certification, selective enforcement audits, and in-use testing. The CO_2 FCLs serve as the CO_2 emission standards for the engine family with respect to certification and confirmatory testing instead of the standards specified in paragraph (a)(1) of this section. The FELs serve as the emission standards for the engine family with respect to all other duty-cycle testing. See §§1036.235 and 1036.241 to determine which engine configurations within the engine family are subject to testing. Note that engine fuel maps and powertrain test results also serve as standards as described in §1036.535, §1036.540, §1036.630 and 40 CFR 1037.550.

(f) *Multi-fuel engines.* For dual-fuel, multi-fuel, and flexible-fuel engines, perform exhaust testing on each fuel type (for example, gasoline and E85).

(1) This paragraph (f)(1) applies where you demonstrate the relative amount of each fuel type that your engines consume in actual use. Based on your demonstration, we will specify a weighting factor and allow you to submit the weighted average of your emission results. For example, if you certify an E85 flexible-fuel engine and we determine the engine will produce one-half of its work from E85 and one-half of its work from gasoline, you may apply a 50 percent weighting factor to each of your E85 and gasoline emission results.

(2) If you certify your engine family to N_2O and/or CH_4 FELs the FELs apply for testing on all fuel types for which your engine is designed, to the same extent as criteria emission standards apply.

§1036.115 Other requirements.

(a) The warranty and maintenance requirements, adjustable parameter provisions, and defeat device prohibition of 40 CFR part 86 apply with respect to the standards of this part.

(b) You must perform fuel mapping for your engine as described in §1036.510(b).

(c) You must design and produce your engines to comply with evaporative emission standards as follows:

(1) For complete heavy-duty vehicles you produce, you must certify the vehicles to emission standards as specified in 40 CFR 1037.103.

(2) For incomplete heavy-duty vehicles, and for engines used in vehicles you do not produce, you do not need to certify your engines to evaporative emission standards or otherwise meet those standards. However, vehicle manufacturers certifying their vehicles

with your engines may depend on you to produce your engines according to their specifications. Also, your engines must meet applicable exhaust emission standards in the installed configuration.

§ 1036.130 Installation instructions for vehicle manufacturers.

(a) If you sell an engine for someone else to install in a vehicle, give the engine installer instructions for installing it consistent with the requirements of this part. Include all information necessary to ensure that an engine will be installed in its certified configuration.

(b) Make sure these instructions have the following information:

(1) Include the heading: ''Emission-related installation instructions''.

(2) State: ''Failing to follow these instructions when installing a certified engine in a heavy-duty motor vehicle violates federal law, subject to fines or other penalties as described in the Clean Air Act.''

(3) Provide all instructions needed to properly install the exhaust system and any other components.

(4) Describe any necessary steps for installing any diagnostic system required under 40 CFR part 86.

(5) Describe how your certification is limited for any type of application. For example, if you certify heavy heavy-duty engines to the CO_2 standards using only transient FTP testing, you must make clear that the engine may not be installed in tractors.

(6) Describe any other instructions to make sure the installed engine will operate according to design specifications in your application for certification. This may include, for example, instructions for installing aftertreatment devices when installing the engines.

(7) State: ''If you install the engine in a way that makes the engine's emission control information label hard to read during normal engine maintenance, you must place a duplicate label on the vehicle, as described in 40 CFR 1068.105.''

(c) Give the vehicle manufacturer fuel map results as described in § 1036.510(b).

(d) You do not need installation instructions for engines that you install in your own vehicles.

(e) Provide instructions in writing or in an equivalent format. For example, you may post instructions on a publicly available Web site for downloading or printing. If you do not provide the instructions in writing, explain in your application for certification how you will ensure that each installer is informed of the installation requirements.

§ 1036.135 Labeling.

Label your engines as described in 40 CFR 86.007–35(a)(3), with the following additional information:

(a) [Reserved]

(b) Identify the emission control system. Use terms and abbreviations as described in 40 CFR 1068.45 or other applicable conventions.

(c) Identify any limitations on your certification. For example, if you certify heavy heavy-duty engines to the CO_2 standards using only transient cycle testing, include the statement ''VOCATIONAL VEHICLES ONLY''.

(d) You may ask us to approve modified labeling requirements in this part 1036 if you show that it is necessary or appropriate. We will approve your request if your alternate label is consistent with the requirements of this part. We may also specify modified labeling requirement to be consistent with the intent of 40 CFR part 1037.

§ 1036.140 Primary intended service class and engine cycle.

You must identify a single primary intended service class for each engine family that best describes vehicles for which you design and market the engine, as follows:

(a) Divide compression-ignition engines into primary intended service classes based on the following engine and vehicle characteristics:

(1) Light heavy-duty engines usually are not designed for rebuild and do not have cylinder liners. Vehicle body types in this group might include any heavy-duty vehicle built from a light-duty truck chassis, van trucks, multi-stop vans, and some straight trucks

with a single rear axle. Typical applications would include personal transportation, light-load commercial delivery, passenger service, agriculture, and construction. The GVWR of these vehicles is normally at or below 19,500 pounds.

(2) Medium heavy-duty engines may be designed for rebuild and may have cylinder liners. Vehicle body types in this group would typically include school buses, straight trucks with single rear axles, city tractors, and a variety of special purpose vehicles such as small dump trucks, and refuse trucks. Typical applications would include commercial short haul and intra-city delivery and pickup. Engines in this group are normally used in vehicles whose GVWR ranges from 19,501 to 33,000 pounds.

(3) Heavy heavy-duty engines are designed for multiple rebuilds and have cylinder liners. Vehicles in this group are normally tractors, trucks, straight trucks with dual rear axles, and buses used in inter-city, long-haul applications. These vehicles normally exceed 33,000 pounds GVWR.

(b) Divide spark-ignition engines into primary intended service classes as follows:

(1) Spark-ignition engines that are best characterized by paragraph (a)(1) or (2) of this section are in a separate ''spark-ignition'' primary intended service class.

(2) Spark-ignition engines that are best characterized by paragraph (a)(3) of this section share a primary intended service class with compression-ignition heavy heavy-duty engines. Gasoline-fueled engines are presumed not to be characterized by paragraph (a)(3) of this section; for example, vehicle manufacturers may install some number of gasoline-fueled engines in Class 8 trucks without causing the engine manufacturer to consider those to be heavy heavy-duty engines.

(c) References to ''spark-ignition standards'' in this part relate only to the spark-ignition engines identified in paragraph (b)(1) of this section. References to ''compression-ignition standards'' in this part relate to compression-ignition engines, to spark-ignition engines optionally certified to standards that apply to compression-ignition engines, and to all engines identified under paragraph (b)(2) of this section as heavy heavy-duty engines.

§ 1036.150 Interim provisions.

The provisions in this section apply instead of other provisions in this part.

(a) *Early banking of greenhouse gas emissions.* You may generate CO_2 emission credits for engines you certify in model year 2013 (2015 for spark-ignition engines) to the standards of § 1036.108.

(1) Except as specified in paragraph (a)(2) of this section, to generate early credits, you must certify your entire U.S.-directed production volume within that averaging set to these standards. This means that you may not generate early credits while you produce engines in the averaging set that are certified to the criteria pollutant standards but not to the greenhouse gas standards. Calculate emission credits as described in subpart H of this part relative to the standard that would apply for model year 2014 (2016 for spark-ignition engines).

(2) You may generate early credits for an individual compression-ignition engine family where you demonstrate that you have improved a model year 2013 engine model's CO_2 emissions relative to its 2012 baseline level and certify it to an FCL below the applicable standard. Calculate emission credits as described in subpart H of this part relative to the lesser of the standard that would apply for model year 2014 engines or the baseline engine's CO_2 emission rate. Use the smaller U.S.-directed production volume of the 2013 engine family or the 2012 baseline engine family. We will not allow you to generate emission credits under this paragraph (a)(2) unless we determine that your 2013 engine is the same engine as the 2012 baseline or that it replaces it.

(3) You may bank credits equal to the surplus credits you generate under this paragraph (a) multiplied by 1.50. For example, if you have 10 Mg of surplus credits for model year 2013, you may bank 15 Mg of credits. Credit deficits for an averaging set prior to model year 2014 (2016 for spark-ignition engines) do not carry over to model year 2014 (2016 for spark-ignition engines). We recommend that you notify us of

your intent to use this provision before submitting your applications.

(b) *Model year 2014 N_2O standards.* In model year 2014 and earlier, manufacturers may show compliance with the N_2O standards using an engineering analysis. This allowance also applies for later families certified using carryover CO_2 data from model 2014 consistent with §1036.235(d).

(c) *Engine cycle classification.* Through model year 2020, engines meeting the definition of spark-ignition, but regulated as diesel engines under 40 CFR part 86, must be certified to the requirements applicable to compression-ignition engines under this part. Such engines are deemed to be compression-ignition engines for purposes of this part. Similarly, through model year 2020, engines meeting the definition of compression-ignition, but regulated as Otto-cycle under 40 CFR part 86 must be certified to the requirements applicable to spark-ignition engines under this part. Such engines are deemed to be spark-ignition engines for purposes of this part. See §1036.140 for provisions that apply for model year 2021 and later.

(d) *Small manufacturers.* The standards of this part apply on a delayed schedule for manufacturers meeting the small business criteria specified in 13 CFR 121.201. Apply the small business criteria for NAICS code 336310 for engine manufacturers with respect to gasoline-fueled engines and 333618 for engine manufacturers with respect to other engines; the employee limits apply to the total number employees together for affiliated companies. Qualifying small manufacturers are not subject to the greenhouse gas emission standards in §1036.108 for engines with a date of manufacture on or after November 14, 2011 but before January 1, 2022. In addition, qualifying small manufacturers producing engines 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. Small manufacturers may certify their engines and generate emission credits under this part 1036 before standards start to apply, but only if they certify their entire U.S.-directed production volume within that averaging set for that model year. Note that engines not yet subject to standards must nevertheless supply fuel maps to vehicle manufacturers as described in paragraph (n) of this section. Note also that engines produced by small manufacturers are subject to criteria pollutant standards.

(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.

Tractors	LHD Engines	MHD Engines	HHD Engines
Model Years 2013–2015	NA	512 g/hp-hr	485 g/hp-hr.
Model Years 2016 and later [1]	NA	487 g/hp-hr	460 g/hp-hr.
Vocational	LHD Engines	MHD Engines	HHD Engines
Model Years 2013–2015	618 g/hp-hr	618 g/hp-hr	577 g/hp-hr.
Model Years 2016 through 2020 [a]	576 g/hp-hr	576 g/hp-hr	555 g/hp-hr.

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

(f) *Separate OBD families.* This paragraph (f) applies where you separately certify engines for the purpose of applying OBD requirements (for engines used in vehicles under 14,000 pounds GVWR) from non-OBD engines that could be certified as a single engine family. You may treat the two engine families as a single engine family in

certain respects for the purpose of this part, as follows:

(1) This paragraph (f) applies only where the two families are identical in all respects except for the engine ratings offered and the inclusion of OBD.

(2) For purposes of this part and 40 CFR part 86, the two families remain two separate families except for the following:

(i) Specify the testable configurations of the non-OBD engine family as the testable configurations for the OBD family.

(ii) Submit the same CO_2, N_2O, and CH_4 emission data for both engine families.

(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 0.020 g/hp-hr for N_2O emissions from any engine through model year 2020, and 0.010 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.

(h) *Advanced-technology credits.* If you generate credits from model year 2020 and earlier engines certified for advanced technology, you may multiply these credits by 1.5, except that you may not apply this multiplier and the early-credit multiplier of paragraph (a) of this section.

(i) *CO_2 credits for low N_2O emissions.* If you certify your model year 2014, 2015, or 2016 engines to an N_2O FEL less than 0.04 g/hp-hr (provided you measure N_2O emissions from your emission-data engines), you may generate additional CO_2 credits under this paragraph (i). Calculate the additional CO_2 credits from the following equation instead of the equation in §1036.705:

$$CO_2\ \text{Credits (Mg)} = (0.04 - \text{FEL}_{N2O}) \cdot (\text{CF}) \cdot (\text{Volume}) \cdot (\text{UL}) \cdot (10^{-6}) \cdot (298)$$

(j) *Alternate standards under 40 CFR part 86.* This paragraph (j) describes alternate emission standards for loose engines certified under 40 CFR 86.1819–14(k)(8). The standards of §1036.108 do not apply for these engines. The standards in this paragraph (j) apply for emissions measured with the engine installed in a complete vehicle consistent with the provisions of 40 CFR 86.1819–14(k)(8)(vi). The only requirements of this part that apply to these engines are those in this paragraph (j), §§1036.115 through 1036.135, 1036.535, and 1036.540.

(k) [Reserved]

(l) *Credit adjustment for spark-ignition engines and light heavy-duty compression-ignition engines.* For emission credits generated from model year 2020 and earlier engines subject to spark-ignition standards and light heavy-duty compression-ignition engines, multiply any banked credits that you carry forward to demonstrate compliance with model year 2021 and later standards by 1.36.

(m) *Infrequent regeneration.* For model year 2020 and earlier, you may invalidate any test interval with respect to CO_2 measurements if an infrequent regeneration event occurs during the test interval. Note that §1036.530 specifies how to apply infrequent regeneration adjustment factors for later model years.

(n) *Supplying fuel maps.* Engine manufacturers not yet subject to standards under §1036.108 in model year 2021 must supply vehicle manufacturers with fuel maps (or powertrain test results) as described in §1036.130 for those engines.

(o) *Engines used in glider vehicles.* For purposes of recertifying a used engine for installation in a glider vehicle, we may allow you to include in an existing certified engine family those engines you modify (or otherwise demonstrate) to be identical to engines already covered by the certificate. We would base such an approval on our review of any appropriate documentation. These engines must have emission control information labels that accurately describe their status.

(p) *Transition to Phase 2 CO_2 standards.* If you certify all your model year

2020 engines within an averaging set to the model year 2021 FTP and SET standards and requirements, you may apply the provisions of this paragraph (p) for enhanced generation and use of emission credits. These provisions apply separately for medium heavy-duty engines and heavy heavy-duty engines.

(1) GHG emission credits you 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 §1036.740(d).

(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	538	506	467	442

Subpart C—Certifying Engine Families

§1036.205 What must I include in my application?

Submit an application for certification as described in 40 CFR 86.007–21, with the following additional information:

(a) Describe the engine family's specifications and other basic parameters of the engine's design and emission controls with respect to compliance with the requirements of this part. Describe in detail all system components for controlling greenhouse gas emissions, including all auxiliary emission control devices (AECDs) and all fuel-system components you will install on any production or test engine. Identify the part number of each component you describe. For this paragraph (a), treat as separate AECDs any devices that modulate or activate differently from each other.

(b) Describe any test equipment and procedures that you used if you performed any tests that did not also involve measurement of criteria pollutants. Describe any special or alternate test procedures you used (see 40 CFR 1065.10(c)).

(c) Include the emission-related installation instructions you will provide if someone else installs your engines in their vehicles (see §1036.130).

(d) Describe the label information specified in §1036.135. We may require you to include a copy of the label.

(e) Identify the CO_2 FCLs with which you are certifying engines in the engine family; also identify any FELs that apply for CH_4 and N_2O. The actual U.S.-directed production volume of configurations that have CO_2 emission rates at or below the FCL and CH_4 and N_2O emission rates at or below the applicable standards or FELs must be at least one percent of your actual (not projected) U.S.-directed production volume for the engine family. Identify configurations within the family that have emission rates at or below the FCL and meet the one percent requirement. For example, if your U.S.-directed production volume for the engine family is 10,583 and the U.S.-directed production volume for the tested rating is 75 engines, then you can comply with this provision by setting your FCL so that one more rating with a U.S.-directed production volume of at least 31 engines meets the FCL. Where applicable, also identify other testable configurations required under §1036.230(b)(2).

(f) Identify the engine family's deterioration factors and describe how you developed them (see §1036.241). Present any test data you used for this.

(g) Present emission data to show that you meet emission standards, as follows:

(1) Present exhaust emission data for CO_2, CH_4, and N_2O on an emission-data engine to show that your engines meet the applicable emission standards we specify in §1036.108. Show emission figures before and after applying deterioration factors for each engine. In addition to the composite results, show individual measurements for cold-start testing and hot-start testing over the transient test cycle. For each of these tests, also include the corresponding exhaust emission data for criteria

emissions. Note that §1036.235 allows you to submit an application in certain cases without new emission data.

(2) [Reserved]

(h) State whether your certification is limited for certain engines. For example, if you certify heavy heavy-duty engines to the CO_2 standards using only transient testing, the engines may be installed only in vocational vehicles.

(i) Unconditionally certify that all the engines in the engine family comply with the requirements of this part, other referenced parts of the CFR, and the Clean Air Act. Note that §1036.235 specifies which engines to test to show that engines in the entire family comply with the requirements of this part.

(j) Include the information required by other subparts of this part. For example, include the information required by §1036.725 if you participate in the ABT program.

(k) Include the warranty statement and maintenance instructions if we request them.

(l) Include other applicable information, such as information specified in this part or 40 CFR part 1068 related to requests for exemptions.

(m) For imported engines or equipment, identify the following:

(1) Describe your normal practice for importing engines. For example, this may include identifying the names and addresses of any agents you have authorized to import your engines. Engines imported by nonauthorized agents are not covered by your certificate.

(2) The location of a test facility in the United States where you can test your engines if we select them for testing under a selective enforcement audit, as specified in 40 CFR part 1068, subpart E.

(n) Include information needed to certify vehicles to GHG standards under 40 CFR part 1037 as described in §1036.510.

§1036.210 Preliminary approval before certification.

If you send us information before you finish the application, we may review it and make any appropriate determinations, especially for questions related to engine family definitions, auxiliary emission control devices, adjustable parameters, deterioration factors, testing for service accumulation, and maintenance. Decisions made under this section are considered to be preliminary approval, subject to final review and approval. We will generally not reverse a decision where we have given you preliminary approval, unless we find new information supporting a different decision. If you request preliminary approval related to the upcoming model year or the model year after that, we will make best-efforts to make the appropriate determinations as soon as practicable. We will generally not provide preliminary approval related to a future model year more than two years ahead of time.

§1036.225 Amending my application for certification.

Before we issue you a certificate of conformity, you may amend your application to include new or modified engine configurations, subject to the provisions of this section. After we have issued your certificate of conformity, you may send us an amended application requesting that we include new or modified engine configurations within the scope of the certificate, subject to the provisions of this section. You must also amend your application if any changes occur with respect to any information that is included or should be included in your application.

(a) You must amend your application before you take any of the following actions:

(1) Add an engine configuration to an engine family. In this case, the engine configuration added must be consistent with other engine configurations in the engine family with respect to the criteria listed in §1036.230.

(2) Change an engine configuration already included in an engine family in a way that may affect emissions, or change any of the components you described in your application for certification. This includes production and design changes that may affect emissions any time during the engine's lifetime.

(3) Modify an FEL and FCL for an engine family as described in paragraph (f) of this section.

(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 engine model or configuration you intend to make.

(2) Include engineering evaluations or data showing that the amended engine family complies with all applicable requirements. You may do this by showing that the original emission-data engine 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.

(c) We may ask for more test data or engineering evaluations. You must give us these within 30 days after we request them.

(d) For engine families already covered by a certificate of conformity, we will determine whether the existing certificate of conformity covers your newly added or modified engine. You may ask for a hearing if we deny your request (see § 1036.820).

(e) For engine families already covered by a certificate of conformity, you may start producing the 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.

(f) You may ask us to approve a change to your FEL in certain cases after the start of production, but before the end of the model year. If you change an FEL for CO_2, your FCL for CO_2 is automatically set to your new FEL divided by 1.03. The changed FEL may not apply to engines you have already introduced into U.S. commerce, except as described in this paragraph (f). You may ask us to approve a change to your FEL in the following cases:

(1) You may ask to raise your FEL for your engine family at any time. 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.

(2) You may ask to lower the FEL for your engine family only if you have test data from production engines showing that emissions are below the proposed lower FEL (or below the proposed FCL for CO_2). The lower FEL/FCL applies only to engines you produce after we approve the new FEL/FCL. 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.

(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.

§ 1036.230 Selecting engine families.

See 40 CFR 86.001–24 for instructions on how to divide your product line into families of engines that are expected to have similar emission characteristics throughout the useful life. You must certify your engines to the standards of § 1036.108 using the same engine families you use for criteria pollutants under 40 CFR part 86. The following provisions also apply:

(a) Engines certified as hybrid engines may not be included in an engine family with engines with conventional powertrains. Note that this does not prevent you from including engines in a conventional family if they are used in hybrid vehicles, as long as you certify them conventionally.

(b) If you certify engines in the family for use as both vocational and tractor engines, you must split your family into two separate subfamilies. Indicate in the application for certification that the engine family is to be split.

(1) Calculate emission credits relative to the vocational engine standard for the number of engines sold into vocational applications and relative to the tractor engine standard for the number of engines sold into non-vocational tractor applications. You may assign the numbers and configurations of engines within the respective subfamilies at any time before submitting the end-of-year report required by § 1036.730. If the family participates in averaging, banking, or trading, you must identify the type of vehicle in which each engine is installed; we may alternatively allow you to use statistical methods to determine this for a fraction of your engines. Keep records to document this determination.

(2) If you restrict use of the test configuration for your split family to only tractors, or only vocational vehicles, you must identify a second testable configuration for the other type of vehicle (or an unrestricted configuration). Identify this configuration in your application for certification. The FCL for the engine family applies for this configuration as well as the primary test configuration.

(c) If you certify in separate engine families engines that could have been certified in vocational and tractor engine subfamilies in the same engine family, count the two families as one family for purposes of determining your obligations with respect to the OBD requirements and in-use testing requirements of 40 CFR part 86. Indicate in the applications for certification that the two engine families are covered by this paragraph (c).

(d) 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.

(e) If you certify both engine fuel maps and powertrain fuel maps for an engine family, you may split the engine family into two separate subfamilies. Indicate this in your application for certification, and identify whether one or both of these sets of fuel maps applies for each group of engines. If you do not split your family, all engines within the family must conform to the engine fuel maps, including any engines for with the powertrain maps also apply.

§ 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.

(a) Select a single emission-data engine from each engine family as specified in 40 CFR part 86. The standards of this part apply only with respect to emissions measured from this tested configuration and other configurations identified in § 1036.205(e). Note that configurations identified in § 1036.205(e) are considered to be ''tested configurations''. Whether or not you actually tested them for certification. However, you must apply the same (or equivalent) emission controls to all other engine configurations in the engine family. In other contexts, the tested configuration is sometimes referred to as the ''parent configuration'', although the terms are not synonymous.

(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 ramped-modal cycle specified in §1036.505, 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 40 CFR part 86, subpart N.

(3) You may certify your engine family for both tractor and vocational use by submitting CO_2 emission data from both ramped-modal 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 ramped-modal cycle 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 40 CFR 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, as long as we perform at least three valid tests. We will use mean values for each point to specify our fuel maps and may use the resulting fuel maps as the official emission results. We may also consider how the different fuel maps affect GEM emission results as part of our decision. We will not replace individual points from your fuel map, but we may make separate determinations for

steady-state, idle, cycle-average and powertrain fuel maps.

(6) 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:

(i) Directly measuring the highway cruise cycle-average fuel maps.

(ii) 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.

(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 engine family from the previous model year differs from the current engine family only with respect to model year, items identified in §1036.225(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 engine family covered by the application for certification.

(e) We may require you to test a second engine of the same configuration in addition to the engine tested under paragraph (a) of this section.

(f) If you use an alternate test procedure under 40 CFR 1065.10 and later testing shows that such testing does not produce results that are equivalent to the procedures specified in subpart F of this part, we may reject data you generated using the alternate procedure.

§1036.241 Demonstrating compliance with greenhouse gas emission standards.

(a) For purposes of certification, your engine family is considered in compliance with the emission standards in §1036.108 if all emission-data engines representing the tested configuration of that engine family have test results showing official emission results and deteriorated emission levels at or below the standards. Note that your FCLs are considered to be the applicable emission standards with which you must comply for certification.

(b) Your engine family is deemed not to comply if any emission-data engine representing the tested configuration of that engine family has test results showing an official emission result or a deteriorated emission level for any pollutant that is above an applicable emission standard (generally the FCL). Note that you may increase your FCL if any certification test results exceed your initial FCL.

(c) Apply deterioration factors to the measured emission levels for each pollutant to show compliance with the applicable emission standards. Your deterioration factors must take into account any available data from in-use testing with similar engines. Apply deterioration factors as follows:

(1) *Additive deterioration factor for greenhouse gas emissions.* Except as specified in paragraphs (c)(2) and (3) of this section, use an additive deterioration factor for exhaust emissions. An additive deterioration factor is the difference between the highest exhaust emissions (typically at the end of the useful life) and exhaust emissions at the low-hour test point. In these cases, adjust the official emission results for each tested engine at the selected test point by adding the factor to the measured emissions. If the factor is less than zero, use zero. Additive deterioration factors must be specified to one more decimal place than the applicable standard.

(2) *Multiplicative deterioration factor for greenhouse gas emissions.* Use a multiplicative deterioration factor for a pollutant if good engineering judgment calls for the deterioration factor for that pollutant to be the ratio of the highest exhaust emissions (typically at the end of the useful life) to exhaust emissions at the low-hour test point. Adjust the official emission results for each tested engine at the selected test point by multiplying the measured emissions by the deterioration factor. If the factor is less than one, use one. A multiplicative deterioration factor

may not be appropriate in cases where testing variability is significantly greater than engine-to-engine variability. Multiplicative deterioration factors must be specified to one more significant figure than the applicable standard.

(3) *Sawtooth and other nonlinear deterioration patterns.* The deterioration factors described in paragraphs (c)(1) and (2) of this section assume that the highest useful life emissions occur either at the end of useful life or at the low-hour test point. The provisions of this paragraph (c)(3) apply where good engineering judgment indicates that the highest useful life emissions will occur between these two points. For example, emissions may increase with service accumulation until a certain maintenance step is performed, then return to the low-hour emission levels and begin increasing again. Such a pattern may occur with battery-based electric hybrid engines. Base deterioration factors for engines with such emission patterns on the difference between (or ratio of) the point at which the highest emissions occur and the low-hour test point. Note that this applies for maintenance-related deterioration only where we allow such critical emission-related maintenance.

(4) [Reserved]

(5) *Dual-fuel and flexible-fuel engines.* In the case of dual-fuel and flexible-fuel engines, apply deterioration factors separately for each fuel type by measuring emissions with each fuel type at each test point. You may accumulate service hours on a single emission-data engine using the type of fuel or the fuel mixture expected to have the highest combustion and exhaust temperatures; you may ask us to approve a different fuel mixture if you demonstrate that a different criterion is more appropriate.

(d) Calculate emission data using measurements to at least one more decimal place than the applicable standard. Apply the deterioration factor to the official emission result, as described in paragraph (c) of this section, 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.

(e) If you identify more than one configuration in §1036.205(e), we may test (or require you to test) any of the identified configurations. We may also require you to provide an engineering analysis that demonstrates that untested configurations listed in §1036.205(e) comply with their FCL.

§1036.250 Reporting and recordkeeping for certification.

(a) Within 90 days after the end of the model year, send the Designated Compliance Officer a report including the total U.S.-directed production volume of engines you produced in each engine family during the model year (based on information available at the time of the report). Report the production by serial number and engine configuration. Small manufacturers may omit this requirement. You may combine this report with reports required under subpart H of this part.

(b) Organize and maintain the following records:

(1) A copy of all applications and any summary information you send us.

(2) Any of the information we specify in §1036.205 that you were not required to include in your application.

(c) Keep routine data from emission tests required by this part (such as test cell temperatures and relative humidity readings) for one year after we issue the associated certificate of conformity. Keep all other information specified in this section for eight years after we issue your certificate.

(d) Store these records in any format and on any media, as long as you can promptly send us organized, written records in English if we ask for them. You must keep these records readily available. We may review them at any time.

§1036.255 What decisions may EPA make regarding my certificate of conformity?

(a) If we determine your 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 your engine family for that model year. We

may make the approval subject to additional conditions.

(b) We may deny your application for certification if we determine that your 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 your application, we will explain why in writing.

(c) In addition, we may deny your application or suspend or revoke your certificate if you do any of the following:

(1) Refuse to comply with any testing or reporting requirements.

(2) Submit false or incomplete information (paragraph (e) of this section applies if this is fraudulent). This includes doing anything after submission of your application to render any of the submitted information false or incomplete.

(3) Render inaccurate any test data.

(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 your application to include all engines being produced.

(7) Take any action that otherwise circumvents the intent of the Act or this part, with respect to your engine family.

(d) We may void the certificate of conformity for an engine family 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 your certificate if we find that you intentionally submitted false or incomplete information. This includes rendering submitted information false or incomplete after submission.

(f) If we deny your application or suspend, revoke, or void your certificate, you may ask for a hearing (see §1036.820).

Subpart D—Testing Production Engines

§1036.301 Measurements related to GEM inputs in a selective enforcement audit.

(a) Selective enforcement audits apply for engines as specified in 40 CFR part 1068, subpart E. This section describes how this applies uniquely in certain circumstances.

(b) Selective enforcement audit provisions apply with respect to your fuel maps as follows:

(1) A selective enforcement audit for an engine with respect to fuel maps would consist of performing measurements with production engines to determine fuel-consumption rates as declared for GEM simulations, and running GEM for the vehicle configurations specified in paragraph (b)(2) of this section based on those measured values. The engine is considered passing for a given configuration if the new modeled emission result for each applicable duty cycle is at or below the modeled emission result corresponding to the declared GEM inputs. The engine is considered failing for a given configuration if the new modeled emission result for any applicable duty cycle is above the modeled emission result corresponding to the declared GEM inputs.

(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 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 $M_{avg} = M_{subcategory} - \frac{2}{3} \cdot M_{reduction}$, 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:

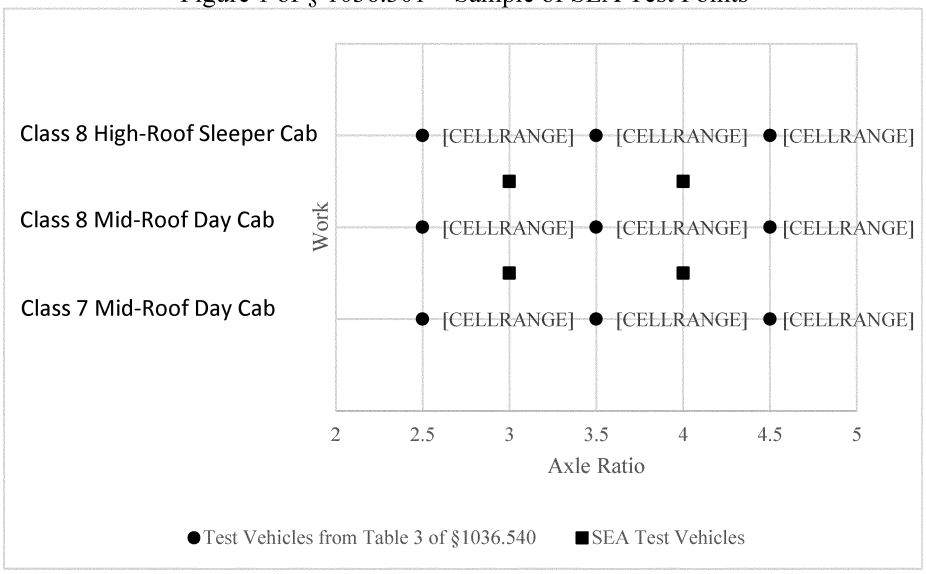
TABLE 1 OF § 1036.301—DEFAULT VEHICLE MASS BY VEHICLE SUBCATEGORY

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

(3) This paragraph (b)(3) provides an example to illustrate how to determine GEM input values for the four vehicle configurations identified in paragraph (b)(2) of this section. If axle ratio is 2.5 for Tests 1 and 2, and 3.5 for Tests 4 and 5, the average value is 3.0. A tire size of 500 revolutions per mile would apply for all four tests, so the average tire size would be that same value. Similarly, C_{rr} is 6.9 kg/tonne since that value applies for all four points. The calculated average value of C_dA is 6.9 m^2. The calculated average vehicle mass is 28,746.5 kg. Weight reduction is 4,847 kg or 10,686 pounds ($\frac{3}{2} \cdot (31{,}978 - 28{,}746.5)$).

(4) Because your cycle-average map may have more or fewer test points, you may have more than or fewer than the number of audit points shown in Figure 1 of this section. If the audit includes fuel-map testing in conjunction with engine testing relative to exhaust emission standards, the fuel-map simulations for the whole set of vehicles and duty cycles counts as a single test result for purposes of evaluating whether the engine family meets the pass-fail criteria under 40 CFR 1068.420. If the audit includes only fuel-map testing, determine emission results from at least three different engine configurations simulated with each applicable vehicle configuration identified in § 1036.540; the fuel-map simulation for each vehicle configuration counts as a separate test for the engine.

Figure 1 of § 1036.301 – Sample of SEA Test Points



(c) If your certification includes powertrain testing as specified in 40 CFR 1036.630, these selective enforcement audit provisions apply with respect to powertrain test results as specified in 40 CFR part 1037, subpart D, and 40 CFR 1037.550. We may allow manufacturers to instead perform the engine-based testing to simulate the powertrain test as specified in 40 CFR 1037.551.

(d) We may suspend or revoke certificates for any appropriate configurations within one or more engine families based on the outcome of a selective enforcement audit.

Subpart E—In-Use Testing

§ 1036.401 In-use testing.

We may perform in-use testing of any engine family subject to the standards of this part, consistent with the Clean Air Act and the provisions of § 1036.235. Note that this provision does not affect your obligation to test your in-use engines as described in 40 CFR part 86, subpart T.

Subpart F—Test Procedures

§ 1036.501 How do I run a valid emission test?

(a) Use the equipment and procedures specified in this subpart and 40 CFR 86.1305 to determine whether engines meet the emission standards in § 1036.108.

(b) You may use special or alternate procedures to the extent we allow them under 40 CFR 1065.10.

(c) This subpart is addressed to you as a manufacturer, but it applies equally to anyone who does testing for you, and to us when we perform testing to determine if your engines meet emission standards.

(d) For engines that use aftertreatment technology with infrequent regeneration events, apply infrequent regeneration adjustment factors as described in § 1036.530.

(e) Test hybrid engines as described in § 1036.525 and 40 CFR part 1065.

(f) Determine engine fuel maps as described in § 1036.510(b).

(g) 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 use good engineering judgment to turn the engine off during the idle portions of the duty cycle to represent in-use operation, consistent with good engineering judgment.

(2) Use one of the following methods to measure CO_2 emissions:

(i) Use the ramped-modal cycle specified in §1036.505 using either continuous or batch sampling.

(ii) Measure CO_2 emissions over the ramped-modal 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 weighting factors specified in 40 CFR 86.1362 to calculate a composite emission result.

(3) 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, subart A.

§ 1036.505 Ramped-modal testing procedures.

(a) Starting in model year 2021, you must measure CO_2 emissions using the ramped-modal cycle in 40 CFR 86.1362 as described in §1036.501, or using the ramped-modal cycle in this section.

(b) Measure emissions using the ramped-modal duty cycle shown in the following table to determine whether engines meet the steady-state compression-ignition standards specified in subpart B of this part:

TABLE 1 OF § 1036.505—RAMPED-MODAL DUTY CYCLE

RMC mode	Time in mode (seconds)	Engine speed[1 2]	Torque (percent)[2 3]
1a Steady-state	124	Warm Idle	0.
1b Transition	20	Linear Transition	Linear Transition.
2a Steady-state	196	A	100.
2b Transition	20	Linear Transition	Linear Transition.
3a Steady-state	220	B	50.
3b Transition	20	B	Linear Transition.
4a Steady-state	220	B	75.
4b Transition	20	Linear Transition	Linear Transition.
5a Steady-state	268	A	50.
5b Transition	20	A	Linear Transition.
6a Steady-state	268	A	75.
6b Transition	20	A	Linear Transition.
7a Steady-state	268	A	25.
7b Transition	20	Linear Transition	Linear Transition.
8a Steady-state	196	B	100.
8b Transition	20	B	Linear Transition.
9a Steady-state	196	B	25.
9b Transition	20	Linear Transition	Linear Transition.
10a Steady-state	28	C	100.
10b Transition	20	C	Linear Transition.
11a Steady-state	4	C	25.
11b Transition	20	C	Linear Transition.
12a Steady-state	4	C	75.
12b Transition	20	C	Linear Transition.
13a Steady-state	4	C	50.
13b Transition	20	Linear Transition	Linear Transition.
14 Steady-state	144	Warm Idle	0.

[1] 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 speed or torque setting of the current mode to the speed or torque setting of the next mode.
[3] The percent torque is relative to maximum torque at the commanded engine speed.

§ 1036.510 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, engine family name, calibration identification, and engine displacement. Also identify which standards the engines meet.

(b) This paragraph (b) describes three different methods to generate engine fuel maps. Manufacturers may generally rely on any of the three mapping methods. However, manufacturers must generate fuel maps using either cycle-average or powertrain testing as described in paragraphs (b)(2) and (3) of this section for hybrid engines and hybrid vehicles. Also, vehicle manufacturers must use the powertrain method for any vehicle with a transmission that is not automatic, automated manual, manual, or dual-clutch.

(1) *Combined steady-state and cycle-average.* Determine steady-state engine fuel maps and fuel consumption at idle as described in §1036.535, 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, 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. 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 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.

(d) Provide the following information if you generate engine fuel maps using either paragraph (b)(1) or (2) of this section:

(1) Full-load torque curve for installed engines, and the full-load torque curve of the 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 as described in 40 CFR 1065.510(g) with the hybrid system active.

(2) Motoring torque map as described in 40 CFR 1065.510(c)(2) and (4) for conventional and hybrid engines, respectively.

(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.

§1036.525 Hybrid engines.

(a) 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.

(b) If you produce a hybrid engine designed with power take-off capability and sell the engine coupled with a transmission, you may calculate a reduction in CO_2 emissions resulting from the power take-off operation as described in 40 CFR 1037.540. Quantify the CO_2 reduction for your engines using the vehicle-based procedures, consistent with good engineering judgment.

(c) For engines that include electric hybrid systems, test the engine with the hybrid electric motor, the rechargeable energy storage system (RESS), and the power electronics between the hybrid electric motor and the RESS. You may ask us to modify the provisions of this section for testing engines with other kinds of hybrid systems.

(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 ramped-modal testing, deactivate the hybrid features unless we specify otherwise. The following provisions apply for testing hybrid engines:

(1) *Engine mapping*. Map the engine as specified in 40 CFR 1065.510. This requires separate torque maps for the engine with and without the hybrid features active. For transient testing, denormalize the duty cycle using the map generated with the hybrid feature active. For steady-state testing, denormalize the duty cycle using the map generated without the hybrid feature.

(2) *Engine shutdown during testing*. If you will configure production engines to shut down automatically during idle operation, you may let the engine shut down during the idle portions of the duty cycle.

(3) *Work calculation*. Calculate positive and negative work done over the cycle according to 40 CFR 1065.650(d), except that you must set power to zero to calculate negative work done for any period over the cycle where the engine produces net positive power or where the negative power is solely from the engine and not the hybrid system.

(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.

$$W_{cycle} = W_{pos} - \left(\left| W_{neg} \right| - x_{bl} \cdot W_{pos} \right)$$

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

$$x_b = \left|\frac{1.69}{14.67}\right| = 0.320 \text{ kW}$$

$x_{bl} = 4.158.10^{-4}.223 + 0.2247 = 0.317$ kW
since $x_b > x_{bl}$;
$W_{cycle} = 14.67 - (|4.59| - 0.317 \cdot 14.67) = 14.63$ kW-hr

(ii) Convert from g/kW-hr to g/hp-hr as the final step in calculating emission results.

(5) *State of charge.* Correct for the net energy change of the energy storage device as described in 40 CFR 1066.501.

§ 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 cycle-average results as described in 40 CFR 86.004–28 for CO_2 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 mass-specific net energy content, $E_{mfuelmeas}$, also known as lower heating value, in MJ/kg, expressed to at least three decimal places, as follows:

(i) For liquid fuels, determine $E_{mfuelmeas}$ according to ASTM D4809 (incorporated by reference in §1036.810).

(ii) For gaseous fuels, determine $E_{mfuelmeas}$ using good engineering judgment.

(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. Have the sample analyzed by three different labs and use the arithmetic mean of the results 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:

$$e_{CO2cor} = e_{CO2} \cdot \frac{E_{mfuelmeas}}{E_{mfuelCref} \cdot w_{Cmeas}}$$

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 OF § 1036.530—REFERENCE FUEL PROPERTIES

Fuel type[1]	Reference fuel carbon-mass-specific net energy content, $E_{mfuelCref}$, (MJ/kgC)[2]	Reference fuel carbon mass fraction, w_{Cref}[2]
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

[1] For fuels that are not listed, you must ask us to approve reference fuel properties.

[2] 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.

§ 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 § 1037.540, omit mapping under paragraph (b) of the section and instead perform mapping as described in paragraph (c) and (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 as described in § 1036.510(a)(2) 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 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) Select ten speed points that include warm idle speed, $f_{nidle,}$ the highest speed above maximum power at which 70% of maximum power occurs, $n_{hi,}$ and eight equally spaced points between f_{nidle} and $n_{hi.}$ Control speed to within ±1% of n_{hi} (see 40 CFR 1065.610(c)).

(2) Select ten torque values, including T = 0, maximum mapped torque, $T_{max\ mapped}$, and eight equally spaced points between T = 0 and $T_{max\ mapped}$. Replace any torque setpoints that are above the mapped torque at a given speed, T_{max}, minus 5 percent of $T_{max\ mapped}$. with one test point at $T_{max.}$ Control engine torque to within ±5% of $T_{max\ mapped}$.

(3) You may need to adjust dynamometer settings any time the engine is operating on the low-speed or high-speed governor to maintain stable engine operation. You may change the dynamometer's speed setpoint as needed to avoid activating the engine's governor. You may alternatively set the dynamometer mode to torque-control, in which case speed can fall outside of ±1% of n_{hi}.

(4) Precondition the engine as described in 40 CFR 1065.510(b)(2).

(5) Within 60 seconds after concluding the preconditioning procedure, operate the engine at n_{hi} and T_{max}.

(6) After the engine operates at the set speed and torque for 60 seconds, start recording measurements using one of the following methods:

(i) *Carbon mass balance.* Record speed and torque and measure emissions and other inputs needed to run the chemical balance in 40 CFR 1065.655(c) for (29 to 31) seconds; determine the corresponding mean values for the sampling period. We will use carbon mass balance.

(ii) *Direct measurement of fuel flow.* Record speed and torque and measure fuel consumption with a fuel flow meter for (29 to 31) seconds; determine the corresponding mean values for the sampling period.

(7) After completing the sampling period described in paragraph (b)(6) of this section, linearly ramp the engine over 15 seconds to the next lowest torque value while holding speed constant. Perform the measurements described at the new torque setting and repeat this sequence for all remaining torque values down to T = 0.

(8) Continue testing to complete fuel mapping as follows:

(i) At T = 0, linearly ramp the engine over 15 seconds to operate at the next lowest speed value and increase torque to T_{max}. Perform measurements for all the torque values at the selected speed as described in paragraphs (b)(6) and (7) of this section. Repeat this sequence for all remaining speed values down to f_{nidle} to complete the fuel-mapping procedure. You may interrupt the mapping sequence to calibrate emission-measurement instrumentation only during stabilization at T_{max} for a given speed. If you use batch sampling to measure background emissions, you may sample periodically into the bag over the course of multiple test intervals defined by the period between calibrations of emission-measurement instrumentation. The background sample must be applied to correct emissions sampled over the test interval(s) between calibrations.

(ii) If an infrequent regeneration event occurs during fuel mapping, invalidate all the measurements made at that engine speed. Allow the regeneration event to finish, then restart engine stabilization at T_{max} at the same engine speed and continue with measurements from that point in the fuel-mapping sequence.

(9) If you determine fuel-consumption rates using emission measurements from the raw or diluted exhaust, calculate the mean fuel mass flow rate, $\overline{m}_{fuel}$, for each point in the fuel map using the following equation:

$$\overline{\dot{m}}_{\text{fuel}} = \frac{M_{\text{C}}}{w_{\text{Cmeas}}} \cdot \left(\overline{\dot{n}}_{\text{exh}} \cdot \frac{\overline{x}_{\text{Ccombdry}}}{1 + \overline{x}_{\text{H2Oexhdry}}} - \frac{\overline{\dot{m}}_{\text{CO2DEF}}}{M_{\text{CO2}}} \right)$$

Eq. 1036.535-1

Where:

$\overline{\dot{m}}_{\text{fuel}}$ = 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.

$\overline{\dot{n}}_{\text{exh}}$= 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).

$\overline{\dot{m}}_{\text{CO2DEF}}$= the mean CO_2 mass emission rate resulting from diesel exhaust fluid decomposition as determined in paragraph (b)(10) of this section. If your engine does not use diesel exhaust fluid, or if you choose not to perform this correction, set $\overline{\dot{m}}_{\text{CO2DEF}}$ equal to 0.

M_{CO2} = molar mass of carbon dioxide.

Example:

M_{C} = 12.0107 g/mol
w_{Cmeas} = 0.869
$\overline{\dot{n}}_{\text{exh}}$= 25.534 mol/s
$\bar{x}_{\text{Ccombdry}}$= 0.002805 mol/mol
$\bar{x}_{\text{H2Oexhdry}}$= 0.0353 mol/mol
$\overline{\dot{m}}_{\text{CO2DEF}}$= 0.0726 g/s
M_{CO2} = 44.0095 g/mol

$$\overline{\dot{m}}_{\text{fuel}} = \frac{12.0107}{0.869} \cdot \left(25.534 \cdot \frac{0.002805}{1 + 0.0353} - \frac{0.0726}{44.0095} \right) = 0.933 \text{ g/s}$$

(10) 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:

$$\overline{\dot{m}}_{\text{CO2DEF}} = \overline{\dot{m}}_{\text{DEF}} \cdot \frac{M_{\text{CO2}} \cdot w_{\text{CH4N2O}}}{M_{\text{CH4N2O}}}$$

Eq. 1036.535-2

Where:

$\overline{\dot{m}}_{\text{DEF}}$= the mean mass flow rate of injected urea solution diesel exhaust fluid for a given sampling period, determined directly from the engine 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 32.5% urea diesel exhaust fluid as a solution of urea in water with a nominal urea concentration of 32.5%.

M_{CH4N2O} = molar mass of urea.

Example:
$\dot{\bar{m}}_{DEF}$= 0. 304 g/s
M_{CO2} = 44.0095 g/mol
w_{CH4N2O} = 32.5% = 0.325
M_{CH4N2O} = 60.05526 g/mol

$$\dot{\bar{m}}_{CO2DEF} = 0.304 \cdot \frac{44.0095 \cdot 0.325}{60.05526} = 0.0726 \text{ g/s}$$

(11) Correct the measured or calculated mean fuel mass flow rate, $\dot{\bar{m}}_{fuel}$ at each engine operating condition to a mass-specific net energy content of a reference fuel using the following equation:

$$\dot{\bar{m}}_{fuelcor} = \dot{\bar{m}}_{fuel} \cdot \frac{E_{mfuelmeas}}{E_{mfuelCref} \cdot w_{Cref}}$$

Eq. 1036.535-3

Where:

$E_{mfuelmeas}$ = the mass-specific net energy content of the test fuel as determined in §1036.530(b)(1).

$E_{mfuelCref}$ = 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:
$\dot{\bar{m}}_{fuel}$= 0.933 g/s
$E_{mfuelmeas}$ = 42.7984 MJ/kgC
$E_{mfuelCref}$ = 49.3112 MJ/kgC
w_{Cref} = 0.874

$$\dot{\bar{m}}_{fuel} = 0.933 \cdot \frac{42.7984}{49.3112 \cdot 0.874} = 0.927 \text{ g/s}$$

(c) *Fuel consumption at idle.* Determine values for fuel-consumption rate at idle for each engine configuration as described in this paragraph (c). You may use shared data across engine configurations, consistent with good engineering judgment. Perform measurements as follows:

(1) Precondition the engine as described in 40 CFR 1065.510(b)(2).

(2) Within 60 seconds after concluding the preconditioning procedure, operate the engine at its minimum declared warm idle speed, $f_{nidlemin}$, as described in 40 CFR 1065.510(b)(3), set zero torque, and start the sampling period. Continue sampling for (595 to 605) seconds. Perform measurements using carbon mass balance. Record speed and torque and measure emissions and other inputs as described in 40 CFR 1065.655(c); determine the corresponding mean values for the sampling period. Calculate the mean fuel mass flow rate, $\dot{\bar{m}}_{fuel}$, during the sampling period as described in paragraph (b)(9) of this section.

Manufacturers may instead measure fuel consumption with a fuel flow meter and determine the corresponding mean values for the sampling period.

(3) Repeat the steps in paragraphs (c)(1) and (2) of this section with the

engine set to operate at a torque setting of 100 N·m.

(4) Repeat the steps in paragraphs (c)(1) through (3) of this section with the engine operated at its declared maximum warm idle speed, $f_{nidlemax}$.

(5) If an infrequent regeneration event occurs during this procedure, invalidate any measurements made at that idle condition. Allow the regeneration event to finish, then repeat the measurement and continue with the test sequence.

(6) Correct the measured or calculated mean fuel mass flow rate, $\overline{\dot{m}}_{fuel}$ at each of the four idle settings to account for mass-specific net energy content as described in paragraph (b)(11) of this section.

(d) *Steady-state fuel maps used for cycle-average fuel mapping of the cruise cycles.* Use the appropriate default steady-state engine fuel map as specified in Appendix I to this part to generate cycle-average fuel maps under §1036.540, as amended based on the measurements specified in this paragraph (d). Measure fuel consumption at idle at the four specified engine operating conditions. For any values from the default map that lie within the boundaries of the engine speed and torque values represented by these idle-operating points, use the measured values instead of the default values. You may use shared data across engine configurations, consistent with good engineering judgment. Determine values for fuel-consumption rate at idle for each engine configuration as follows:

(1) Determine idle torque, T_{idle}, at the engine's maximum warm idle speed using the following equation:

$$T_{idle[speed]} = \left(\frac{T_{fnstall} \cdot f_{nidle[speed]}^2}{f_{fnstall}^2} + \frac{P_{acc}}{f_{nidle[speed]}} \right) \cdot 1.1$$

Eq. 1036.535-4

Where:

$T_{fnstall}$ = the maximum engine torque at f_{nstall}.
$f_{nidle[speed]}$ = 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 rpm, 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
$f_{nidlemax}$ = 700 r/min = 73.30 rad/s
P_{acc} = 1500 W

$$T_{idlemax} = \left(\frac{1870 \cdot 73.30^2}{182.30^2} + \frac{1500}{73.30} \right) \cdot 1.1 = 352.12 \text{ N} \cdot \text{m}$$

(2) Precondition the engine as described in 40 CFR 1065.510(b)(2).

(3) Within 60 seconds after concluding the preconditioning procedure, operate the engine at its maximum declared warm idle speed, $f_{nidlemax,}$ as described in 40 CFR 1065.510(b)(3), set torque to the value determined in paragraph (d)(1) of this section, after the engine operates at the set speed and torque for 60 seconds, start the sampling period. Continue sampling for (29 to 31) seconds. Perform measurements using carbon mass balance. Record speed and torque and measure emissions and other inputs as described in 40 CFR 1065.655(c); determine the corresponding mean values for the sampling period. Calculate the mean fuel mass flow rate, $\overline{\dot{m}}_{fuel}$, during the sampling period as described in

paragraph (b)(9) of this section. Manufacturers may instead measure fuel consumption with a fuel flow meter and determine the corresponding mean values for the sampling period.

(4) Repeat the steps in paragraphs (d)(2) and (3) of this section with the engine set to operate at zero torque.

(5) Repeat the steps in paragraphs (d)(1) through (4) of this section with the engine operated at its declared minimum warm idle speed, f_{nidlemin}.

(6) If an infrequent regeneration event occurs during this procedure, invalidate any measurements made at that idle condition. Allow the regeneration event to finish, then repeat the measurement and continue with the test sequence.

(7) Correct the measured or calculated mean fuel mass flow rate, $\overline{\dot{m}}_{\text{fuel}}$ at each of the four idle settings to account for mass-specific net energy content as described in paragraph (b)(11) of this section.

(e) *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. 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.

§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.

(c) *Create engine cycles.* Use GEM to simulate several different vehicle configurations to create transient and highway cruise engine 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, and fuel consumption at idle as described in paragraph (a)(1) and (2) of this section.

(2) Set up GEM with transmission gear ratios for different vehicle service classes and vehicle duty cycles as described in Table 1 of this section. These values are based on automatic or automated manual transmissions, but they apply for all transmission types.

TABLE 1 OF § 1036.540—ASSIGNED TRANSMISSION GEAR RATIOS

Gear number	Light HDV and medium HDV	Tractors and heavy HDV, transient cycle	Tractors and heavy HDV, highway cruise cycle
1	3.10	3.51	12.8
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

(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 4 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

$$\left[\frac{f_{ntire}}{v_{vehicle}}\right]_{B} = \frac{31.17}{4.0 \cdot 0.61 \cdot 29.06} = 0.4396 \text{ rev/m}$$

(ii) Test at least eight different vehicle configurations for engines that will be installed in vocational Light HDV or vocational Medium HDV. If the engine will also be installed in vocational Heavy HDV, use good engineering judgment to select at least nine test configurations that best represent the range of vehicles. For example, if your engines will be installed in vocational Medium HDV and vocational Heavy HDV, you might select Tests 1 through 6 of Table 2 of this section to represent Class 7 vehicles and Tests 3, 6, and 9 of Table 3 of this section to represent Class 8 vehicles. 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. Set C_dA to 5.4 for all test configurations.For powertrain testing, set $M_{rotating}$ to 340 kg and Eff_{axle} to 0.955 for all test configurations.

Set the axle ratio, k_a, and tire size, $\frac{f_{ntire}}{v_{vehicle}}$, for each test configuration based on the corresponding designated engine speed (A, B, C, 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 engine speeds apply equally for engines subject to spark-ignition standards. Use the following settings specific to each vehicle configuration:

Table 2 of § 1036.540—Vehicle Settings for Testing Vocational Light HDV or Vocational Medium HDV

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 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)	7,257	11,408	7,257	11,408	7,257	11,408	7,257	11,408

(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 over six different test 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 test configurations. For powertrain testing, set Eff_{axle} to 0.955 for all test configurations. Set the axle ratio, k_a, and tire size, $\frac{f_{ntire}}{v_{vehicle}}$, for each test 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. Use the settings specific to each test 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 test configurations, so complete fuel mapping requires testing 12 (not 15) test configurations for those engines. 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 Settings for Testing General Purpose Tractors and Vocational Heavy HDV

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 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)	0	13,275	6,147	0	13,275	6,147	0	13,275	6,147
M (kg)	31,978	25,515	19,051	31,978	25,515	19,051	31,978	25,515	19,051

Table 4 of § 1036.540—Vehicle Settings for Testing Heavy-Haul Tractors

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 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) 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 duty cycles generated in paragraph (c) of this section as follows:

(1) Precondition the engine either as described in 40 CFR 1037.510(a)(2)(i) for the transient duty-cycle and 40 CFR 1037.510(a)(2)(ii) for the highway cruise duty cycles using the Test 1 vehicle configuration, and then continue testing the different configurations in the order presented in this section. Measure emissions as described in 40 CFR part 1065; perform cycle validation according to 40 CFR part 1065, subpart F, except as noted in this paragraph (d)(1). If the range of reference speeds is less than 10 percent of the mean reference speed, you need to meet only the standard error of estimate in Table 2 of 40 CFR 1065.514. For purposes of cycle validation, treat points as being at idle if reference speed is at or below declared idle speed. For plug-in hybrid engines, precondition the battery and then complete all back-to-back tests for each test configuration according to 40 CFR 1066.501 before moving to the next test configuration. 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.

(2) If an infrequent regeneration event occurs during a mapping test interval, invalidate that test interval. Continue operating the vehicle to allow the regeneration event to finish, then

repeat engine preconditioning and resume testing at the start of the invalidated test cycle.

(3) For each test, record measurements needed to determine fuel mass using carbon mass balance. Record speed and torque and measure emissions and other inputs as described in 40 CFR 1065.655(c). Manufacturers may instead measure fuel consumption with a fuel flow meter. 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.

(4) 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, $m_{fuel[cycle]}$, 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:

$$m_{\text{fuel[cycle]}} = \frac{M_C}{w_{\text{Cmeas}}} \cdot \left(\sum_{i=1}^{N} \left(\dot{n}_{\text{exh}_i} \cdot \frac{x_{\text{Ccombdry}_i}}{1 + x_{\text{H2Oexhdry}_i}} \cdot \Delta t \right) - \frac{1}{M_{\text{CO2}}} \sum_{i=1}^{N} \left(\dot{m}_{\text{CO2DEF}_i} \cdot \Delta t \right) \right)$$

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.

$\dot{m}_{CO2DEF}$ = 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 $\dot{m}_{CO2DEF}$ 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

$x_{H2Oexhdry1} = 3.53 \cdot 10^{-2}$ mol/mol

$x_{H2Oexhdry2} = 3.13 \cdot 10^{-2}$ 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

$$m_{\text{fueltransient}} = \frac{12.0107}{0.867} \cdot \left(\begin{array}{l} \left(\begin{array}{l} 2.876 \cdot \frac{2.61 \cdot 10^{-3}}{1 + 3.53 \cdot 10^{-2}} \cdot 0.1 + \\ 2.224 \cdot \frac{1.91 \cdot 10^{-3}}{1 + 3.13 \cdot 10^{-2}} \cdot 0.1 + \\ \ldots + \dot{n}_{\text{exh}_{6680}} \cdot \frac{x_{\text{Ccombdry}_{6680}}}{1 + x_{\text{H2Oexhdry}_{6680}}} \cdot \Delta t_{6680} \end{array} \right) \\ - \frac{1}{44.0095} \cdot \left(0.0726 \cdot 1.0 + 0.0751 \cdot 1.0 + \ldots + \dot{m}_{\text{CO2DEF}_{6680}} \cdot \Delta t_{6680} \right) \end{array} \right)$$

$M_{\text{fueltransient}} = 1619.6$ g

(B) If you measure batch emissions and continuous CO_2 from urea, calculate $m_{\text{fuel[cycle]}}$ using the following equation:

$$m_{\text{fuel[cycle]}} = \frac{M_C}{w_{\text{Cmeas}}} \cdot \left(\frac{\overline{x}_{\text{Ccombdry}}}{1 + \overline{x}_{\text{H2Oexhdry}}} \cdot \sum_{i=1}^{N} \left(\dot{n}_{\text{exh}_i} \cdot \Delta t \right) - \frac{1}{M_{\text{CO2}}} \sum_{i=1}^{N} \left(\dot{m}_{\text{CO2DEF}_i} \cdot \Delta t \right) \right)$$

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:

$$m_{\text{fuel[cycle]}} = \frac{M_C}{w_{\text{Cmeas}}} \cdot \left(\sum_{i=1}^{N} \left(\dot{n}_{\text{exh}_i} \cdot \frac{x_{\text{Ccombdry}_i}}{1 + x_{\text{H2Oexhdry}_i}} \cdot \Delta t \right) - \frac{m_{\text{CO2DEF}}}{M_{\text{CO2}}} \right)$$

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:

$$m_{\text{fuel[cycle]}} = \frac{M_C}{w_{\text{Cmeas}}} \cdot \left(\frac{\overline{x}_{\text{Ccombdry}}}{1 + \overline{x}_{\text{H2Oexhdry}}} \cdot \sum_{i=1}^{N} \left(\dot{n}_{\text{exh}_i} \cdot \Delta t \right) - \frac{m_{\text{CO2DEF}}}{M_{\text{CO2}}} \right)$$

Eq. 1036.540-6

(ii) Manufacturers may choose to measure fuel mass flow rate. Calculate the mass of fuel for each duty cycle, $m_{fuel[cycle]}$, as follows:

$$m_{fuel} = \sum_{i=1}^{N} \dot{m}_{fueli} \cdot \Delta t$$

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 $N = 1$.

$\dot{m}_{fuel_i}$ = the fuel mass flow rate, for each point, i, starting from $i = 1$.

$\Delta t = 1/f_{record}$

f_{record} = the data recording frequency.

Example:

$N = 6680$

$\dot{m}_{fuel_1} = 1.856$ g/s

$\dot{m}_{fuel_2} = 1.962$ g/s

$f_{record} = 10$ Hz

$\Delta t = 1/10 = 0.1$ s

$m_{fueltransient} = (1.856 + 1.962 + \ldots + \dot{m}_{fuel6680}) \cdot 0.1$

$m_{fueltransient} = 111.95$ g

(5) 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(b)(11), replacing with $\overline{m}_{fuel}$ with m_{fuel} in Eq. 1036.535–3.

(6) 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, $m_{\text{fueltransient}}$. The declared values may be at or above the values calculated in paragraph (d) of this section, as described in §1036.535(e).

(2) Engine output speed per unit vehicle speed,

$$\frac{\overline{f}_{\text{nengine}}}{\overline{v}_{\text{vehicle}}},$$

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.

(3) Positive work determined accordering to 40 CFR 1065, $W_{\text{transient}}$.

(4) The following table illustrates the GEM data inputs corresponding to the different vehicle configurations:

Table 5 of § 1036.540—Example test result output matrix for Class 8 vocational vehicles

	Test 1	Test 2	Test 3	Test 4	Test 5	Test 6	Test 7	Test 8	Test 9
$m_{\text{fueltransient}}$									
$\frac{\overline{f}_{\text{nengine}}}{\overline{v}_{\text{engine}}}$									
$W_{\text{transient}}$									

Subpart G—Special Compliance Provisions

§ 1036.601 What compliance provisions apply?

(a) Engine and vehicle manufacturers, as well as owners, operators, and rebuilders of engines subject to the requirements of this part, and all other persons, must observe the provisions of this part, the provisions of 40 CFR part 1068, and the provisions of the Clean Air Act. The provisions of 40 CFR part 1068 apply for heavy-duty highway engines as specified in that part, subject to the following provisions:

(1) The exemption provisions of 40 CFR 1068.201 through 1068.230, 1068.240, and 1068.260 through 265 apply for heavy-duty motor vehicle engines. The other exemption provisions, which are specific to nonroad engines, do not apply for heavy-duty vehicles or heavy-duty engines.

(2) The tampering prohibition in 40 CFR 1068.101(b)(1) applies for alternative fuel conversions as specified in 40 CFR part 85, subpart F.

(3) The warranty-related prohibitions in section 203(a)(4) of the Act (42 U.S.C. 7522(a)(4)) apply to manufacturers of new heavy-duty highway engines in addition to the prohibitions described in 40 CFR 1068.101(b)(6). We may assess a civil penalty up to $44,539 for each engine or vehicle in violation.

(b) Engines exempted from the applicable standards of 40 CFR part 86 under the provisions of 40 CFR part 1068 are exempt from the standards of this part without request.

(c) The emergency vehicle field modification provisions of 40 CFR 85.1716 apply with respect to the standards of this part.

(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. 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.

§ 1036.605 GHG exemption for engines used in specialty vehicles.

Engines certified to the alternative standards specified in 40 CFR 86.007–11 and 86.008–10 for use in specialty vehicles as described in 40 CFR 1037.605 are exempt from the standards of this part. See 40 CFR part 1037 for provisions that apply to the vehicle.

§ 1036.610 Off-cycle technology credits and adjustments for reducing greenhouse gas emissions.

(a) You may ask us to apply the provisions of this section for CO_2 emission reductions resulting from powertrain technologies that were not in common use with heavy-duty vehicles before model year 2010 that are not reflected in the specified test procedure. While you are not required to prove that such technologies were not in common use with heavy-duty vehicles before model year 2010, we will not approve your request if we determine that they do not qualify. We will apply these provisions only for technologies that will result in a measurable, demonstrable, and verifiable real-world CO_2 reduction. Note that prior to model year 2016, these technologies were referred to as ''innovative technologies''.

(b) The provisions of this section may be applied as either an improvement factor (used to adjust emission results) or as a separate credit, consistent with good engineering judgment. Note that the term ''credit'' in this section describes an additive adjustment to emission rates and is not equivalent to an emission credit in the ABT program of subpart H of this part. We recommend that you base your credit/adjustment on A to B testing of pairs of engines/vehicles differing only with respect to the technology in question.

(1) Calculate improvement factors as the ratio of in-use emissions with the technology divided by the in-use emissions without the technology. Adjust the emission results by multiplying by the improvement factor. Use the improvement-factor approach where good engineering judgment indicates that the actual benefit will be proportional to emissions measured over the test procedures specified in this part. For example, the benefits from technologies that reduce engine operation would generally be proportional to the engine's emission rate.

(2) Calculate separate credits based on the difference between the in-use emission rate (g/ton-mile) with the technology and the in-use emission rate without the technology. Subtract this value from your measured emission result and use this adjusted value to determine your FEL. We may also allow you to calculate the credits based on g/hp-hr emission rates. Use the separate-credit approach where good engineering judgment indicates that the actual benefit will not be proportional to emissions measured over the test procedures specified in this part.

(3) We may require you to discount or otherwise adjust your improvement factor or credit to account for uncertainty or other relevant factors.

(c) Send your request to the Designated Compliance Officer. We recommend that you do not begin collecting test data (for submission to EPA) before contacting us. For technologies for which the vehicle manufacturer could also claim credits (such as transmissions in certain circumstances), we may require you to include a letter from the vehicle manufacturer stating that it will not seek credits for the same technology. Your request must contain the following items:

(1) A detailed description of the off-cycle technology and how it functions to reduce CO_2 emissions under conditions not represented on the duty cycles required for certification.

(2) A list of the engine configurations that will be equipped with the technology.

(3) A detailed description and justification of the selected test engines.

(4) All testing and simulation data required under this section, plus any other data you have considered in your analysis. You may ask for our preliminary approval of your test plan under §1036.210.

(5) A complete description of the methodology used to estimate the off-cycle benefit of the technology and all supporting data, including engine testing and in-use activity data. Also include a statement regarding your recommendation for applying the provisions of this section for the given technology as an improvement factor or a credit.

(6) An estimate of the off-cycle benefit by engine model, and the fleetwide benefit based on projected sales of engine models equipped with the technology.

(7) A demonstration of the in-use durability of the off-cycle technology, based on any available engineering analysis or durability testing data (either by testing components or whole engines).

(d) We may seek public comment on your request, consistent with the provisions of 40 CFR 86.1869–12(d). However, we will generally not seek public comment on credits/adjustments based on A to B engine dynamometer testing, chassis testing, or in-use testing.

(e) We may approve an improvement factor or credit for any configuration that is properly represented by your testing.

(1) For model years before 2021, you may continue to use an approved improvement factor or credit for any appropriate engine families in future model years through 2020.

(2) For model years 2021 and later, you may not rely on an approval for model years before 2021. You must separately request our approval before applying an improvement factor or credit under this section for 2021 and later engines, even if we approved an improvement factor or credit for similar engine models before model year 2021. Note that approvals for model year 2021 and later may carry over for multiple years.

§1036.615 Engines with Rankine cycle waste heat recovery and hybrid powertrains.

This section specifies how to generate advanced-technology emission credits for hybrid powertrains that include energy storage systems and regenerative braking (including regenerative engine braking) and for engines that include Rankine-cycle (or other bottoming cycle) exhaust energy recovery systems. This section applies only for model year 2020 and earlier engines.

(a) *Pre-transmission hybrid powertrains.* Test pre-transmission hybrid powertrains with the hybrid engine test procedures of 40 CFR part 1065 or with the post-transmission test procedures in 40 CFR 1037.550. Pre-transmission hybrid powertrains are those engine systems that include features to recover and store energy during engine motoring operation but not from the vehicle's wheels. Engines certified with pre-transmission hybrid powertrains must be certified to meet the diagnostic requirements of 40 CFR 86.018–10 with respect to powertrain components and systems; if different manufacturers produce the engine and the hybrid powertrain, the hybrid powertrain manufacturer may separately certify its powertrain relative to diagnostic requirements.

(b) *Rankine engines.* Test engines that include Rankine-cycle exhaust energy recovery systems according to the test

procedures specified in subpart F of this part unless we approve alternate procedures.

(c) *Calculating credits.* Calculate credits as specified in subpart H of this part. Credits generated from engines and powertrains certified under this section may be used in other averaging sets as described in §1036.740(c).

(d) *Off-cycle technologies.* You may certify using both the provisions of this section and the off-cycle technology provisions of §1036.610, provided you do not double-count emission benefits.

§1036.620 Alternate CO_2 standards based on model year 2011 compression-ignition engines.

For model years 2014 through 2016, you may certify your compression-ignition engines to the CO_2 standards of this section instead of the CO_2 standards in §1036.108. However, you may not certify engines to these alternate standards if they are part of an averaging set in which you carry a balance of banked credits. You may submit applications for certifications before using up banked credits in the averaging set, but such certificates will not become effective until you have used up (or retired) your banked credits in the averaging set. For purposes of this section, you are deemed to carry credits in an averaging set if you carry credits from advanced technology that are allowed to be used in that averaging set.

(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 ramped-modal 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) This paragraph (b) applies if you do not certify all your engine families in the averaging set to the alternate standards of this section. Identify separate baseline engine families for each engine family that you are certifying to the alternate standards of this section. For an engine family to be considered the baseline engine family, it must meet the following criteria:

(1) It must have been certified to all applicable emission standards in model year 2011. If the baseline engine was certified to a NO_X FEL above the standard and incorporated the same emission control technologies as the new engine family, you may adjust the baseline CO_2 emission rate to be equivalent to an engine meeting the 0.20 g/hp-hr NO_X standard (or your higher FEL as specified in this paragraph (b)(1)), using certification results from model years 2009 through 2011, consistent with good engineering judgment.

(i) Use the following equation to relate model year 2009–2011 NO_X and CO_2 emission rates (g/hp-hr): $CO_2 = a \times \log(NO_X)+b$.

(ii) For model year 2014–2016 engines certified to NO_X FELs above 0.20 g/hp-hr, correct the baseline CO_2 emissions to the actual NO_X FELs of the 2014–2016 engines.

(iii) Calculate separate adjustments for emissions over the ramped-modal cycle and the transient cycle.

(2) The baseline configuration tested for certification must have the same engine displacement as the engines in the engine family being certified to the alternate standards, and its rated power must be within five percent of the highest rated power in the engine family being certified to the alternate standards.

(3) The model year 2011 U.S.-directed production volume of the configuration tested must be at least one percent of the total 2011 U.S.-directed production volume for the engine family.

(4) The tested configuration must have cycle-weighted BSFC equivalent to or better than all other configurations in the engine family.

(c) This paragraph (c) applies if you certify all your engine families in the primary intended service class to the alternate standards of this section. For purposes of this section, you may combine light heavy-duty and medium heavy-duty engines into a single averaging set. Determine your baseline CO_2 emission rate as the production-weighted emission rate of the certified engine families you produced in the 2011 model year. If you produce engines for both tractors and vocational vehicles, treat them as separate averaging sets. Adjust the CO_2 emission rates to be equivalent to an engine meeting the average NO_X FEL of new engines (assuming engines certified to the 0.20 g/hp-hr NO_X standard have a NO_X FEL equal to 0.20 g/hp-hr), as described in paragraph (b)(1) of this section.

(d) Include the following statement on the emission control information label: ''THIS ENGINE WAS CERTIFIED TO AN ALTERNATE CO_2 STANDARD UNDER § 1036.620.''

(e) You may not bank CO_2 emission credits for any engine family in the same averaging set and model year in which you certify engines to the standards of this section. You may not bank any advanced-technology credits in any averaging set for the model year you certify under this section (since such credits would be available for use in this averaging set). Note that the provisions of § 1036.745 apply for deficits generated with respect to the standards of this section.

(f) You need our approval before you may certify engines under this section, especially with respect to the numerical value of the alternate standards. We will not approve your request if we determine that you manipulated your engine families or test engine configurations to certify to less stringent standards, or that you otherwise have not acted in good faith. You must keep and provide to us any information we need to determine that your engine families meet the requirements of this section. Keep these records for at least five years after you stop producing engines certified under this section.

§ 1036.625 In-use compliance with family emission limits (FELs).

Section 1036.225 describes how to change the FEL for an engine family during the model year. This section, which describes how you may ask us to increase an engine family's FEL after the end of the model year, is intended to address circumstances in which it is in the public interest to apply a higher in-use FEL based on forfeiting an appropriate number of emission credits. For example, this may be appropriate where we determine that recalling vehicles would not significantly reduce in-use emissions. We will generally not allow this option where we determine the credits being forfeited would likely have expired.

(a) You may ask us to increase an engine family's FEL after the end of the model year if you believe some of your in-use engines exceed the CO_2 FEL that applied during the model year (or the CO_2 emission standard if the family did not generate or use emission credits). We may consider any available information in making our decision to approve or deny your request.

(b) If we approve your request under this section, you must apply emission credits to cover the increased FEL for all affected engines. Apply the emission credits as part of your credit demonstration for the current production year. Include the appropriate calculations in your final report under § 1036.730.

(c) Submit your request to the Designated Compliance Officer. Include the following in your request:

(1) Identify the names of each engine family that is the subject of your request. Include separate family names for different model years.

(2) Describe why your request does not apply for similar engine models or additional model years, as applicable.

(3) Identify the FEL(s) that applied during the model year and recommend a replacement FEL for in-use engines; include a supporting rationale to describe how you determined the recommended replacement FEL.

(4) Describe whether the needed emission credits will come from averaging, banking, or trading.

(d) If we approve your request, we will identify the replacement FEL. The

value we select will reflect our best judgment to accurately reflect the actual in-use performance of your engines, consistent with the testing provisions specified in this part. We may apply the higher FELs to other engine families from the same or different model years to the extent they used equivalent emission controls. We may include any appropriate conditions with our approval.

(e) If we order a recall for an engine family under 40 CFR 1068.505, we will no longer approve a replacement FEL under this section for any of your engines from that engine family, or from any other engine family that relies on equivalent emission controls.

§ 1036.630 Certification of engine GHG emissions for powertrain testing.

For engines included in powertrain families under 40 CFR part 1037, you may choose to include the corresponding engine emissions in your engine families under this part 1036 instead of (or in addition to) the otherwise applicable engine fuel maps.

(a) If you choose to certify powertrain fuel maps in an engine family, the declared powertrain emission levels become standards that apply for selective enforcement audits and in-use testing. We may require that you provide to us the engine test cycle (not normalized) corresponding to a given powertrain for each of the specified duty cycles.

(b) If you choose to certify only fuel map emissions for an engine family and to not certify emissions over powertrain test cycles under 40 CFR 1037.550, we will not presume you are responsible for emissions over the powertrain cycles. However, where we determine that you are responsible in whole or in part for the emission exceedance in such cases, we may require that you participate in any recall of the affected vehicles. Note that this provision to limit your responsibility does not apply if you also hold the certificate of conformity for the vehicle.

(c) If you split an engine family into subfamilies based on different fuel-mapping procedures as described in § 1036.230(e), the fuel-mapping procedures you identify for certifying each subfamily also apply for selective enforcement audits and in-use testing.

Subpart H—Averaging, Banking, and Trading for Certification

§ 1036.701 General provisions.

(a) You may average, bank, and trade (ABT) emission credits for purposes of certification as described in this subpart and in subpart B of this part to show compliance with the standards of § 1036.108. Participation in this program is voluntary. (Note: As described in subpart B of this part, you must assign an FCL to all engine families, whether or not they participate in the ABT provisions of this subpart.)

(b) The definitions of subpart I of this part apply to this subpart in addition to the following definitions:

(1) *Actual emission credits* means emission credits you have generated that we have verified by reviewing your final report.

(2) *Averaging set* means a set of engines in which emission credits may be exchanged. See § 1036.740.

(3) *Broker* means any entity that facilitates a trade of emission credits between a buyer and seller.

(4) *Buyer* means the entity that receives emission credits as a result of a trade.

(5) *Reserved emission credits* means emission credits you have generated that we have not yet verified by reviewing your final report.

(6) *Seller* means the entity that provides emission credits during a trade.

(7) *Standard* means the emission standard that applies under subpart B of this part for engines not participating in the ABT program of this subpart.

(8) *Trade* means to exchange emission credits, either as a buyer or seller.

(c) Emission credits may be exchanged only within an averaging set, except as specified in § 1036.740.

(d) You may not use emission credits generated under this subpart to offset any emissions that exceed an FCL or standard. This applies for all testing, including certification testing, in-use testing, selective enforcement audits, and other production-line testing. However, if emissions from an engine exceed an FCL or standard (for example,

during a selective enforcement audit), you may use emission credits to recertify the engine family with a higher FCL that applies only to future production.

(e) You may use either of the following approaches to retire or forego emission credits:

(1) You may retire emission credits generated from any number of your engines. This may be considered donating emission credits to the environment. Identify any such credits in the reports described in §1036.730. Engines must comply with the applicable FELs even if you donate or sell the corresponding emission credits under this paragraph (h). Those credits may no longer be used by anyone to demonstrate compliance with any EPA emission standards.

(2) You may certify an engine family using an FEL (FCL for CO_2) below the emission standard as described in this part and choose not to generate emission credits for that family. If you do this, you do not need to calculate emission credits for those engine families and you do not need to submit or keep the associated records described in this subpart for that family.

(f) Emission credits may be used in the model year they are generated. Surplus emission credits may be banked for future model years. Surplus emission credits may sometimes be used for past model years, as described in §1036.745.

(g) You may increase or decrease an FCL during the model year by amending your application for certification under §1036.225. The new FCL may apply only to engines you have not already introduced into commerce.

(h) See §1036.740 for special credit provisions that apply for greenhouse gas credits generated under 40 CFR 86.1819–14(k)(7) or §1036.615 or 40 CFR 1037.615.

(i) Unless the regulations explicitly allow it, you may not calculate credits more than once for any emission reduction. For example, if you generate CO_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 vehicle under 40 CFR part 1037. However, 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 only if the credit-generating engines were certified to the tractor engine standards in §1036.108 and credits were calculated relative to the tractor engine standards. You may otherwise use emission credits generated in one model year without adjustment for certifying vehicles in a later model year, even if emission standards are different.

(k) Engine families you certify with a nonconformance penalty under 40 CFR part 86, subpart L, may not generate emission credits.

§1036.705 Generating and calculating emission credits.

(a) The provisions of this section apply separately for calculating emission credits for each pollutant.

(b) For each participating family, calculate positive or negative emission credits relative to the otherwise applicable emission standard based on the engine family's FCL for greenhouse gases. If your engine family is certified to both the vocational and tractor engine standards, calculate credits separately for the vocational engines and the tractor engines (as specified in paragraph (b)(3) of this section). Calculate positive emission credits for a family that has an FCL below the standard. Calculate negative emission credits for a family that has an FCL above the standard. Sum your positive and negative credits for the model year before rounding. Round the sum of emission credits to the nearest megagram (Mg), using consistent units throughout the following equations:

(1) For vocational engines:

$$\text{Emission credits (Mg)} = (\text{Std} - \text{FCL}) \cdot (\text{CF}) \cdot (\text{Volume}) \cdot (\text{UL}) \cdot (10^{-6})$$

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 transient 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 vocational 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. This represents the average work performed by vocational engines in the family over the mileage represented by operation over the duty cycle.

Volume = the number of vocational 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.

(2) For tractor engines:

$$\text{Emission credits (Mg)} = (\text{Std} - \text{FCL}) \cdot (\text{CF}) \cdot (\text{Volume}) \cdot (\text{UL}) \cdot (10^{-6})$$

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 ramped-modal 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 ramped-modal 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.

(3) For engine families certified to both the vocational and tractor engine standards, we may allow you to use statistical methods to estimate the total production volumes where a small fraction of the engines cannot be tracked precisely.

(4) You may not generate emission credits for tractor engines (*i.e.*, engines not certified to the transient cycle for CO_2) installed in vocational vehicles (including vocational tractors certified under 40 CFR 1037.630 or exempted under 40 CFR 1037.631). We will waive this provision where you demonstrate that less than five percent of the engines in your tractor family were installed in vocational vehicles. For example, if you know that 96 percent of your tractor engines were installed in non-vocational tractors, but cannot determine the vehicle type for the remaining four percent, you may generate credits for all the engines in the family.

(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 these 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.

(c) As described in §1036.730, compliance with the requirements of this subpart is determined at the end of the model year based on actual U.S.-directed production volumes. Keep appropriate records to document these production volumes. Do not include any of the following engines to calculate emission credits:

(1) Engines that you do not certify to the CO_2 standards of this part because they are permanently exempted under subpart G of this part or under 40 CFR part 1068.

(2) Exported engines.

(3) Engines not subject to the requirements of this part, such as those excluded under §1036.5. For example, do not include engines used in vehicles certified to the greenhouse gas standards of 40 CFR 86.1819.

(4) Any other engines if we indicate elsewhere in this part 1036 that they are not to be included in the calculations of this subpart.

(d) You may use CO_2 emission credits to show compliance with CH_4 and/or N_2O FELs instead of the otherwise applicable emission standards. To do this, calculate the CH_4 and/or N_2O emission credits needed (negative credits) using the equation in paragraph (b) of this section, using the FEL(s) you specify for your engines during certification instead of the FCL. You must use 34 Mg of positive CO_2 credits to offset 1 Mg of negative CH_4 credits for model year 2021 and later engines, and you must use 25 Mg of positive CO_2 credits to offset 1 Mg of negative CH_4 credits for earlier engines. You must use 298 Mg of positive CO_2 credits to offset 1 Mg of negative N_2O credits.

§ 1036.710 Averaging.

(a) Averaging is the exchange of emission credits among your engine families. You may average emission credits only within the same averaging set, except as specified in § 1036.740.

(b) You may certify one or more engine families to an FCL above the applicable standard, subject to any applicable FEL caps and other the provisions in subpart B of this part, if you show in your application for certification that your projected balance of all emission-credit transactions in that model year is greater than or equal to zero, or that a negative balance is allowed under § 1036.745.

(c) If you certify an engine family to an FCL that exceeds the otherwise applicable standard, you must obtain enough emission credits to offset the engine family's deficit by the due date for the final report required in § 1036.730. The emission credits used to address the deficit may come from your other engine families that generate emission credits in the same model year (or from later model years as specified in § 1036.745), from emission credits you have banked, or from emission credits you obtain through trading.

§ 1036.715 Banking.

(a) Banking is the retention of surplus emission credits by the manufacturer generating the emission credits for use in future model years for averaging or trading.

(b) You may designate any emission credits you plan to bank in the reports you submit under § 1036.730 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.

(c) Reserved credits become actual emission credits when you submit your final report. However, we may revoke these emission credits if we are unable to verify them after reviewing your reports or auditing your records.

(d) Banked credits retain the designation of the averaging set in which they were generated.

§ 1036.720 Trading.

(a) Trading is the exchange of emission credits between manufacturers. You may use traded emission credits for averaging, banking, or further trading transactions. Traded emission credits remain subject to the averaging-set restrictions based on the averaging set in which they were generated.

(b) You may trade actual emission credits as described in this subpart. You may also trade reserved emission credits, but we may revoke these emission credits based on our review of your records or reports or those of the company with which you traded emission credits. You may trade banked credits within an averaging set to any certifying manufacturer.

(c) If a negative emission credit balance results from a transaction, both the buyer and seller are liable, except in cases we deem to involve fraud. See § 1036.255(e) for cases involving fraud. We may void the certificates of all engine families participating in a trade that results in a manufacturer having a negative balance of emission credits. See § 1036.745.

§ 1036.725 What must I include in my application for certification?

(a) You must declare in your application for certification your intent to use the provisions of this subpart for each engine family that will be certified using the ABT program. You must also declare the FELs/FCL you select for the engine family for each pollutant for which you are using the ABT program. Your FELs must comply with the specifications of subpart B of this

part, including the FEL caps. FELs/FCLs must be expressed to the same number of decimal places as the applicable standards.

(b) Include the following in your application for certification:

(1) A statement that, to the best of your belief, you will not have a negative balance of emission credits for any averaging set when all emission credits are calculated at the end of the year; or a statement that you will have a negative balance of emission credits for one or more averaging sets, but that it is allowed under §1036.745.

(2) Detailed calculations of projected emission credits (positive or negative) based on projected U.S.-directed production volumes. We may require you to include similar calculations from your other engine families to project your net 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.

§1036.730 ABT reports.

(a) If any of your engine families are certified using the ABT provisions of this subpart, you must send an end-of-year report by March 31 following the end of the model year and a final report by September 30 following the end of the model year. We may waive the requirement to send an end-of-year report.

(b) Your end-of-year and final reports must include the following information for each engine family participating in the ABT program:

(1) Engine-family designation and averaging set.

(2) The emission standards that would otherwise apply to the engine family.

(3) The FCL for each pollutant. If you change the FCL after the start of production, identify the date that you started using the new FCL and/or give the engine identification number for the first engine covered by the new FCL. In this case, identify each applicable FCL and calculate the positive or negative emission credits as specified in §1036.225.

(4) The projected and actual U.S.-directed production volumes for the model year. If you changed an FCL during the model year, identify the actual production volume associated with each FCL.

(5) The transient cycle conversion factor for each engine configuration as described in §1036.705.

(6) Useful life.

(7) Calculated positive or negative emission credits for the whole engine family. Identify any emission credits that you traded, as described in paragraph (d)(1) of this section.

(c) Your end-of-year and final reports must include the following additional information:

(1) Show that your net balance of emission credits from all your participating engine families in each averaging set in the applicable model year is not negative, except as allowed under §1036.745. Your credit tracking must account for the limitation on credit life under §1036.740(d).

(2) State whether you will reserve any emission credits for banking.

(3) State that the report's contents are accurate.

(d) If you trade emission credits, you must send us a report within 90 days after the transaction, as follows:

(1) As the seller, you must include the following information in your report:

(i) The corporate names of the buyer and any brokers.

(ii) A copy of any contracts related to the trade.

(iii) The averaging set corresponding to the engine families that generated emission credits for the trade, including the number of emission credits from each averaging set.

(2) As the buyer, you must include the following information in your report:

(i) The corporate names of the seller and any brokers.

(ii) A copy of any contracts related to the trade.

(iii) How you intend to use the emission credits, including the number of emission credits you intend to apply for each averaging set.

(e) Send your reports electronically to the Designated Compliance Officer using an approved information format. If you want to use a different format,

send us a written request with justification for a waiver.

(f) Correct errors in your end-of-year or final report as follows:

(1) You may correct any errors in your end-of-year report when you prepare the final report, as long as you send us the final report by the time it is due.

(2) If you or we determine within 270 days after the end of the model year that errors mistakenly decreased your balance of emission credits, you may correct the errors and recalculate the balance of emission credits. You may not make these corrections for errors that are determined more than 270 days after the end of the model year. If you report a negative balance of emission credits, we may disallow corrections under this paragraph (f)(2).

(3) If you or we determine any time that errors mistakenly increased your balance of emission credits, you must correct the errors and recalculate the balance of emission credits.

§ 1036.735 Recordkeeping.

(a) You must organize and maintain your records as described in this section. We may review your records at any time.

(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 if you do not keep all the records required under this section. You must therefore keep these records to continue to bank valid credits. Store these records in any format and on any media, as long as you can promptly send us organized, written records in English if we ask for them. You must keep these records readily available. We may review them at any time.

(c) Keep a copy of the reports we require in §§ 1036.725 and 1036.730.

(d) Keep records of the engine identification number (usually the serial number) for each engine you produce that generates or uses emission credits under the ABT program. You may identify these numbers as a range. If you change the FEL after the start of production, identify the date you started using each FCL and the range of engine identification numbers associated with each FCL. You must also identify the purchaser and destination for each engine you produce to the extent this information is available.

(e) We may require you to keep additional records or to send us relevant information not required by this section in accordance with the Clean Air Act.

§ 1036.740 Restrictions for using emission credits.

The following restrictions apply for using emission credits:

(a) *Averaging sets.* Except as specified in paragraph (c) of this section, emission credits may be exchanged only within the following averaging sets:

(1) Engines subject to spark-ignition standards.

(2) Light heavy-duty engines subject to compression-ignition standards.

(3) Medium heavy-duty engines subject to compression-ignition standards.

(4) Heavy heavy-duty engines.

(b) *Applying credits to prior year deficits.* Where your credit balance for the previous year is negative, you may apply credits to that credit deficit only after meeting your credit obligations for the current year.

(c) *Credits from hybrid engines and other advanced technologies.* Credits you generate under § 1036.615 may be used for any of the averaging sets identified in paragraph (a) of this section; you may also use those credits to demonstrate compliance with the CO_2 emission standards in 40 CFR 86.1819 and 40 CFR part 1037. Similarly, you may use Phase 1 advanced-technology credits generated under 40 CFR 86.1819–14(k)(7) or 40 CFR 1037.615 to demonstrate compliance with the CO_2 standards in this part. In the case of engines subject to spark-ignition standards and compression-ignition light heavy-duty engines, you may not use more than 60,000 Mg of credits from other averaging sets in any model year.

(1) The maximum amount of CO_2 credits you may bring into the following service class groups is 60,000 Mg per model year:

(i) Engines subject to spark-ignition standards, light heavy-duty compression-ignition engines, and light heavy-duty vehicles. This group comprises the averaging sets listed in paragraphs (a)(1) and (2) of this section and the

averaging set listed in 40 CFR 1037.740(a)(1).

(ii) Medium heavy-duty engines subject to compression-ignition standards and medium heavy-duty vehicles. This group comprises the averaging sets listed in paragraph (a)(3) of this section and 40 CFR 1037.740(a)(2).

(iii) Heavy heavy-duty engines subject to compression-ignition standards and heavy heavy-duty vehicles. This group comprises the averaging sets listed in paragraph (a)(4) of this section and 40 CFR 1037.740(a)(3).

(2) Paragraph (c)(1) of this section does not limit the advanced-technology credits that can be used within a service class group if they were generated in that same service class group.

(d) *Credit life.* Credits may be used only for five model years after the year in which they are generated. For example, credits you generate in model year 2018 may be used to demonstrate compliance with emission standards only through model year 2023.

(e) *Other restrictions.* Other sections of this part specify additional restrictions for using emission credits under certain special provisions.

§ 1036.745 End-of-year CO_2 credit deficits.

Except as allowed by this section, we may void the certificate of any engine family certified to an FCL above the applicable standard for which you do not have sufficient credits by the deadline for submitting the final report.

(a) Your certificate for an engine family for which you do not have sufficient CO_2 credits will not be void if you remedy the deficit with surplus credits within three model years. For example, if you have a credit deficit of 500 Mg for an engine family at the end of model year 2015, you must generate (or otherwise obtain) a surplus of at least 500 Mg in that same averaging set by the end of model year 2018.

(b) You may not bank or trade away CO_2 credits in the averaging set in any model year in which you have a deficit.

(c) You may apply only surplus credits to your deficit. You may not apply credits to a deficit from an earlier model year if they were generated in a model year for which any of your engine families for that averaging set had an end-of-year credit deficit.

(d) You must notify us in writing how you plan to eliminate the credit deficit within the specified time frame. If we determine that your plan is unreasonable or unrealistic, we may deny an application for certification for a vehicle family if its FEL would increase your credit deficit. We may determine that your plan is unreasonable or unrealistic based on a consideration of past and projected use of specific technologies, the historical sales mix of your vehicle models, your commitment to limit production of higher-emission vehicles, and expected access to traded credits. We may also consider your plan unreasonable if your credit deficit increases from one model year to the next. We may require that you send us interim reports describing your progress toward resolving your credit deficit over the course of a model year.

(e) If you do not remedy the deficit with surplus credits within three model years, we may void your certificate for that engine family. We may void the certificate based on your end-of-year report. Note that voiding a certificate applies *ab initio*. Where the net deficit is less than the total amount of negative credits originally generated by the family, we will void the certificate only with respect to the number of engines needed to reach the amount of the net deficit. For example, if the original engine family generated 500 Mg of negative credits, and the manufacturer's net deficit after three years was 250 Mg, we would void the certificate with respect to half of the engines in the family.

(f) For purposes of calculating the statute of limitations, the following actions are all considered to occur at the expiration of the deadline for offsetting a deficit as specified in paragraph (a) of this section:

(1) Failing to meet the requirements of paragraph (a) of this section.

(2) Failing to satisfy the conditions upon which a certificate was issued relative to offsetting a deficit.

(3) Selling, offering for sale, introducing or delivering into U.S. commerce, or importing vehicles that are found not to be covered by a certificate as a result of failing to offset a deficit.

§ 1036.750 What can happen if I do not comply with the provisions of this subpart?

(a) For each engine family participating in the ABT program, the certificate of conformity is conditioned upon full compliance with the provisions of this subpart during and after the model year. You are responsible to establish to our satisfaction that you fully comply with applicable requirements. We may void the certificate of conformity for an engine family if you fail to comply with any provisions of this subpart.

(b) You may certify your engine family to an FCL above an applicable standard based on a projection that you will have enough emission credits to offset the deficit for the engine family. See §1036.745 for provisions specifying what happens if you cannot show in your final report that you have enough actual emission credits to offset a deficit for any pollutant in an engine family.

(c) We may void the certificate of conformity for an engine family if you fail to keep records, send reports, or give us information we request. Note that failing to keep records, send reports, or give us information we request is also a violation of 42 U.S.C. 7522(a)(2).

(d) You may ask for a hearing if we void your certificate under this section (see §1036.820).

§ 1036.755 Information provided to the Department of Transportation.

After receipt of each manufacturer's final report as specified in §1036.730 and completion of any verification testing required to validate the manufacturer's submitted final data, we will issue a report to the Department of Transportation with CO_2 emission information and will verify the accuracy of each manufacturer's equivalent fuel consumption data that required by NHTSA under 49 CFR 535.8. We will send a report to DOT for each engine manufacturer based on each regulatory category and subcategory, including sufficient information for NHTSA to determine fuel consumption and associated credit values. See 49 CFR 535.8 to determine if NHTSA deems submission of this information to EPA to also be a submission to NHTSA.

Subpart I—Definitions and Other Reference Information

§ 1036.801 Definitions.

The following definitions apply to this part. The definitions apply to all subparts unless we note otherwise. All undefined terms have the meaning the Act gives to them. The definitions follow:

Act means the Clean Air Act, as amended, 42 U.S.C. 7401—7671q.

Adjustable parameter has the meaning given in 40 CFR part 86.

Advanced technology means technology certified under 40 CFR 86.1819–14(k)(7), §1036.615, or 40 CFR 1037.615.

Aftertreatment means relating to a catalytic converter, particulate filter, or any other system, component, or technology mounted downstream of the exhaust valve (or exhaust port) whose design function is to decrease emissions in the engine exhaust before it is exhausted to the environment. Exhaust gas recirculation (EGR) and turbochargers are not aftertreatment.

Aircraft means any vehicle capable of sustained air travel more than 100 feet above the ground.

Alcohol-fueled engine mean an engine that is designed to run using an alcohol fuel. For purposes of this definition, alcohol fuels do not include fuels with a nominal alcohol content below 25 percent by volume.

Auxiliary emission control device means any element of design that senses temperature, motive speed, engine rpm, 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.

Averaging set has the meaning given in §1036.740.

Calibration means the set of specifications and tolerances specific to a particular design, version, or application of a component or assembly capable of functionally describing its operation over its working range.

Carryover means relating to certification based on emission data generated from an earlier model year as described in §1036.235(d).

Certification means relating to the process of obtaining a certificate of conformity for an engine family that

complies with the emission standards and requirements in this part.

Certified emission level means the highest deteriorated emission level in an engine family for a given pollutant from the applicable transient and/or steady-state testing, rounded to the same number of decimal places as the applicable standard. Note that you may have two certified emission levels for CO_2 if you certify a family for both vocational and tractor use.

Complete vehicle means a vehicle meeting the definition of complete vehicle in 40 CFR 1037.801 when it is first sold as a vehicle. For example, where a vehicle manufacturer sells an incomplete vehicle to a secondary vehicle manufacturer, the vehicle is not a complete vehicle under this part, even after its final assembly.

Compression-ignition means relating to a type of reciprocating, internal-combustion engine that is not a spark-ignition engine. Note that §1036.1 also deems gas turbine engines and other engines to be compression-ignition engines.

Crankcase emissions means airborne substances emitted to the atmosphere from any part of the engine crankcase's ventilation or lubrication systems. The crankcase is the housing for the crankshaft and other related internal parts.

Criteria pollutants means emissions of NO_X, HC, PM, and CO. Note that these pollutants are also sometimes described collectively as ''non-greenhouse gas pollutants'', although they do not necessarily have negligible global warming potentials.

Designated Compliance Officer means one of the following:

(1) For engines subject to compression-ignition standards, *Designated Compliance Officer* means Director, Diesel Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *complianceinfo@epa.gov*; *epa.gov/otaq/verify*.

(2) For engines subject to spark-ignition standards, *Designated Compliance Officer* means Director, Gasoline Engine Compliance Center, U.S. Environmental Protection Agency, 2000 Traverwood Drive, Ann Arbor, MI 48105; *nonroad-si-cert@epa.gov*; *epa.gov/otaq/verify*.

Deteriorated emission level means the emission level that results from applying the appropriate deterioration factor to the official emission result of the emission-data engine. Note that where no deterioration factor applies, references in this part to the *deteriorated emission level* mean the official emission result.

Deterioration factor means the relationship between emissions at the end of useful life (or point of highest emissions if it occurs before the end of useful life) and emissions at the low-hour/low-mileage test point, expressed in one of the following ways:

(1) For multiplicative deterioration factors, the ratio of emissions at the end of useful life (or point of highest emissions) to emissions at the low-hour test point.

(2) For additive deterioration factors, the difference between emissions at the end of useful life (or point of highest emissions) and emissions at the low-hour test point.

Diesel exhaust fluid (DEF) means a liquid reducing agent (other than the engine fuel) used in conjunction with selective catalytic reduction to reduce NO_X emissions. *Diesel exhaust fluid* is generally understood to be an aqueous solution of urea conforming to the specifications of ISO 22241.

Dual-fuel means relating to an engine designed for operation on two different types of fuel but not on a continuous mixture of those fuels (see §1036.601(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.

Emission control system means any device, system, or element of design that controls or reduces the emissions of regulated pollutants from an engine.

Emission-data engine means an engine that is tested for certification. This includes engines tested to establish deterioration factors.

Emission-related maintenance means maintenance that substantially affects emissions or is likely to substantially affect emission deterioration.

Engine configuration means a unique combination of engine hardware and calibration (related to the emission

standards) within an engine family. Engines within a single engine configuration differ only with respect to normal production variability or factors unrelated to compliance with emission standards.

Engine family has the meaning given in §1036.230.

Excluded means relating to engines that are not subject to some or all of the requirements of this part as follows:

(1) An engine that has been determined not to be a heavy-duty engine is excluded from this part.

(2) Certain heavy-duty engines are excluded from the requirements of this part under §1036.5.

(3) Specific regulatory provisions of this part may exclude a heavy-duty engine generally subject to this part from one or more specific standards or requirements of this part.

Exempted has the meaning given in 40 CFR 1068.30.

Exhaust gas recirculation means a technology that reduces emissions by routing exhaust gases that had been exhausted from the combustion chamber(s) back into the engine to be mixed with incoming air before or during combustion. The use of valve timing to increase the amount of residual exhaust gas in the combustion chamber(s) that is mixed with incoming air before or during combustion is not considered exhaust gas recirculation for the purposes of this part.

Family certification level (FCL) means a CO_2 emission level declared by the manufacturer that is at or above emission test results for all emission-data engines. The FCL serves as the emission standard for the engine family with respect to certification testing if it is different than the otherwise applicable standard. The FCL must be expressed to the same number of decimal places as the emission standard it replaces.

Family emission limit (FEL) means an emission level declared by the manufacturer to serve in place of an otherwise applicable emission standard (other than CO_2 standards) under the ABT program in subpart H of this part. The FEL must be expressed to the same number of decimal places as the emission standard it replaces. The FEL serves as the emission standard for the engine family with respect to all required testing except certification testing for CO_2. The CO_2 FEL is equal to the CO_2 FCL multiplied by 1.03 and rounded to the same number of decimal places as the standard (*e.g.*, the nearest whole g/hp-hr for the 2016 CO_2 standards).

Flexible-fuel means relating to an engine designed for operation on any mixture of two or more different types of fuels (see §1036.601(d)).

Fuel type means a general category of fuels such as diesel fuel, gasoline, or natural gas. There can be multiple grades within a single fuel type, such as premium gasoline, regular gasoline, or gasoline with 10 percent ethanol.

Good engineering judgment has the meaning given in 40 CFR 1068.30. See 40 CFR 1068.5 for the administrative process we use to evaluate good engineering judgment.

Greenhouse gas means one or more compounds regulated under this part based primarily on their impact on the climate. This generally includes CO_2, CH_4, and N_2O.

Greenhouse gas Emissions Model (GEM) means the GEM simulation tool described in 40 CFR 1037.520. Note that an updated version of GEM applies starting in model year 2021.

Gross vehicle weight rating (GVWR) means the value specified by the vehicle manufacturer as the maximum design loaded weight of a single vehicle, consistent with good engineering judgment.

Heavy-duty engine means any engine which the engine manufacturer could reasonably expect to be used for motive power in a heavy-duty vehicle. For purposes of this definition in this part, the term ''engine'' includes internal combustion engines and other devices that convert chemical fuel into motive power. For example, a fuel cell or a gas turbine used in a heavy-duty vehicle is a heavy-duty engine.

Heavy-duty vehicle means any motor vehicle above 8,500 pounds GVWR or that has a vehicle curb weight above 6,000 pounds or that has 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 relating to 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 powertrains intended for vehicles that include regenerative braking different than those intended for vehicles that do not include regenerative braking.

Hydrocarbon (HC) means the hydrocarbon group on which the emission standards are based for each fuel type. For alcohol-fueled engines, HC means nonmethane hydrocarbon equivalent (NMHCE). For all other engines, HC means nonmethane hydrocarbon (NMHC).

Identification number means a unique specification (for example, a model number/serial number combination) that allows someone to distinguish a particular engine from other similar engines.

Incomplete vehicle means a vehicle meeting the definition of incomplete vehicle in 40 CFR 1037.801 when it is first sold (or otherwise delivered to another entity) as a vehicle.

Innovative technology means technology certified under §1036.610 (also described as ''off-cycle technology'').

Liquefied petroleum gas (LPG) means a liquid hydrocarbon fuel that is stored under pressure and is composed primarily of nonmethane compounds that are gases at atmospheric conditions. Note that, although this commercial term includes the word ''petroleum'', LPG is not considered to be a petroleum fuel under the definitions of this section.

Low-hour means relating to an engine that has stabilized emissions and represents the undeteriorated emission level. This would generally involve less than 125 hours of operation.

Manufacture means the physical and engineering process of designing, constructing, and/or assembling a heavy-duty engine or a heavy-duty vehicle.

Manufacturer has the meaning given in section 216(1) of the Act. In general, this term includes any person who manufactures or assembles an engine, vehicle, or piece of equipment for sale in the United States or otherwise introduces a new engine into commerce in the United States. This includes importers who import engines or vehicles for resale.

Medium-duty passenger vehicle has the meaning given in 40 CFR 86.1803.

Model year means the manufacturer's annual new model production period, except as restricted under this definition. 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. Manufacturers may not adjust model years to circumvent or delay compliance with emission standards or to avoid the obligation to certify annually.

Motor vehicle has the meaning given in 40 CFR 85.1703.

Natural gas means a fuel whose primary constituent is methane.

New motor vehicle engine has the meaning given in the Act. This generally means a motor vehicle engine meeting the criteria of either paragraph (1), (2), or (3) of this definition.

(1) A motor vehicle engine for which the ultimate purchaser has never received the equitable or legal title is a n*ew motor vehicle engine.* This kind of engine might commonly be thought of as ''brand new'' although a *new motor vehicle engine* may include previously used parts. Under this definition, the engine is new from the time it is produced until the ultimate purchaser receives the title or places it into service, whichever comes first.

(2) An imported motor vehicle engine is a *new motor vehicle engine* if it was originally built on or after January 1, 1970.

(3) Any motor vehicle engine installed in a new motor vehicle.

Noncompliant engine means an engine that was originally covered by a certificate of conformity, but is not in the certified configuration or otherwise does not comply with the conditions of the certificate.

Nonconforming engine means an engine not covered by a certificate of conformity that would otherwise be subject to emission standards.

Nonmethane hydrocarbon (NMHC) means the sum of all hydrocarbon species except methane, as measured according to 40 CFR part 1065.

Nonmethane hydrocarbon equivalent (NMHCE) has the meaning given in 40 CFR 1065.1001.

Off-cycle technology means technology certified under §1036.610 (also described as ''innovative technology'').

Official emission result means the measured emission rate for an emission-data engine on a given duty cycle before the application of any deterioration factor, but after the applicability of any required regeneration or other adjustment factors.

Owners manual means a document or collection of documents prepared by the engine or vehicle manufacturer for the owner or operator to describe appropriate engine maintenance, applicable warranties, and any other information related to operating or keeping the engine. The owners manual is typically provided to the ultimate purchaser at the time of sale. The owners manual may be in paper or electronic format.

Oxides of nitrogen has the meaning given in 40 CFR 1065.1001.

Percent has the meaning given in 40 CFR 1065.1001. Note that this means percentages identified in this part are assumed to be infinitely precise without regard to the number of significant figures. For example, one percent of 1,493 is 14.93.

Placed into service means put into initial use for its intended purpose, excluding incidental use by the manufacturer or a dealer.

Preliminary approval means approval granted by an authorized EPA representative prior to submission of an application for certification, consistent with the provisions of §1036.210.

Primary intended service class has the meaning given in §1036.140.

Rechargeable Energy Storage System (RESS) means the component(s) of a hybrid engine or vehicle that store recovered energy for later use, such as the battery system in an electric hybrid vehicle.

Relating to as used in this section means relating to something in a specific, direct manner. This expression is used in this section only to define terms as adjectives and not to broaden the meaning of the terms.

Revoke has the meaning given in 40 CFR 1068.30.

Round has the meaning given in 40 CFR 1065.1001.

Scheduled maintenance means adjusting, repairing, removing, disassembling, cleaning, or replacing components or systems periodically to keep a part or system from failing, malfunctioning, or wearing prematurely. It also may mean actions you expect are necessary to correct an overt indication of failure or malfunction for which periodic maintenance is not appropriate.

Small manufacturer means a manufacturer meeting the criteria specified in 13 CFR 121.201. The employee and revenue limits apply to the total number of employees and total revenue together for affiliated companies. Note that manufacturers with low production volumes may or may not be ''small manufacturers''.

Spark-ignition means relating to a gasoline-fueled engine or any other type of engine with a spark plug (or other sparking device) and with operating characteristics significantly similar to the theoretical Otto combustion cycle. Spark-ignition engines usually use a throttle to regulate intake air flow to control power during normal operation.

Steady-state has the meaning given in 40 CFR 1065.1001.

Suspend has the meaning given in 40 CFR 1068.30.

Test engine means an engine in a test sample.

Test sample means the collection of engines selected from the population of an engine family for emission testing. This may include testing for certification, production-line testing, or in-use testing.

Tractor means a vehicle meeting the definition of ''tractor'' in 40 CFR 1037.801, but not classified as a ''vocational tractor'' under 40 CFR 1037.630, or relating to such a vehicle.

Tractor engine means an engine certified for use in tractors. Where an engine family is certified for use in both tractors and vocational vehicles, ''tractor engine'' means an engine that the engine manufacturer reasonably

believes will be (or has been) installed in a tractor. Note that the provisions of this part may require a manufacturer to document how it determines that an engine is a tractor engine.

Ultimate purchaser means, with respect to any new engine or vehicle, the first person who in good faith purchases such new engine or vehicle for purposes other than resale.

United States has the meaning given in 40 CFR 1068.30.

Upcoming model year means for an engine family the model year after the one currently in production.

U.S.-directed production volume means the number of engines, subject to the requirements of this part, produced by a manufacturer for which the manufacturer has a reasonable assurance that sale was or will be made to ultimate purchasers in the United States. This does not include engines certified to state emission standards that are different than the emission standards in this part.

Vehicle has the meaning given in 40 CFR 1037.801.

Vocational engine means an engine certified for use in vocational vehicles. Where an engine family is certified for use in both tractors and vocational vehicles, ''vocational engine'' means an engine that the engine manufacturer reasonably believes will be (or has been) installed in a vocational vehicle. Note that the provisions of this part may require a manufacturer to document how it determines that an engine is a vocational engine.

Vocational vehicle means a vehicle meeting the definition of ''vocational'' vehicle in 40 CFR 1037.801.

Void has the meaning given in 40 CFR 1068.30.

We (us, our) means the Administrator of the Environmental Protection Agency and any authorized representatives.

§ 1036.805 Symbols, abbreviations, and acronyms.

The procedures in this part generally follow either the International System of Units (SI) or the United States customary units, as detailed in NIST Special Publication 811 (incorporated by reference in §1036.810). See 40 CFR 1065.20 for specific provisions related to these conventions. This section summarizes the way we use symbols, units of measure, and other abbreviations.

(a) *Symbols for chemical species.* This part uses the following symbols for chemical species and exhaust constituents:

Symbol	Species
C	carbon.
CH_4	methane.
CH_4N_2O	urea.
CO	carbon monoxide.
CO_2	carbon dioxide.
H_2O	water.
HC	hydrocarbon.
NMHC	nonmethane hydrocarbon.
NMHCE	nonmethane hydrocarbon equivalent.
NO	nitric oxide.
NO_2	nitrogen dioxide.
NO_X	oxides of nitrogen.
N_2O	nitrous oxide.
PM	particulate matter.

(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
a	atomic hydrogen-to-carbon ratio	mole per mole	mol/mol	1.
b	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.
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	$\pi \cdot 30 \cdot s^{-1}$.
i	indexing variable.			
k_a	drive axle ratio.			
$k_{topgear}$	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.

Symbol	Quantity	Unit	Unit symbol	Unit in terms of SI base units
$M_{rotating}$	inertial mass of rotating components.	kilogram	kg	kg.
N	total number in a series.			
P	power	kilowatt	kW	$10^3 \cdot m^2 \cdot kg \cdot s^{-3}$.
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 to define a quantity:

Superscript	Quantity
overbar (such as $\bar{y}$)	arithmetic mean.
overdot overdot (such as $\dot{y}$)	quantity per unit time.

(d) *Subscripts.* This part uses the following subscripts to define a quantity:

Subscript	Quantity
65	65 miles per hour.
A	A speed.
acc	accessory.
app	approved.
axle	axle.
B	B speed.
C	C speed.
Ccombdry	carbon from fuel per mole of dry exhaust.
CD	charge-depleting.
CO2DEF	CO_2 resulting from diesel exhaust fluid decomposition.
comb	combustion.
cor	corrected.
CS	charge-sustaining.
cycle	test cycle.
DEF	diesel exhaust fluid.
engine	engine.
exh	raw exhaust.
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.
record	record.
ref	reference quantity.
speed	speed.
stall	stall.
test	test.
tire	tire.
transient	transient.
vehicle	vehicle.

(e) *Other acronyms and abbreviations.* This part uses the following additional abbreviations and acronyms:

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
CS charge-sustaining
DF deterioration factor
DOT Department of Transportation
E85 gasoline blend including nominally 85 percent denatured ethanol
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
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

rpm revolutions per minute
SCR Selective catalytic reduction
SI spark ignition
U.S. United States
U.S.C. United States Code

(f) *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}

[81 FR 74011, Oct. 25, 2016; 82 FR 29761, June 30, 2017]

§ 1036.810 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 U.S. EPA, Air and Radiation Docket and Information Center, 1301 Constitution Ave., NW., Room B102, EPA West Building, Washington, DC 20460, (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 *http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html*.

(b) American Society for Testing and Materials, 100 Barr Harbor Drive, P.O. Box C700, West Conshohocken, PA, 19428–2959, (877) 909–2786, *http://www.astm.org/*.

(1) 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).

(2) [Reserved]

(c) 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]

§ 1036.815 Confidential information.

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

§ 1036.820 Requesting a hearing.

(a) You may request a hearing under certain circumstances, as described elsewhere in this part. To do this, you must file a written request, including a description of your objection and any supporting data, within 30 days after we make a decision.

(b) For a hearing you request under the provisions of this part, we will approve your request if we find that your request raises a substantial factual issue.

(c) If we agree to hold a hearing, we will use the procedures specified in 40 CFR part 1068, subpart G.

§ 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. You are expected to keep your own copy of required records rather than relying on someone else to keep records on your behalf. We may review these records at any time. You must promptly send us organized, written records in English if we ask for them. We may require you to submit written records in an electronic format.

(b) The regulations in § 1036.255 and 40 CFR 1068.25 and 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 §1036.801).

(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. Keep these records for eight years unless the regulations specify a different period. We may require you to send us these records whether or not you are a certificate holder.

(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 vehicles regulated under this part:

(1) We specify the following requirements related to engine certification in this part 1036:

(i) In §1036.135 we require engine manufacturers to keep certain records related to duplicate labels sent to vehicle manufacturers.

(ii) In §1036.150 we include various reporting and recordkeeping requirements related to interim provisions.

(iii) In subpart C of this part we identify a wide range of information required to certify engines.

(iv) 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.

(v) In §§1036.725, 1036.730, and 1036.735 we specify certain records related to averaging, banking, and trading.

(2) 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.

(3) 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 vehicle 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.

APPENDIX I TO PART 1036 — DEFAULT ENGINE FUEL MAPS FOR §1036.540

This appendix includes default steady-state fuel maps for performing cycle-average engine fuel mapping as described in §§1036.535 and 1036.540.

(a) Use the following default fuel map for compression-ignition engines that will be installed in Tractors and Vocational Heavy HDV:

Engine speed (r/min)	Engine torque (N·m)	Fuel mass rate (g/sec)
666.7	0	0.436
833.3	0	0.665
1000	0	0.94
1166.7	0	1.002
1333.3	0	1.17
1500	0	1.5
1666.7	0	1.899
1833.3	0	2.378
2000	0	2.93
2166.7	0	3.516
2333.3	0	4.093
2500	0	4.672
500	300	0.974
666.7	300	1.405
833.3	300	1.873
1000	300	2.324
1166.7	300	2.598
1333.3	300	2.904
1500	300	3.397
1666.7	300	3.994
1833.3	300	4.643
2000	300	5.372
2166.7	300	6.141
2333.3	300	7.553
2500	300	8.449
500	600	1.723
666.7	600	2.391
833.3	600	3.121
1000	600	3.756
1166.7	600	4.197
1333.3	600	4.776
1500	600	5.492
1666.7	600	6.277
1833.3	600	7.129
2000	600	8.069
2166.7	600	9.745
2333.3	600	11.213
2500	600	12.59
500	900	2.637
666.7	900	3.444
833.3	900	4.243
1000	900	4.997
1166.7	900	5.802
1333.3	900	6.702
1500	900	7.676
1666.7	900	8.7
1833.3	900	9.821
2000	900	11.08
2166.7	900	13.051
2333.3	900	15.002
2500	900	16.862
500	1200	3.833
666.7	1200	4.679
833.3	1200	5.535
1000	1200	6.519
1166.7	1200	7.603
1333.3	1200	8.735
1500	1200	9.948
1666.7	1200	11.226
1833.3	1200	12.622
2000	1200	14.228
2166.7	1200	16.488
2333.3	1200	18.921
2500	1200	21.263
500	1500	6.299
666.7	1500	6.768
833.3	1500	6.95
1000	1500	8.096
1166.7	1500	9.399
1333.3	1500	10.764
1500	1500	12.238
1666.7	1500	13.827
1833.3	1500	15.586
2000	1500	17.589
2166.7	1500	20.493
2333.3	1500	23.366
2500	1500	26.055
500	1800	9.413
666.7	1800	9.551
833.3	1800	8.926
1000	1800	9.745
1166.7	1800	11.26
1333.3	1800	12.819
1500	1800	14.547
1666.7	1800	16.485
1833.3	1800	18.697
2000	1800	21.535
2166.7	1800	24.981
2333.3	1800	28.404
2500	1800	31.768
500	2100	13.128
666.7	2100	12.936
833.3	2100	12.325
1000	2100	11.421
1166.7	2100	13.174
1333.3	2100	14.969
1500	2100	16.971
1666.7	2100	19.274
1833.3	2100	22.09
2000	2100	25.654
2166.7	2100	29.399
2333.3	2100	32.958
2500	2100	36.543
500	2400	17.446
666.7	2400	16.922
833.3	2400	15.981
1000	2400	14.622
1166.7	2400	15.079
1333.3	2400	17.165
1500	2400	19.583
1666.7	2400	22.408
1833.3	2400	25.635
2000	2400	29.22
2166.7	2400	33.168
2333.3	2400	37.233
2500	2400	41.075
500	2700	22.365
666.7	2700	21.511
833.3	2700	20.225
1000	2700	17.549
1166.7	2700	17.131
1333.3	2700	19.588
1500	2700	22.514
1666.7	2700	25.574
1833.3	2700	28.909
2000	2700	32.407
2166.7	2700	36.18
2333.3	2700	40.454
2500	2700	44.968
500	3000	27.476
666.7	3000	22.613
833.3	3000	19.804
1000	3000	17.266
1166.7	3000	19.197
1333.3	3000	22.109
1500	3000	25.288
1666.7	3000	28.44
1833.3	3000	31.801
2000	3000	35.405
2166.7	3000	39.152
2333.3	3000	42.912
2500	3000	47.512

(b) Use the following default fuel map for compression-ignition engines that will be installed in Vocational Light HDV and Medium HDV:

Engine speed (r/min)	Engine torque (N·m)	Fuel mass rate (g/sec)
708.3	0	0.255
916.7	0	0.263
1125	0	0.342
1333.3	0	0.713
1541.7	0	0.885
1750	0	1.068
1958.3	0	1.27
2166.7	0	1.593
2375	0	1.822
2583.3	0	2.695
2791.7	0	4.016
3000	0	5.324
500	120	0.515
708.3	120	0.722
916.7	120	0.837
1125	120	1.097
1333.3	120	1.438
1541.7	120	1.676
1750	120	1.993
1958.3	120	2.35
2166.7	120	2.769
2375	120	3.306
2583.3	120	4.004
2791.7	120	4.78
3000	120	5.567
500	240	0.862
708.3	240	1.158
916.7	240	1.462
1125	240	1.85
1333.3	240	2.246
1541.7	240	2.603
1750	240	3.086
1958.3	240	3.516
2166.7	240	4.093
2375	240	4.726
2583.3	240	5.372
2791.7	240	6.064
3000	240	6.745
500	360	1.221
708.3	360	1.651
916.7	360	2.099
1125	360	2.62
1333.3	360	3.116
1541.7	360	3.604
1750	360	4.172
1958.3	360	4.754
2166.7	360	5.451
2375	360	6.16
2583.3	360	7.009
2791.7	360	8.007
3000	360	8.995
500	480	1.676
708.3	480	2.194
916.7	480	2.76
1125	480	3.408
1333.3	480	4.031
1541.7	480	4.649
1750	480	5.309
1958.3	480	6.052
2166.7	480	6.849
2375	480	7.681
2583.3	480	8.783
2791.7	480	10.073
3000	480	11.36
500	600	2.147
708.3	600	2.787
916.7	600	3.478
1125	600	4.227
1333.3	600	4.999
1541.7	600	5.737
1750	600	6.511
1958.3	600	7.357
2166.7	600	8.289
2375	600	9.295
2583.3	600	10.541
2791.7	600	11.914
3000	600	13.286
500	720	2.744
708.3	720	3.535
916.7	720	4.356
1125	720	5.102
1333.3	720	5.968
1541.7	720	6.826
1750	720	7.733
1958.3	720	8.703
2166.7	720	9.792
2375	720	10.984
2583.3	720	12.311
2791.7	720	13.697
3000	720	15.071
500	840	3.518
708.3	840	4.338
916.7	840	5.186
1125	840	6.063
1333.3	840	6.929
1541.7	840	7.883
1750	840	8.94
1958.3	840	10.093
2166.7	840	11.329
2375	840	12.613
2583.3	840	13.983
2791.7	840	15.419
3000	840	16.853
500	960	4.251
708.3	960	5.098
916.7	960	5.974
1125	960	6.917
1333.3	960	7.889
1541.7	960	8.913
1750	960	10.152
1958.3	960	11.482
2166.7	960	12.87
2375	960	14.195
2583.3	960	15.562
2791.7	960	16.995
3000	960	18.492
500	1080	4.978
708.3	1080	5.928
916.7	1080	6.877
1125	1080	7.827
1333.3	1080	8.838
1541.7	1080	9.91
1750	1080	11.347
1958.3	1080	12.85
2166.7	1080	14.398
2375	1080	15.745
2583.3	1080	17.051
2791.7	1080	18.477
3000	1080	19.971
500	1200	5.888
708.3	1200	6.837
916.7	1200	7.787
1125	1200	8.736
1333.3	1200	9.786
1541.7	1200	10.908
1750	1200	12.541
1958.3	1200	14.217
2166.7	1200	15.925
2375	1200	17.3

Engine speed (r/min)	Engine torque (N·m)	Fuel mass rate (g/sec)
2583.3	1200	18.606
2791.7	1200	19.912
3000	1200	21.357

(c) Use the following default fuel map for all spark-ignition engines:

Engine speed (r/min)	Engine torque (N·m)	Fuel mass rate (g/sec)
875	0	0.535
1250	0	0.734
1625	0	0.975
2000	0	1.238
2375	0	1.506
2750	0	1.772
3125	0	2.07
3500	0	2.394
3875	0	2.795
4250	0	3.312
4625	0	3.349
5000	0	3.761
500	65	0.458
875	65	0.759
1250	65	1.065
1625	65	1.43
2000	65	1.812
2375	65	2.22
2750	65	2.65
3125	65	3.114
3500	65	3.646
3875	65	4.225
4250	65	4.861
4625	65	5.328
5000	65	6.028
500	130	0.666
875	130	1.063
1250	130	1.497
1625	130	1.976
2000	130	2.469
2375	130	3.015
2750	130	3.59
3125	130	4.218
3500	130	4.9
3875	130	5.652
4250	130	6.484
4625	130	7.308
5000	130	8.294
500	195	0.856
875	195	1.377
1250	195	1.923
1625	195	2.496
2000	195	3.111
2375	195	3.759
2750	195	4.49
3125	195	5.269
3500	195	6.13
3875	195	7.124
4250	195	8.189
4625	195	9.288
5000	195	10.561
500	260	1.079
875	260	1.716
1250	260	2.373
1625	260	3.083
2000	260	3.832
2375	260	4.599
2750	260	5.443
3125	260	6.391
3500	260	7.444
3875	260	8.564
4250	260	9.821
4625	260	11.268
5000	260	12.828
500	325	1.354
875	325	2.06
1250	325	2.844
1625	325	3.696
2000	325	4.579
2375	325	5.466
2750	325	6.434
3125	325	7.542
3500	325	8.685
3875	325	9.768
4250	325	11.011
4625	325	13.249
5000	325	15.095
500	390	1.609
875	390	2.44
1250	390	3.317
1625	390	4.31
2000	390	5.342
2375	390	6.362
2750	390	7.489
3125	390	8.716
3500	390	9.865
3875	390	10.957
4250	390	12.405
4625	390	15.229
5000	390	17.363
500	455	2.245
875	455	2.969
1250	455	3.867
1625	455	4.992
2000	455	6.215
2375	455	7.415
2750	455	8.76
3125	455	10.175
3500	455	11.53
3875	455	12.889
4250	455	14.686
4625	455	17.243
5000	455	19.633
500	520	3.497
875	520	4.444
1250	520	5.084
1625	520	5.764
2000	520	7.205
2375	520	8.597
2750	520	10.135
3125	520	11.708
3500	520	12.962
3875	520	14.225
4250	520	15.647
4625	520	17.579
5000	520	20.031
500	585	5.179
875	585	5.962
1250	585	5.8
1625	585	6.341
2000	585	7.906
2375	585	9.452
2750	585	10.979
3125	585	13.019
3500	585	13.966
3875	585	15.661
4250	585	16.738
4625	585	17.935
5000	585	19.272
500	650	6.834
875	650	7.316
1250	650	5.632
1625	650	6.856

Engine speed (r/min)	Engine torque (N·m)	Fuel mass rate (g/sec)
2000	650	8.471
2375	650	10.068
2750	650	11.671
3125	650	14.655
3500	650	14.804
3875	650	16.539
4250	650	18.415
4625	650	19.152
5000	650	20.33

PART 1037—CONTROL OF EMISSIONS FROM NEW HEAVY-DUTY MOTOR VEHICLES

Subpart A—Overview and Applicability

Subpart B—Emission Standards and Related Requirements

Subpart C—Certifying Vehicle Families

Subpart D—Testing Production Vehicles and Engines

Subpart E—In-use Testing

Subpart F—Test and Modeling Procedures