Appendix II - Further Detail on Phase 1 Greenhouse Gas Emission Standards

This appendix provides further detail on the Phase 1 GHG standards. As discussed in Chapter IV.A., each vehicle manufacturer must meet the PUV standards on a fleet average basis for its entire produced fleet. U.S. EPA's PUV vehicle standard is determined by calculating the total average emissions of the produced fleet for a manufacturer, dependent on the work factor (WF) of each individual vehicle family. The WF and design of these vehicles draw upon two key characteristics: payload and towing capabilities. The WF also includes an adjustment for four-wheel drive capability. As explained further in 40 CFR 1037.104 and 1037.150, the target CO2 standards established by U.S. EPA are taken from a set of mathematical functions or curves (CFR, 2013). Beginning with MY 2014 vehicles and increasing in stringency through MY 2019, a unique CO2 target is calculated from each vehicle family's load capacity and production volume. The standards for each manufacturer are then calculated each year, by taking the average of each fleet's total production volume and then multiplying by a unique CO2 target value for that fleet.

Equation II- 1: Proposed Standard for Class 2b and 3 PUVs

$$\text{Fleet-Average Standard} = \frac{\sum[\text{Target}_i \times \text{Volume}_i]}{\sum[\text{Volume}_i]}$$

Within this regulatory vehicle class, U.S. EPA has created separate CO2 standard formulas for diesel and gasoline heavy-duty PUVs. Electric vehicles, fuel cell vehicles, and vehicles that operate without engines are treated as compression-ignition vehicles. The following are the CO2 target calculations for spark-ignition PUVs and compression-ignition PUVs:

Equation II- 2: Proposed Target Standard for Spark-Ignition Vehicles

$$\text{CO2 Target (g/mile)} = 0.0440 \cdot \text{WF} + 339$$

Equation II- 3: Proposed Target Standard for Compression-Ignition Vehicles and Vehicles that Operate Without Engines

$$\text{CO2 Target (g/mile)} = 0.0416 \cdot \text{WF} + 320$$

Manufacturers have two phase-in options for meeting the targets shown in Equation II-2 and Equation II- 3: Phase-In Option A and Phase-In Option B. Once a manufacturer chooses Phase-In Option A or B, it must continue with that option. As referenced in 40 CFR 1037.150, Phase-In Option A begins with 2014 MY vehicles and gradually increases each year in stringency through the 2018 MY (CFR, 2013).
Table II- 1: Proposed Phase-In Option A Standards for Diesel PUVs
and Table II- 2 below outline the proposed Phase-In Option A CO2 standards for diesel and gasoline PUV fleets, respectively.

Table II- 1: Proposed Phase-In Option A Standards for Diesel PUVs

Option A Phase-In Provisions for Diesel Fleet-Average CO_2 Target	
Vehicle MY	Option A CO_2 target (g/mile)
2014	[0.0478 × (WF)] + 368
2015	[0.0474 × (WF)] + 366
2016	[0.0460 × (WF)] + 354
2017	[0.0445 × (WF)] + 343
2018 and subsequent	[0.0416 × (WF)] + 320

Table II- 2: Proposed Phase-In Option A Standards for Gasoline PUVs

Option A Phase-In Provisions for Otto-Cycle Fleet-Average CO_2 Target	
Vehicle MY	Option A CO_2 target (g/mile)
2014	[0.0482 × (WF)] + 371
2015	[0.0479 × (WF)] + 369
2016	[0.0469 × (WF)] + 362
2017	[0.0460 × (WF)] + 354
2018 and subsequent	[0.0440 × (WF)] + 339

Phase-In Option B matches Phase-In Option A CO2 target values for MYs 2014 and 2015, but is more stringent for MY 2016 and 2017 but less stringent for M2018, as shown in Table II- 3 and Table II- 4.

Table II- 3: Proposed Phase-In Option A Standards for Diesel PUVs

Option B Phase-In Provisions for Diesel Fleet-Average CO_2 Target	
Vehicle MY	Option B CO_2 target (g/mile)
2014	[0.0478 × (WF)] + 368
2015	[0.0474 × (WF)] + 366
2016 – 2018	[0.0440 × (WF)] + 339
2019 and subsequent	[0.0416 × (WF)] + 320

Table II- 4: Proposed Phase-In Option B Standards for Gasoline PUVs

Option B Phase-In Provisions for Otto-Cycle Fleet-Average CO_2 Target	
Vehicle MY	Option B CO_2 target (g/mile)
2014	[0.0482 × (WF)] + 371
2015	[0.0479 × (WF)] + 369
2016–2018	[0.0456 × (WF)] + 352
2019 and subsequent	[0.0440 × (WF)] + 339

1. Alternate Phase-In Standards for Medium- and Heavy-Duty Diesel Engines

As described in 40 CFR 1036.150(e), the federal Phase 1 program provides added flexibility for manufacturers of diesel engines, looking to align their technology changes with multiple regulatory requirements (CFR, 2013). For VV manufacturers, an "OBD phase-in" option was specifically requested for meeting heavy-duty diesel engine standards so that manufacturers could combine design changes where possible to meet OBD and GHG requirements (U.S. EPA, 2011b). The same flexibility was also extended to manufacturers of heavy-duty diesel engines for use in tractor-trailers to alleviate compliance burden. As summarized in

below, staff is proposing to adopt the federal Phase 1's Alternate Phase-In Standards, also known as the "OBD phase-in" option, which allows manufacturers to reduce the resources needed for new product designs and certification (ibid). For this alternate phase-in option, manufacturers must certify all of their MY 2013 diesel engines and continue using this option through the 2016 MY. Compared to the primary phase-in option, this option requires engines built in MYs 2013 and 2016 to achieve greater reductions, and requires fewer reductions for engines built in 2014 and 2015. By 2017, manufacturers must meet the requirements in the proposed Primary Phase-In Option Standards. Manufacturers must designate the engines for a specific intended service class—VV class or tractor-trailer class—and cannot opt out of the standards once certified. As explained in 40 CFR 1036.108(e), engines certified to these alternate standards are fixed to the primary intended service class, and these engines are not eligible for early credits (CFR, 2013). Staff proposal would maintain the same compliance requirements as outlined in the federal Phase 1 program when allowing manufacturers to certify to this alternate phase-in standard.

Table II- 5: Proposed Alternate Phase-In CO2 Emission Engine Standards

Alternate Phase-in CO_2 Emission Standards (in g/bhp-hr)					
	LHD – vocational	**MHD – vocational**	**HHD – vocational**	**MHD – tractor**	**HHD – tractor**
2013-2015	618	618	577	512	485
2016 and later	576	576	555	487	460

2. Alternate Emission Standards Based on 2011 MY Engines

Some 2011 MY engines may have higher emissions than the 2010 baseline level, due to various factors including criteria pollution control devices, unique engine calibrations, or duty cycle differences (U.S. EPA, 2011b). Therefore, the federal Phase 1 program allows manufacturers to use an optional, alternate emission standard program to certify their engines during the 2014 to 2016 time frame using a 2011 engine as the baseline for emissions (ibid). Manufacturers using this option for MYs 2014 to 2016 will need to make a greater relative improvement for MY 2017 engines, compared to the rest of the industry, since the starting emissions level will be higher. A manufacturer can only opt into this alternate emission standard program if all credit opportunities are exhausted, and if the manufacturer cannot meet the primary standards. Staff is proposing to adopt the federal Phase 1 alternate emission standard program to allow for identical compliance strategies with the Phase 1 program. The alternate standards referenced in 40 CFR 1036.620 are determined by measuring the emission rate of the test engine of the applicable baseline 2011 engine family and then multiplying by a percent emissions reduction value (CFR, 2013). The alternate CO2 standard for LHD and MHD vocational-certified engines is equal to the baseline 2011 emission rate multiplied by 0.975. The alternate CO2 standard for tractor-certified engines and all other heavy-duty engines is equal to the baseline 2011 emission rate multiplied by 0.970. To minimize the risk of unfair certification practices, where a manufacturer could establish an unreasonably high 2011 baseline emission level, the federal Phase 1 program is requiring that the 2011 MY baseline be determined either by averaging emissions over all engines in an engine averaging set, certified and sold during 2011 or meet additional criteria in 40 CFR 1036.620 and 49 CFR 535.5(d) (CFR, 2013; U.S. EPA, 2011b).

A. Maintenance Requirements/In-Use Standards

i. Manufacturer Maintenance Requirements

Staff is proposing to align California's maintenance requirements with the Phase 1 program requirements for manufacturers. The Phase 1 program requires vehicle manufacturers to submit detailed maintenance schedules with their certification application. This maintenance schedule should include instructions on lubricant replacement, fairing adjustments, periodic

inspections of aerodynamics, and other operations that ensure products maintain compliance with emissions standards through the useful life of the vehicle (U.S. EPA, 2011b). The federal program also expects manufacturers to ensure that critical emission-related maintenance is performed. Manufacturers can accomplish this supplemental maintenance by submitting survey data that shows at least 80% of their engines receive the required in-use maintenance or by providing critical emission-related maintenance at no cost to the user (ibid). The federal program also requires vehicle manufacturers to include detailed information in the owner's manual to instruct owner/operators on how to replace LRR tires with tires performing equal to or better than the original tires (ibid). However, while tire replacement instructions must be provided in the owner's manual, vehicle manufacturers are not directly responsible for ensuring owner/operators replace original tires with LRR tires.

ii. Owner/Operator Maintenance Requirements

Staff is also proposing to align with federal maintenance requirements for owners/operators. As stated in 40 CFR 1037.655, the federal Phase 1 program prohibits any person from removing or rendering inoperative any emission control device. Vehicle owners are expected to maintain installed vehicle equipment, and modifications must be done on a reasonable technical basis that does not result in increased emissions of any regulated pollutant (CFR, 2013).

iii. Vehicle Warranty

Staff's proposal would maintain the same vehicle warranty requirements as those established by the federal Phase 1 program. At the time of certification, the federal program requires manufacturers to submit a copy of a vehicle's warranty statement. GHG emission-related components are to be covered under the vehicle warranty. The federal Phase 1 program also requires manufacturers to design and build products that comply with emissions requirements at the time of sale. The warranty period is dependent on the type of vehicle certified. Gasoline and light heavy-duty diesel vehicles have a warranty of 5 years or 50,000 miles, whichever comes first. Medium- and heavy heavy-duty diesel vehicles have a warranty period of 5 years or 100,000 miles, whichever comes first. In addition, tires must be free from defects for two years or 24,000 miles, whichever comes first. Vehicle manufacturers must describe emissions related warranty agreements in the owner's manual.

iv. In-Use Vehicle Standards

The federal Phase 1 program requires vehicles to meet in-use emissions standards throughout the useful life of the vehicle. Staff is proposing to adopt identical useful life requirements for vehicle manufacturers to remain consistent with federal in-use compliance periods as shown in Table II- 7 below. The useful life of a vehicle can be expressed in miles or years,

whichever comes first. The useful life of a vehicle varies, depending on the vehicle type and the GVWR of the vehicle.

Table II- 6: In-Use Performance Vehicle Standards

Vehicle Type	GVWR	Useful Life: Miles or Years (whichever comes first)	
Pickup Trucks & Vans (PUVs)	8,501 pounds -14,000 pounds	120,000 miles	11 years
Vocational Vehicles (VVs)	≤19,500 pounds	110,000 miles	10 years
	19,500 pounds-33,000 pounds	185,000 miles	10 years
	>33,000 pounds	435,000 miles	10 years
Tractor-Trailers	26,000 pounds-33,000 pounds	185,000 miles	10 years
	>33,000 pounds	435,000 miles	10 years

v. In-Use Engine Standards

The federal Phase 1 program requires engines to remain in compliance with CO2 emissions standards throughout the useful life of the engine. Staff is proposing to adopt identical useful life requirements for engine manufacturers to remain consistent with in-use compliance periods as shown in Table II- 7 below. For engines, useful life values are the same as those applicable to criteria air pollutants.

Table II- 7: In-Use Performance Engine Standards

GVWR	Useful life: Miles or Years (whichever comes first)	
≤19,500 pounds	110,000 miles	10 years
19,501 pounds-33,000 pounds	185,000 miles	10 years
>33,000 pounds	435,000 miles	10 years

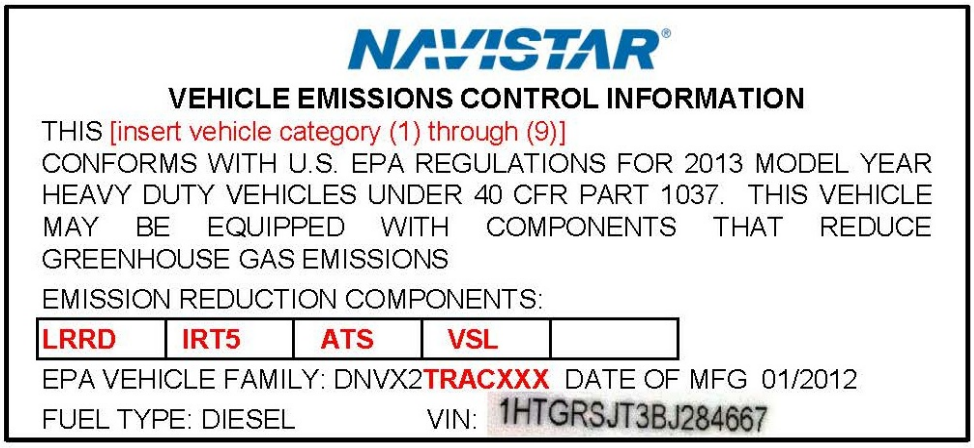
For in-use engine standards, the family emission limit (FEL) serves as the primary emission standard for engine family testing, excluding certification and confirmatory testing. Family certification limits (FCLs) are used to calculate the FEL value. As explained in 40 CFR1036.108, the CO2 FEL is calculated by multiplying the FCL by 1.03 (CFR, 2013). Finally, the federal Phase 1 program creates a separate adjustment factor to calculate in-use standards unique to heavy-duty PUV vehicles (U.S. EPA, 2011b). The federal Phase 1 program's intent for this adjustment factor was to provide a reasonable margin for production and testing variability from initial and in-use testing results. Staff is proposing to adopt identical useful life periods and in-use standard calculations to align with federal requirements.

vi. Vehicle Labels

The federal Phase 1 standards establish vehicle labeling requirements for medium- and heavy-duty vehicles as verification that vehicles meet required GHG emission standards. Similar to the emission control labels found on

engines, the vehicle labels include a heading, corporate name and trademark, vehicle family name, regulatory subcategory, date of manufacture, emission control system, fuel and lubricant requirements, and a compliance statement (U.S. EPA, 2011b). The vehicle labels must also include a list of installed emission control devices to help enforcement staff verify that necessary components are installed by manufacturers, as originally submitted during the certification process (U.S. EPA, 2011b). Emission reduction components include idle reduction technologies, LRR tires, vehicle speed limiters, vehicles with hybrid powertrains, or other advanced or innovative technologies present on the vehicle. The complete list of emission control identifiers for the labels can be found in Appendix 3 of 40 CFR 1037 (CFR, 2013). Vehicle manufacturers meeting the small business criteria for truck manufacturing are exempt from the regulation and must label any exempt vehicles with the following statement: "THIS VEHICLE IS EXCLUDED UNDER 40 CFR 1037.150(c)." An example of a Phase 1 vehicle label is shown as Figure II- 1 below.

Figure II- 1: Phase 1 Vehicle Label Example



Staff is proposing to largely align California's vehicle labeling requirements with the federal Phase 1 program's requirements.

vii. Engine Labels

The federal Phase 1 program has additional labeling requirements for new heavy-duty engines meeting GHG standards. As specified in 40 CFR 86.095, the Phase 1 program requires emission control labels, stating that engines meet both criteria and GHG emission standards, to be attached to a permanent engine part (CFR, 2013). Engine labels are to include a heading, the full corporate name and trademark, engine family and model designations, compliance statement, engine specifications and recommended adjustments. As specified in 40 CFR 1036.135, the labels must identify emission control systems and any limitations on certification (CFR, 2013). Specifically, the label will need to indicate whether the engine is certified for use in VVs, tractor-trailers, or both. For example, if a manufacturer certifies

HHD engines to the CO2 standards using only the transient cycle testing, they would include the statement "VOCATIONAL VEHICLES ONLY." Diesel engines that use the averaging, banking, and trading (ABT) credit program must also include the FEL to which the engine is certified. Heavy-duty engine manufacturers that qualify for the small manufacturer provision (discussed below) must label their exempt engines with a label that includes the following statement: "THIS ENGINE IS EXCLUDED UNDER 40 CFR 1036.150(d)." Engines certified to the alternate engine standard will need to include a label with the following compliance statement: "THIS ENGINE WAS CERTIFIED TO THE ALTERNATE GREENHOUSE GAS EMISSION STANDARDS OF 40 CFR 1036.108(a)(4)." Staff is intending to align California requirements with federal engine labeling requirements.

B. Exemptions

Staff is proposing to retain the same exemptions as allowed by the federal Phase 1 program. Small business engine and vehicle manufacturers that meet the small business size criteria are exempt from the requirements of the Phase 1 program (CFR, 2013). Currently, the Small Business Administration defines a small business for heavy-duty vehicle manufacturing and engine manufacturing as 1,000 employees and 750 employees, respectively. Qualifying entities will need to submit a written declaration as outlined in the reporting section of the proposal.

In addition, Class 7 and 8 heavy-duty vehicles that operate off-road are exempt from the tractor-trailer standards (U.S. EPA, 2011b). However, standards would still apply to the engines in these vehicles. Small volume manufacturers who produce combined U.S. sales of fewer than 10,000 units may follow special certification procedures described in 40 CFR 86.098-14(b) (CFR, 2013).

C. Reporting and Recordkeeping Requirements

The federal Phase 1 program requires engine manufacturers to submit end-of-year reports as part of completing the certification process to approve federal engine use and sale. Engine manufacturers must submit end-of-year reports (U.S. EPA, 2011b) pertaining to:

- engine family designation and averaging set;
- engine emissions and fuel consumption standards including any alternative standards used;
- engine family FCLs;
- final production volumes;
- certified test cycles;
- useful life values for engine families; and
- a credit plan identifying the manufacturer's actual credit balances, flexibilities, trades, and credit deficit plan.

Vehicle manufacturers must submit annual reports (U.S. EPA, 2011b) including:

- vehicle family FELs;
- final production volumes;
- vehicle family designation and averaging set data;
- vehicle emissions standards including any alternative standards used;
- certified test cycles;
- useful life values for vehicle families;
- a plan describing any exempt vehicles for off-road or small business purposes; and
- a credit plan identifying the manufacturer's actual credit balances, flexibilities, trades, and credit deficit plan.

To minimize the costs associated with reporting and to reduce any unnecessary burden, staff is proposing that engine and vehicle manufacturers be required to submit 2 copies of the final reports submitted to U.S. EPA to ARB's Certification Section as well. Staff is proposing that manufacturers submit final reports within 90 days after the end of the MY, as required in 40 CFR 1036.250 and 1037.250 (CFR, 2013). Since the proposed regulation will take effect only after the Office of Administrative Law has approved the proposal (expected in late 2014), engine and vehicle manufacturers may need to submit reports for any affected MYs after the 90-day period; staff intends to issue an advisory to clarify the deadline by which 2013 and 2014 final reports are due to ARB's Certification Section.

As further described in 40 CFR 1036.735 and 1037.735, engine and vehicle manufacturers are required to keep records for at least eight years after the due date for the end-of-year report (CFR, 2013). Engine or vehicle credits will not be recognized by U.S. EPA if the records are not kept on file as required. The records can be kept in any format on any media, and must be readily available in English if U.S. EPA requests them at any time. Staff is proposing to adopt the same Phase 1 recordkeeping requirements for both engine and vehicle manufacturers.

D. Test Procedures and Certification Process

This section includes a discussion of the test procedures and vehicle simulation model mandated for use to show compliance with the Phase 1 standards, as well as a discussion of how the certification process would work for manufacturers that apply for U.S. EPA certification and then wish to be "deemed to comply" for California purposes.

i. Test Procedures

The proposed Phase 1 test procedures for heavy-duty engines and vehicles are outlined below.

1. Engines

Manufacturers must demonstrate compliance with the federal Phase 1 heavy-duty engine standards using the following two test procedures: the "California Exhaust Emission Standards and Test Procedures for 2004

and Subsequent Model Heavy-Duty Diesel Engines and Vehicles" as last amended [April 18, 2013] and the "California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Otto-Cycle Engines" as last amended [April 18, 2013] (U.S. EPA, 2011a). These two test procedures are proposed to be amended to incorporate the federal certification requirements for the control of GHG emissions from heavy-duty engines, Subparts A through I, Part 1036, Title 40, CFR, which specify the certification GHG emission standards, engine family certification process, in-use and certification test procedures, special compliance provisions, and ABT provisions for Phase 1 (CFR, 2013). By utilizing the two test procedures above, manufacturers are able to comply with both federal and California certification requirements.

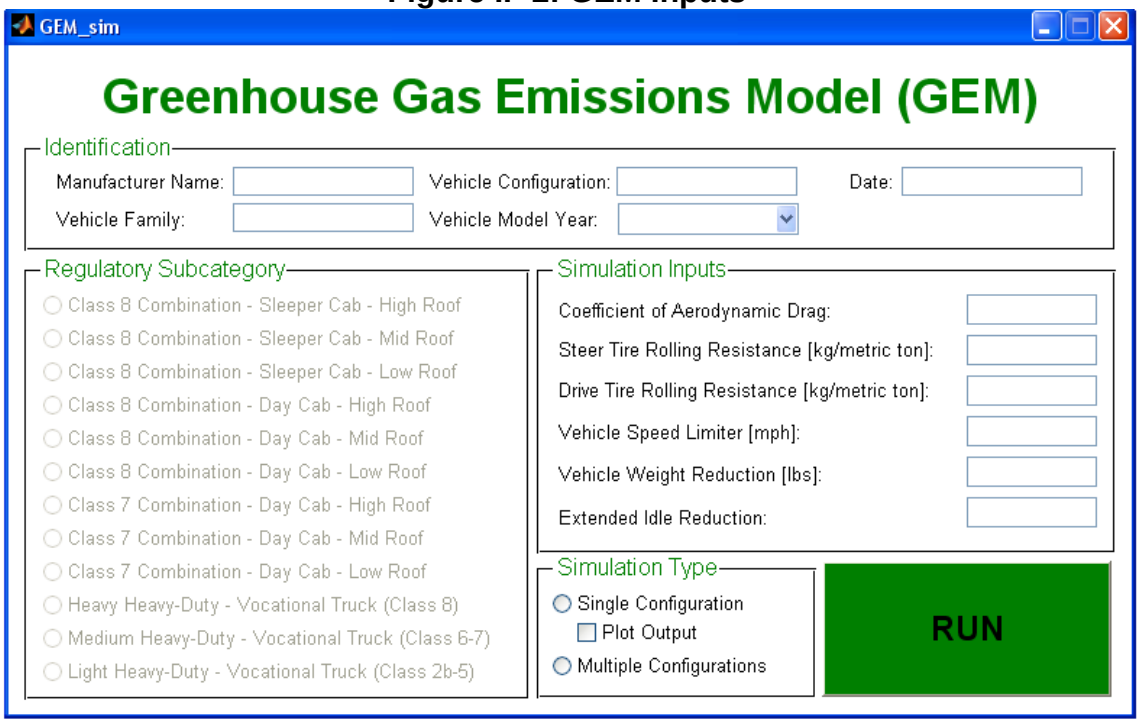
2. Vehicles

Manufacturers must demonstrate compliance with the Phase 1 vehicle standards using the proposed new "California Greenhouse Gas Exhaust Emission Standards and Test Procedures for 2014 and Subsequent Model Heavy-Duty Vehicles." (HDV TPs) These proposed test procedures specify GHG emission standards, requirements to certify vehicle families, in-use testing provisions, test and modeling procedures, special compliance procedures, and ABT provisions. They also incorporate the federal requirements for the control of GHG emissions from heavy-duty vehicles. Similar to the proposed test procedures described above, the federal requirements specify the GHG emission certification standards, vehicle family certification process, in-use and certification test procedures (such as fuel and dynamometer specifications), special compliance provisions, and ABT provisions. By complying with the proposed new test procedure above, manufacturers are able to comply with the federal and California certification requirements simultaneously.

ii. Greenhouse Gas Emissions Model (GEM)

Compliance with the standards for tractor-trailers and VVs, shown above in Table II- 6 and Table II- 7, respectively, will be determined by the GEM customized vehicle simulation model used by the U.S. EPA (U.S. EPA, 2013a; U.S. EPA, 2013b). This compliance model will substitute for the standard method of chassis dynamometer testing. GEM takes various measurements of vehicle characteristics and uses these measurements as inputs, as shown in Figure II- 2 below.

Figure II- 2: GEM Inputs

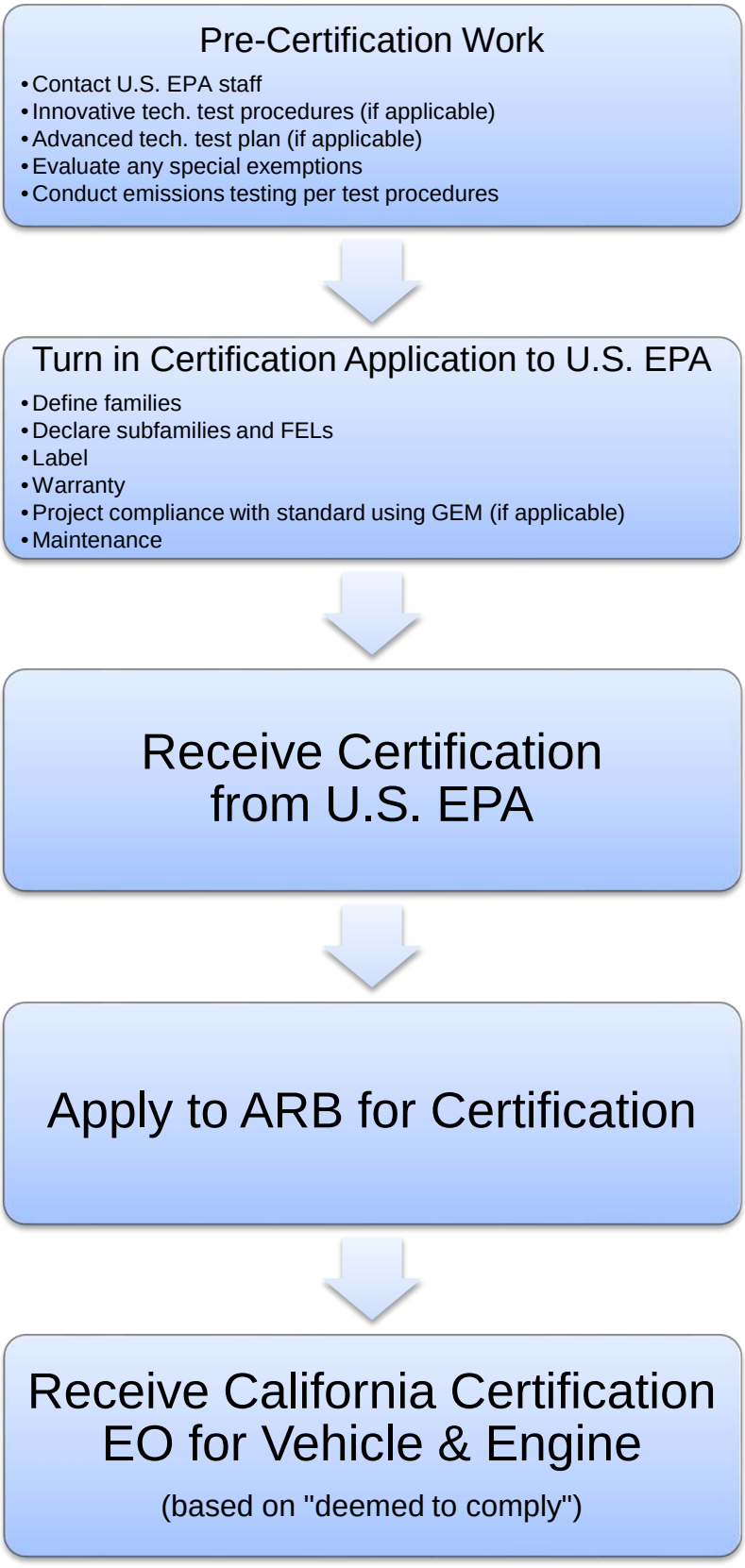


The inputs capture key emissions reduction technologies appropriate for the vehicle type—including coefficient of drag, tire rolling resistance coefficient, weight reduction, idling reduction strategies, and vehicle speed limiters. Based on the inputs, GEM will calculate the expected GHG emissions and fuel efficiency performance of the vehicle with respect to drive cycle in terms of weighted grams of CO2 per ton-mile and gallons per 1,000 ton-miles.

iii. Compliance Process

To comply with California's Phase 1 requirements using "deemed to comply," manufacturers must follow the steps outlined in the flow chart in Figure II- 3 below.

Figure II- 3: Phase 1 Certification Process with "Deemed to Comply" Provisions



E. Compliance Flexibility-Credits

The federal Phase 1 program recognizes the need to provide compliance flexibility in order to set stringent CO2 standards that would reduce emissions at a reasonable rate (U.S. EPA, 2011b). Also, to accommodate any technology feasibility issues and the short lead time for manufacturers, the federal Phase 1 program creates an ABT program and other flexibility provisions including early credits, innovative technology credits, and advanced technology credits to help manufacturers meet CO2 standards. The ABT program allows a manufacturer to exercise maximum flexibility in redesigning and planning where and how to achieve emission reductions with credit options (U.S. EPA, 2011b). There is also a low N2O credit program that allows manufacturers to generate CO2 credits if they are able to employ GHG emission reduction technologies that reduce N2O levels beyond the 2010 baseline. Because staff is proposing the same CO2 standards as in the federal Phase 1 program, even though ARB's regulations will take effect after implementation of the federal Phase 1 program has begun, staff is proposing to adopt the federal CO2 credit programs and flexibilities in their entirety, as well as the federal N2O credit program, so that engine and vehicle manufacturers can use harmonized compliance strategies to meet both the federal and proposed California GHG requirements. A manufacturer using compliance flexibilities or meeting alternate standards to be in compliance with the federal Phase 1 program will be "deemed to comply" with California's proposed Phase 1 regulations as well.

i. Early Credits

The federal Phase 1 program provides an early credit program as an incentive for manufacturers to take early action (U.S. EPA, 2011b). A manufacturer is eligible for early credits if they can certify their entire subcategory of engines or vehicles at GHG emissions below the established primary standards. The federal program uses a 1.5 multiplier for early credits earned with MY 2013 diesel engines and diesel and gasoline vehicles, and 2015 gasoline engines. Manufacturers may not apply both the early credit multiplier and the advanced technology multiplier to the same vehicles (ibid).

A tractor manufacturer may apply for early credits if they are able to sell more 2013 MY SmartWay designated tractors than the number of SmartWay designated tractors sold in MY 2012. Any additional 2013 MY SmartWay designated tractors sold determines the number of tractors eligible for early credit certification. The tractor manufacturer would then need to determine each tractor's 2013 emission performance by using the GEM to calculate the difference between the 2013 performance level and the 2014 MY standard for the appropriate regulatory subcategory (e.g. Class 8 sleeper cab high roof tractors) to determine the amount of eligible early credits (U.S. EPA, 2011b). For PUV manufacturers, the federal Phase 1 early credit program compares

the manufacturer's 2013 heavy-duty PUV fleet with the 2014 fleet-wide targets. The PUV early credit program requires a manufacturer to certify an entire heavy-duty PUV fleet in MY 2013.

ii. Advanced Technology Credits

In order to promote the use of advanced technologies that are not yet commercially available, the federal Phase 1 program creates the advanced technology credit program so that manufacturers will incorporate these technologies in their engine or vehicle designs (U.S. EPA, 2011b). Eligible technologies include hybrid powertrain designs with energy storage systems, Rankine cycle engines with a waste heat recovery system, all-electric vehicles, and fuel cell vehicles. Advanced technology credits are treated differently than any of the other credit programs (e.g. ABT, early credits, or innovative technology credits); these credits can be applied across the entire heavy-duty engine or vehicle sector, and do not need to be kept within an averaging set or subcategory. A manufacturer generating advanced technology credits can apply the credits to any heavy-duty vehicle or engine and is not limited to the vehicle or engine category generating the credit. The federal Phase 1 program establishes a 1.5 multiplier for a manufacturer that accrues advanced technology credits, but also sets a cap of 60,000 megagrams for the amount of advanced credits that can be used by any averaging set for any MY to prevent market distortions (U.S. EPA, 2011b).

Heavy-duty PUVs, all-electric, and other zero tailpipe emission vehicles produced before the 2014 MY are acknowledged for advanced technology credits that can be used to meet 2014 and later fleet target standards, provided that the vehicles are certified to meet the criteria pollutant standards (U.S. EPA, 2011b). The credits for PUVs ware calculated based on the 2014 diesel standard targets, and treated as though they were earned in 2014 with a credit lifespan of five years. PUV manufacturers will not need to early-certify their entire fleet in a given MY, as they would for early credits. MY 2014 and later electric vehicles and other zero emission vehicles could be factored into or taken out of the fleet average GHG calculations based on the diesel standard targets for their MY and WF. The federal Phase 1 program establishes that advanced technology credits for electric and zero-emission vehicles will be exclusively based on a zero emissions tailpipe performance (ibid). The federal program has not finalized a sales cap for the use of electric vehicle technology for PUV vehicles in the 2014 to 2018 MYs since U.S. EPA estimates that introduction of EV technology in this sector will be limited and infrequent (U.S. EPA, 2011b).

iii. Innovative Technology Credits

Acknowledging that emissions reductions may occur off-cycle, the federal Phase 1 program has created an innovative technology credit program to acknowledge reductions not captured over the Federal Test Procedures (FTP) or Supplemental Emission Test (SET) procedures, including the GEM,

used to determine compliance with the CO2 emission standards (U.S. EPA, 2011b). Eligible innovative technologies are those that are newly introduced in one or more engine or vehicle models, but not yet widely implemented in the manufacturer's fleet or averaging set for which the credit is generated (ibid). Such technologies resulting in innovative technology credits include predictive cruise control, gear-down protection, engine cooling strategies, advanced drivelines, light-weight components, active aerodynamic features, and adjustable ride heights. Innovative technologies can be known in the heavy-duty market sector, but must not yet be widely utilized in any particular engine or vehicle subcategory. Credit for tailpipe a/c emissions reductions as opposed to a/c leakage can be obtained through this innovative technology credit program (U.S. EPA, 2011b). Advanced transmissions and drivetrains are also eligible for credits in this program. The federal Phase 1 program has also designated the innovative technology program to allow manufacturers who want to certify hybrid vehicles on a different test cycle than the prescribed cycles as described in 40 CFR 1036.525 (CFR, 2013). Credits obtained for certified hybrid vehicles will be tested through the guidelines set by the Innovative Technology Credit Program, but will be acknowledged as advanced technology credits so that manufacturers can apply such credits across vehicle and engine categories (ibid).

As determined in 40 CFR 1037.610, innovative technology credits that apply to medium- and heavy-duty engines, as compared to vehicles, are separated by application based on the method selected by the manufacturer to determine the amount of emissions reduction achieved from the technology (CFR, 2013; U.S. EPA, 2011b). For example, improvements using chassis dynamometer testing or on-road tests will be considered vehicle credits, and any engine improvements demonstrated by engine dynamometer or powerpack testing will be applied as engine credits (ibid). The federal Phase 1 program recognizes that some exceptions to the application of innovative technology credits may apply, and has created a public evaluation process request a change in credit allocation. To maintain harmonization, ARB proposes to recognize the results of this federal evaluation process.

iv. ABT Credits

Averaging is defined in the federal Phase 1 program as the exchange of emission credits between engine families or truck families within a given manufacturer's regulatory subcategories and averaging sets (U.S. EPA, 2011b). The averaging concept of this credit program allows manufacturers to certify one or more engine or vehicle families within the same averaging set at levels worse than the applicable emission standard. Of course, the increased emissions from the engine or vehicle families within a manufacturer's averaging set would need to be offset by a certified engine or vehicle with better emissions so that the average emissions from all of the manufacturer's engine or vehicle families would be below or equal to the level of the applicable emission standard. Banking is defined as the retention of

emission credits by the manufacturer for use in future MY averaging or trading. Trading is defined as the exchange of emission credits between manufacturers, which are then used for averaging or banking purposes, or trading with another manufacturer (ibid).

Staff is proposing to adopt identical ABT program guidelines and restrictions as established by the federal Phase 1 program. As allowed in the current heavy-duty ABT engine program for criteria pollutants, manufacturers are restricted to ABT credits within a regulatory subcategory. For engines and vehicles, the federal program allows credit averaging within and across vocational and tractor subcategories within the same weight class groups: LHD, MHD, and HHD (U.S. EPA, 2011b). For the PUVs category, the federal program has defined only one averaging set or subcategory since the CO2 standard applies to the entire vehicle.

Under the ABT credit program, while credits can be retained by a manufacturer for a period of up to five years, manufacturers can carry forward credit deficits for up to three years before reconciling any shortfall. However, a manufacturer must use or reconcile any credit deficits before acquiring any banked and traded credits for additional MYs (U.S. EPA, 2011b).

v. N2O Credits for Engine Manufacturers

To encourage N2O reductions, engine manufacturers are encouraged to redesign emission control systems and receive credits for very low N2O emission certification levels. If a manufacturer is able to meet the 0.04 g/bhp-hr level for generating N2O credits, which is significantly less than the established N2O engine standard of 0.10 g/bhp-hr, a manufacturer could generate 2.98 grams of CO2 credit for every 0.01 grams of N2O reduced. The federal Phase 1 program created the N2O credit program to ensure that CO2 credits generated would result in significant N2O emission reductions beyond the 2010 baseline performance level. Manufacturers can apply for N2O credits within engine MYs 2014 to 2016 only.