BEFORE THE

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

In the Matter of California's Request for Waiver Pursuant to Clean Air Act Section 209(b) and for Authorization Pursuant to Clean Air Act Section 209(e) for California's "Omnibus" Regulation	)

CLEAN AIR ACT § 209(b) WAIVER AND § 209(e) AUTHORIZATION REQUEST SUPPORT DOCUMENT SUBMITTED BY THE CALIFORNIA AIR RESOURCES BOARD

January 31, 2022

I. INTRODUCTION AND OVERVIEW

This document supports the request of the California Air Resources Board (CARB or Board) that the Administrator of the United States Environmental Protection Agency (EPA) take waiver action pursuant to Clean Air Act (CAA) section 209(b) with respect to a rulemaking action in which CARB promulgated criteria pollutant exhaust emission standards and other emission-related requirements applicable to new 2024 and subsequent model year (MY) California on-road medium- and heavy-duty engines and vehicles (hereinafter "Omnibus Regulation or Regulation").[1] Elements of the Omnibus Regulation also establish emission-related requirements applicable to off-road engines. CARB requests that EPA take authorization action pursuant to CAA section 209(e) for those elements.

On-road medium and heavy-duty vehicles that exceed 8,500 pounds (lbs) gross vehicle weight rating (GVWR) are a significant source of oxides of nitrogen (NOx) emissions in California; heavy-duty vehicles emit nearly one third of all statewide emissions of NOx. The Omnibus Regulation establishes exhaust emission standards for NOx that are 90 percent more stringent than the currently applicable California and federal heavy-duty NOx emission standards and significantly strengthens several elements of California's certification and in-use programs to ensure that affected engines and vehicles comply with the more stringent standards throughout their useful lives.

[1] The Omnibus regulation is comprised of new title 13, California Code of Regulations (Cal. Code Regs.) sections 2139.5, and 2169.1 through 2169.8; amendments to title 13, Cal. Code Regs., sections 1900, 1956.8, 1961.2, 1965, 1968.2, 1971.1, 1971.5, 2035, 2036, 2111, 2112, 2113, 2114, 2115, 2116, 2117, 2118, 2119, 2121, 2123, 2125, 2126, 2127, 2128, 2129, 2130, 2131, 2133, 2137, 2139, 2140, 2141, 2142, 2143, 2144, 2145, 2146, 2147, 2148, 2149, 2166, 2166.1, 2167, 2168, 2169, 2170, 2423, and 2485; and amendments to title 17 Cal. Code Regs. sections 95662 and 95663.

The Regulation constitutes the single largest NOx control measure in California's current SIP strategy, and will reduce NOx emissions in California by approximately 17.4 tons per day (tpd) statewide by 2031, and by 45.2 tpd statewide, by 2050. NOx emissions in the South Coast Air Basin and in the San Joaquin Valley Air Basin are projected to decrease by 5.2 and 4.3 tpd, respectively, by 2031.

Section II of this document provides a brief description of the Board's rulemaking action. Section III presents a summary of the elements of the Omnibus Regulation that require waiver and authorization actions. Section IV identifies the principles applicable to waivers and authorizations, Section V demonstrates that EPA has no basis to deny granting the requested waiver, and Section VI demonstrates that EPA has no basis to deny granting the requested authorizations. The remainder of Section I discusses waivers that EPA has previously granted for regulations targeting California on-road heavy-duty and medium-duty engine and vehicles.

A. Preexisting California On-Road Heavy-Duty and Medium-Duty Engine and Vehicle Emission Regulations That Have Been Granted Waivers

1. On-Road Medium- and Heavy-Duty Diesel and Otto-Cycle Engine Emission Standards

California regulations classify motor vehicles as light-duty, medium-duty, or heavy-duty based on their GVWR, a measure of the vehicle's weight plus a defined load weight. The current heavy-duty vehicle classification is further subdivided into three subcategories: light heavy-duty (14,001 to 19,500 lbs GVWR), medium heavy-duty (19,501 to 33,000 lbs GVWR), and heavy heavy-duty (greater than 33,000 lbs GVWR).

California first regulated heavy-duty vehicle exhaust emissions in 1969. EPA first regulated heavy-duty vehicles in 1974. Since 1986, state and federal heavy-duty engine and vehicle emission standards and test procedures have been generally aligned. EPA has granted waivers for California heavy-duty regulations for preexisting diesel engine standards[2] and Otto-cycle engine standards.[3] EPA also granted California a number of earlier waivers applicable to heavy-duty diesel engines (HDDEs) and vehicles[4] and to heavy-duty Otto-cycle engines and vehicles.[5]

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[2] 70 Fed. Reg. 50322 (Aug. 26, 2005).

[3] 75 Fed. Reg. 70238 (Nov. 17, 2010).

[4] 69 Fed. Reg. 59920 (Oct. 6, 2004), 53 Fed. Reg. 7021 (March 4, 1988), 52 Fed. Reg. 20777 (June 3, 1987), 49 Fed. Reg. 39731 (Oct. 10, 1984), 46 Fed. Reg. 36742 (July 15, 1981), 46 Fed. Reg. 26371 (May 12, 1981), 43 Fed. Reg. 36679 (Aug. 18, 1978), 42 Fed. Reg. 31639 (June 22, 1977), and 36 Fed. Reg. 8172 (April 30, 1971).

[5] 69 Fed. Reg. 59920 (Oct. 6, 2004), 53 Fed. Reg. 7022 (March 4, 1988), 53 Fed. Reg. 6197 (March 1, 1988), 49 Fed. Reg. 39731 (Oct. 10, 1984), 46 Fed. Reg. 36742 (July 15, 1981), 46 Fed. Reg. 26371 (May 12, 1981), 43 Fed. Reg. 20549 (May 12, 1978), 42 Fed. Reg. 31637 (June 22, 1977), 42 Fed. Reg.

In 1990, CARB adopted amendments to the exhaust emission standards and associated test procedures for light-duty trucks, medium-duty vehicles and engines, and light heavy-duty vehicles and engines, and additionally adopted amendments that redesignated vehicles rated from 8,501 to 14,000 lbs GVWR, formerly classified as heavy-duty vehicles, as medium-duty vehicles.[6] EPA granted California waivers for the new definition of medium-duty vehicles and the standards applicable to this class of vehicles.[7]

California's classification of heavy-duty vehicles is similar, but not identical to the federal classification of heavy-duty vehicles (which, as previously stated, includes vehicles that California classifies as medium-duty vehicles), as indicated by Table 1 below.

Table 1- Federal and California Heavy-Duty Vehicle Weight Classes

GVWR (lbs)	8,501-10,000	10,001-14,000	14,001-16,000	16,001-19,500	19,501-26,000	26,001-33,000	33,001+
Federal	Light heavy-duty				Medium heavy-duty		Heavy heavy-duty
California (1995 and later MY)	Medium-duty		Light heavy-duty		Medium heavy-duty		Heavy heavy-duty

2. California's On-Board Diagnostic (OBD) II Regulation

CARB initially adopted the OBD II Regulation in 1990 and the OBD II Enforcement Regulation in 2003, and subsequently adopted several amendments to both regulations. EPA granted California a waiver of the OBD II Regulation and the OBD II Enforcement Regulation, both as last amended in 2013, in 2016.[8]

The OBD II Regulation requires motor vehicle manufacturers to incorporate OBD II systems into new passenger cars, light-duty trucks, and medium-duty vehicles and engines. OBD II systems effectively monitor all emission-related components and systems for proper operation, and for deterioration or malfunctions that cause emissions

31639 (June 22, 1977), 36 Fed. Reg. 8172 (April 30, 1971), 34 Fed. Reg. 7348 (May 6, 1969), and 33 Fed. Reg. 10160 (July 16, 1968).

[6] EPA does not have a "medium-duty vehicle" category, but classifies heavy-duty vehicles between 8,501 and 14,000 lbs GVWR as light heavy-duty vehicles.

[7] 59 Fed. Reg. 48625 (Sept. 22, 1994), 63 Fed. Reg. 18403 (April 15, 1998).

[8] 81 Fed. Reg. 78143 (Nov. 7, 2016).

to exceed specific thresholds. The OBD II Regulation also requires OBD II systems to provide specific diagnostic information in a standardized format through a standardized serial data link to ensure that service and repair technicians can properly and promptly repair identified malfunctions.

The OBD II Enforcement Regulation establishes in-use testing procedures and associated remedial measures that are designed to ensure that OBD II systems comply with the requirements of the OBD II Regulation in actual use. Specifically, the OBD II Enforcement Regulation specifies criteria and protocols for procuring in-use vehicles or engines, for testing the associated OBD II systems, including performance testing emission threshold-related monitors and evaluating in-use monitoring performance ratios, and the procedures for remediating nonconforming OBD II systems.

3. California's Heavy-Duty On Board Diagnostic (HD OBD) System Regulation

CARB initially adopted the HD OBD System Regulation in December 2005, and EPA granted California a waiver for that regulation under CAA section 209(b) in 2008.[9] The regulation, as initially adopted, required manufacturers to install a fully compliant HD OBD system on all 2013 and later MY diesel and Otto-cycle heavy-duty engines (engines used in vehicles having a GVWR greater than 14,000 lbs). CARB subsequently updated the HD OBD Regulation and also adopted HD OBD-specific enforcement requirements (the HD OBD Enforcement Regulation) in 2010. The 2010 HD OBD amendments also aligned the HD OBD requirements with the OBD II requirements for medium-duty vehicles. EPA issued California a waiver for the 2010 HD OBD amendments in December 2012.[10] In 2013 CARB amended both the HD OBD and the HD OBD Enforcement Regulation. EPA confirmed that certain amendments were within the scope of previously issued waivers, and issued a waiver for the remaining amendments that established new or more stringent requirements.[11]

4. California's Heavy-Duty Diesel In-Use Compliance Regulation

CARB adopted the initial Heavy-Duty Diesel In-Use Compliance Regulation on July 26, 2007. That regulation established a manufacturer-administered in-use compliance program that was largely identical to a similar in-use program that EPA previously adopted in 2005. The regulation, as initially adopted, applied to 2007 and subsequent MY engine-dynamometer certified HDDEs installed in motor vehicles with GVWR greater than 8,500 lbs.

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[9] 73 Fed. Reg. 52042 (Sept. 8, 2008).

[10] 77 Fed. Reg. 73459 (Dec. 10, 2012).

[11] 81 Fed. Reg. 78149 (Nov. 7, 2016).

That regulation specifies that CARB can designate up to 25 percent of a manufacturer's total number of medium- and heavy-duty diesel engine families to be tested each year. Engine manufacturers procure heavy-duty diesel vehicles from vehicle fleets or individual customers, equip test vehicles with portable emission measurement systems (PEMS), and test the vehicles by operating them over typical driving routes, and under the same vehicle loads and environmental conditions that the vehicles routinely encounter in real world operations. PEMS analyzers are smaller versions of the analyzers used to measure emissions from engines tested in either engine or chassis dynamometers in controlled laboratory environments, and utilize the same technologies and measurement principles as their larger counterparts. However, their more compact size allows PEMS analyzers to be mounted on vehicles to measure emissions as the vehicles are operated.

A heavy-duty engine complies with the regulation's requirements if 90 percent of the average emissions of all time-weighted sampling events do not exceed specified pollutant thresholds, as measured over a "Not to Exceed" (NTE) test procedure. The NTE test procedure was developed to ensure that heavy-duty diesel engine emissions are properly controlled over a large range of speed and load combinations and environmental conditions commonly experienced during the daily operations of heavy-duty vehicles.

In 2008 and 2011, CARB amended the Heavy-Duty Diesel In-Use Compliance Regulation to incorporate advancements in measuring emissions generated over the NTE test procedure. EPA granted California a waiver for the initial Heavy-Duty Diesel In-Use Compliance Regulation and the 2008 and 2011 amendments to that regulation in 2017.[12]

5. California's Emissions Warranty and Recall Programs

CARB initially adopted emissions warranty regulations for new California-certified passenger cars, light-duty trucks, medium-duty vehicles, heavy-duty vehicles, and motorcycles in 1978, and EPA confirmed that those regulations were within the scope of previously granted waivers in 1979.[13]

In 1982, CARB adopted regulations that established emissions-related defects reporting, in-use vehicle recall, and in-use vehicle enforcement testing requirements for passenger cars, light-duty trucks, medium-duty vehicles, heavy-duty vehicles, and motorcycles, to ensure that in-use vehicles comply with applicable emissions standards

[12] 82 Fed. Reg. 4867 (Jan. 17, 2017). The Heavy-Duty Conpliance Regulation and the 2008 and 2011 amendments to that regulation established accompanying enforcement procedures to California's emissions standards for 2007 and subsequent model year heavy-duty diesel engines and vehicles.

[13] 44 Fed. Reg. 61096 (Oct. 23, 1979).

during in-use operations. EPA confirmed that those regulations were within the scope of previously granted waivers in 1979.[14]

CARB adopted the California Emission Warranty Information Reporting (EWIR) Regulations that require manufacturers to monitor and report emission control component defects in 1988. EPA confirmed these regulations were within the scope of previously granted waivers in 1990.[15]

In 1999 and 2001, CARB adopted amendments to the California heavy-duty diesel regulations that, in pertinent part, essentially aligned California emissions warranty provisions and emissions-related maintenance intervals for on-road heavy-duty diesel engines used in heavy-duty vehicles with the corresponding federal emissions warranty and emission-related maintenance intervals. EPA granted California a waiver for these amendments in 2005.[16]

6. California's Heavy-Duty Diesel Engine Idling Regulation

In 2005, CARB adopted California's Heavy-Duty Diesel Engine Idling Regulation. One element of that regulation requires new California-certified 2008 and subsequent MY on-road diesel engines in trucks with a GVWR greater than 14,000 lbs to either be equipped with a system that automatically shuts down the engine after five minutes of continuous idling or to be certified to an optional NOx idling emission standard of 30 grams of NOx per hour under loaded, low and high idle operating conditions. EPA granted California a waiver for that element of California's Heavy-Duty Diesel Engine Idling Regulation in 2012,[17] and for 2008 and 2011 amendments to those requirements in 2017.[18]

One element of California's Heavy-Duty Diesel Engine Idling Regulation established emission requirements for auxiliary power units (APUs) mounted on trucks. APUs are not required to be installed on trucks, but many trucks owners elect to install APUs on trucks to supply power for truck cab or sleeper berth climate control purposes and/or other on-board accessories that would otherwise have been generated by the continuous idling of the truck's main engine. Most APUs installed on sleeper berth equipped trucks are powered by small diesel-fueled engines rated at or less than 19 kilowatts (kW)-(equivalent to 26 horsepower (hp)), that are subject to California and federal off-road engine emission standards.[19]

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[14] 49 Fed. Reg. 43502 (Oct. 2, 1984).

[15] 55 Fed. Reg. 28823 (July 13, 1990).

[16] 70 Fed. Reg. 50322 (Aug. 26, 2005).

[17] 77 Fed. Reg. 9239 (Feb. 16, 2012).

[18] 82 Fed. Reg. 4867 (Jan. 17, 2017).

[19] In this request the term "off-road" is used interchangeably with the federal term "nonroad."

California's Heavy-Duty Diesel Engine Idling Regulation specifically requires that beginning January 1, 2008, diesel-fueled APUs installed on trucks powered by 2007 and subsequent MY heavy duty diesel engines must comply with the California or federal off-road emission standards and test procedures applicable to the hp category of the engines and, additionally, to:

- route the exhaust from the APU into the truck's exhaust system so that the APU's particulate matter (PM) emissions are controlled by the truck's PM trap; or

- be equipped with a level 3 verified PM control strategy (i.e., achieve an 85 percent PM reduction efficiency);[20] or

- use other procedures to demonstrate an equivalent level of emissions compliance (compared to a level 3 verified PM control strategy), subject to advance Executive Officer approval.

CARB's verification procedures involve a thorough evaluation of the emission reduction capability of a trap and of its durability. The verification process ensures that the emission reductions achieved by the trap are both real and durable, and that production units in the field are achieving emission reductions that are consistent with the verification. It also requires the manufacturer to warrant that its PM trap is free from defects in design, materials, workmanship, and that operation of the trap achieves the emission reduction levels it was verified to achieve.

7. California's Off-Road Compression Engine Emission Standards

In 2005, CARB adopted amendments to the California off-road compression-ignition (CI) engine regulations that harmonized the California emission standards and test procedures with the federal emission standards and test procedures as established in the federal Tier 4 rulemaking (40 CFR Part 89) and the subsequent Omnibus Technical Amendments (70 Fed. Reg. 40240 (July 13, 2005)), while still maintaining the emission benefits of the current California program. The California Tier 4 exhaust emission standards for new off-road CI engines rated less than 19 kW are applicable to new 2008 and subsequent MY engines. EPA granted California an authorization for these emission standards in 2010.[21]

In 2012, CARB adopted amendments to the California Tier 4 off-road engine requirements to align California test procedures for off-road engines with the corresponding federal test procedures, after EPA updated the federal off-road test

[20] The PM trap verification procedure and in particular, the level 3 verification level, are specified in title 13, CCR sections 2700 to 2710.

[21] 75 Fed. Reg. 8056 (Feb. 23, 2010).

procedures in 2008. The amendments did not affect the stringency or the emission benefits of the previously authorized emission standards or associated test procedures. EPA confirmed that the amendments were within the scope of the previously issued authorization for the California Tier 4 off-road engine Regulation.[22]

8. California's Certification Procedures for Hybrid-Electric Buses and Hybrid-Electric Heavy-Duty Vehicles

In 2002, CARB adopted certification procedures for 2004 and subsequent model year hybrid electric buses and hybrid-electric heavy-duty vehicles as part of a rulemaking action that also established emission standards for urban bus engines. Those certification procedures are based on the usage of a chassis dynamometer, because hybrid-electric vehicles are comprised of both electric drive systems and an internal combustion engine, and consequently engine-dynamometer testing alone will not accurately reflect the emission benefits provided by hybrid-electric drive systems. The certification procedures were entirely optional; in lieu of testing, manufacturers could continue to use existing engine dynamometer based test procedures. EPA granted California a waiver for the hybrid-electric certification procedures in 2013.[23]

In 2014, CARB amended the certification procedures for 2004 and subsequent model hybrid-electric buses and heavy-duty vehicles to extend the applicability of the procedures to additional categories of hybrid technology, such as hydraulic, turbine, flywheel, and fuel-cell technologies, and to ensure that the procedures accurately measure and quantify the emissions reductions attributable to the hybrid technologies used in a wider range of heavy-duty vehicles.[24]

II. OVERVIEW OF CARB'S RULEMAKING ACTION

At its August 27, 2020 public hearing, the Board approved the Omnibus Regulation by Resolution 20-23 (Enclosure 5). At the direction of the Board, after making modifications to the Regulation available for supplemental public comment, CARB's Executive Officer formally adopted the rulemaking in Executive Order R-21-007 on September 9, 2021 (Enclosure 10). The Regulation was approved by California's Office of Administrative Law (OAL), filed with California's Secretary of State, and became operative under state law on December 22, 2021.

[22] 80 Fed. Reg. 76971 (Dec. 11, 2015).

[23] 78 Fed. Reg. 44112 (July 23, 2013).

[24] CARB has requested that EPA grant a waiver for the 2014 amendments to the certification procedures for hybrid-electric vehicles and is awaiting EPA's final action on that request.

III. SUMMARY OF THE OMNIBUS REGULATION'S EMISSIONS STANDARDS AND OTHER EMISSIONS-RELATED REQUIREMENTS

This section provides an overview of the emissions-related and accompanying enforcement provisions of the California Omnibus Regulation for which CARB is requesting a waiver. More detailed descriptions of these provisions are provided in the Staff Report: Initial Statement of Reasons (Staff Report, Enclosures 2 and 4), the Notices of Public Availability of Modified Text (Enclosures 7 and 8), and the Final Statement of Reasons (FSOR, Enclosure 9).

A. Medium- and Heavy-Duty Engine NOx and PM Exhaust Emission Standards

The Omnibus Regulation primarily establishes more stringent NOx and PM exhaust emission standards for new 2024 and subsequent MY medium- and heavy-duty diesel-cycle and Otto-cycle engines.

The new standards are based on both pre-existing certification cycles, including the heavy-duty transient Federal Test Procedure (FTP),[25] the ramped modal cycle (RMC),[26] and the idling test procedure,[27] as well as on a new low load cycle (LLC) that reflects engine operations under low load and low speed urban driving operations. The emission standards and associated test procedures apply to new heavy-duty diesel-cycle and Otto-cycle engines used in heavy-duty vehicles with GVWR greater than 14,000 lbs, and new medium-duty diesel-cycle and Otto-cycle engines used in medium-duty vehicles with GVWR between 10,001 and 14,000 lbs that optionally certify to the requirements in 13 CCR 1956.8.[28]

1. NOx Exhaust Emission Standards

The exhaust emission standards implement more stringent NOx emission standards in two phases, which will help minimize the impacts on engine manufacturers' product

[25] "FTP" is the heavy-duty transient Federal Test Procedure duty cycle specified in 40 CFR §86.007-11(a)(2), as amended October 25, 2016.

[26] "RMC" is the ramped modal cycle specified in 40 CFR §86.1360, as amended October 25, 2016. The RMC represents steady-state highway operations.

[27] The Idling test procedure is the duty cycle specified in Part 86, Subpart A, section 11.B.6 of the California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles, as amended on April 18, 2019. https://ww3.arb.ca.gov/msprog/onroadhd/documents/hddtps_warranty_10-19.pdf

[28] Medium-duty vehicles (from 8,501 to 14,000 lbs GVWR) are generally subject to the Low Emission Vehicle III (LEV III) chassis certification emission standards in 13 CCR § 1961.2, but manufacturers have the option to certify a subset of such engines that are used in incomplete Otto-cycle and incomplete and complete diesel-cycle medium-duty vehicles to the engine-dynamometer based emission standards in 13 CCR § 1956.8.

development cycles. The NOx emission standards are shown below in Table III-1 and III-2.

Table III-1. Medium- and Heavy-Duty Diesel- and Otto-Cycle Engine NOx Standards for 2024 through 2026 MYs

MY	Diesel-Cycle Engines[29]				Otto-Cycle Engines[30]
	FTP (g/bhp-hr)*	RMC (g/bhp-hr)	LLC (g/bhp-hr)	Idling (g/hr)**	FTP (g/bhp-hr)
2024-2026	0.050	0.050	0.200	10	0.050

*grams per brake-horsepower-hour
** grams per hour

[29] The exhaust emission standards for nonmethane hydrocarbons (NMHCs) and carbon monoxide (CO) are 0.14 and 15.5 g/bhp-hr respectively, as measured on the FTP, RMC-SET, and LLC test cycles.

[30] The exhaust emission standards for NMHC, CO, and formaldehyde are 0.14, 14.4, and 0.01 g/bhp-hr, respectively, as measured on the FTP test cycle.

Table III-2 Medium- and Heavy-Duty Diesel- and Otto-Cycle Engine NOx Standards (2027 and Subsequent MYs)

Test Procedure	Medium-Duty, Light Heavy- and Medium Heavy-Duty Diesel Engines[31]	Medium-Duty and Heavy-Duty Otto-Cycle Engines[32]
FTP cycle (g/bhp-hr)	0.020	0.020
RMC cycle (g/bhp-hr)	0.020	---
Low-load cycle (g/bhp-hr)	0.050	---
Idling (g/hr)	5	---

Test Procedure	Heavy Heavy-Duty Diesel Engines			
	2027 – 2030 MY		2031 and Subsequent MY	
	Intermediate Useful Life Std[33]	Full Useful Life	Intermediate Useful Life Std	Full Useful Life
FTP cycle (g/bhp-hr)	0.020	0.035	0.020	0.040
RMC cycle (g/bhp-hr)	0.020	0.035	0.020	0.040
Low-load cycle (g/bhp-hr)	0.050	0.090	0.050	0.100
Idling (g/hr)	5	5	5	5

The new LLC NOx exhaust emission standard and associated test procedure will allow CARB to more accurately assess the capability of medium- and heavy-duty diesel engines equipped with selective catalytic reduction (SCR) systems to reduce emissions of NOx. The NOx conversion efficiency of such systems are strongly dependent on the temperature of the exhaust gas, and below a relatively narrow temperature range, the NOx conversion efficiency of such systems drops precipitously.

The pre-existing medium- and heavy-duty engine certification test cycles, namely the FTP and RMC, do not accurately reflect the emissions performance of SCR-equipped engines in the real world, because they do not incorporate test conditions that reflect sustained engine operations at low engine loads, such as engine idling. The LLC standard and test procedure will therefore better ensure that engine manufacturers will take into account low-load operating conditions when they design emission control systems and aftertreatment strategies, and therefore better ensure that their emissions

[31] See footnote 29.

[32] See footnote 30.

[33] Intermediate Useful Life is the period of use of 435,000 miles or 8 years or 22,000 hours, whichever first occurs. 13 CCR § 1956.8(j)(11)

control systems will be capable of controlling NOx emissions during such low-load conditions.

2. PM Exhaust Emission Standards

The preexisting emission standard for PM for medium- and heavy-duty engines was 0.01 g/bhp-hr on the FTP and RMC test cycles. Certification data indicated that most medium- and heavy-duty engines were capable of certifying to significantly lower levels of PM (approximately 0.001 g/bhp-hr), but CARB staff observed that some engine manufacturers were recently certifying some engine families to much higher PM emission levels (about 0.005 g/bhp-hr), likely because those manufacturers elected to use less efficient (i.e., more porous) diesel particulate filters (DPFs) to reduce engine backpressure and to improve fuel economy, but which increases PM emission levels. In order to ensure that manufacturers do not impair the effectiveness of existing PM exhaust emission control strategies, the Regulation establishes a PM exhaust emission standard of 0.005 g/bhp-hr for 2024 and subsequent MY engines.[34]

B. Optional Low NOx Exhaust Emission Standards

The Regulation establishes optional Low NOx exhaust emission standards for 2022 and subsequent MY diesel- and Otto-cycle heavy-duty engines that are more stringent than the primary exhaust emission standards discussed in Section III.A of this document. The optional standards are intended to encourage manufacturers to develop and produce engines that emit levels of NOx emissions that are lower than even the primary NOx emission standards, and to the extent manufacturers do so, those manufacturers' efforts will provide California with additional NOx emissions benefits.

The optional NOx standards for diesel and Otto-cycle heavy-duty engines are shown below in Tables III-3 and III-4, respectively.

[34] This PM standard is measured over the FTP, RMC, and the LLC test cycle for medium- and heavy-duty diesel engines, and over the FTP cycle for medium- and heavy-duty Otto-cycle engines.

Table III-3. Optional Low NOx Standards for Heavy-Duty Diesel-Cycle Engines Used in Vehicles >14,000 lbs GVWR

Model Year	Test Procedure	Oxides of Nitrogen (NOx)	Non-methane Hydrocarbons NMHC	Carbon Monoxide CO	Particulates PM
2022-2023[A]	FTP and RMC	0.10, 0.05, 0.02, or 0.01	0.14	15.5	0.01
2024-2026[A]	FTP and RMC / LLC	0.020 / 0.080	0.14	15.5	0.005
	FTP and RMC / LLC	0.010 / 0.040			
2027 and subsequent Model Year[A]	FTP and RMC/ LLC	0.010 / 0.025	0.14	15.5	0.005

A. A manufacturer may not include an engine family certified to the optional NOx emission standards in the federal or CA Averaging, Banking, and Trading (ABT) programs for NOx, but may include such engine families in the ABT programs for particulate emissions.

Table III.4 Optional Low NOx Standards for Heavy-Duty Otto-Cycle Engines Used in Vehicles >14,000 lbs. GVWR

Optional Low NOx Exhaust Emission Standards for 2024 and Subsequent Model Otto-Cycle Heavy-Duty Engines* (g/bhp-hr)						
Test Procedure	**Model Year**	**Oxides of Nitrogen (NOx)**	**Non-methane Hydrocarbons NMHC**	**Carbon Monoxide (CO)**	**Formaldehyde (HCHO)**	**Particulates PM**
FTP	2022-2023	0.1, 0.05, 0.02, or 0.01	0.14	14.4	0.01	0.01
FTP	2024- 2026	0.010 or 0.020	0.14	14.4	0.01	0.005
FTP	2027 and Subsequent	0.010	0.14	14.4	0.01	0.005

* A manufacturer may not include an engine family certified to the optional NOx emission standards in the federal or California ABT programs for NOx, but may include such engine families in the ABT programs for particulate matter emissions.

C. Heavy-Duty Diesel Engine Durability Demonstration Program and In-Use Emissions Data Reporting Requirements

The Regulation establishes the following durability demonstration program requirements for new 2024 and subsequent MY medium- and heavy-duty diesel engines, and diesel hybrid powertrain families optionally certified pursuant to title 13, CCR, section 1956.8 for use in incomplete vehicles from 10,001 to 14,000 lbs GVWR.[35]

1. Extended Break-In Period

Engine manufacturers typically accumulate 125 hours of service on an engine before conducting an emissions test, to ensure that the engine's emission levels have stabilized before the test begins. This period is commonly referred to as the break-in period. When the default 125-hour break-in requirement was initially established in 1989, manufacturers did not utilize exhaust aftertreatment systems to control emissions from on-road heavy-duty engines (HDDEs).

Currently, all on-road HDDEs incorporate exhaust aftertreatment systems, including diesel oxidation catalysts (DOCs), diesel particulate filters (DPFs), and selective catalytic reduction (SCR) systems to control exhaust emissions. The increased reliance of current HDDEs on such aftertreatment systems, and especially the SCR system, requires a longer break-in period to ensure that aftertreatment systems have stabilized in their ability to control exhaust emissions. Consequently, the Regulation now specifies a default break-in period of 300 hours for 2024 and subsequent MY on-road heavy-duty engines. Manufacturers have the option of using a shorter break-in period if they can demonstrate that their engines' emissions are stabilized in a shorter break-in period, via periodic emissions testing using applicable certification emissions test cycles.

2. Standardized Aging Cycles

The preexisting durability demonstration program specified that manufacturers of on-road HDDEs determined the form and extent of aging cycles, consistent with good engineering judgment, and provided manufacturers flexibility to propose and use customized aging cycles in conducting their durability demonstration programs.

The Regulation now requires manufacturers to use one of two standardized aging cycles. Each standardized aging cycle is comprised of certification test cycles that are, in turn, developed from data generated from actual in-use heavy-duty vehicles, and therefore more accurately reflect how engines are actually operated in the real world, rather than proposed aging cycles that are designed to complete the aging process as quickly as possible. The two standardized aging cycles (Cycle-1 and Cycle-2) are further described in Figure III-1 and III-2.

[35] The durability demonstration and model year implementation schedules for such powertrains are identical to the durability demonstration and model year implementation schedules specified for the class of diesel engines used in such powertrains.

Figure III-1. Cycle-1 Service Accumulation Cycle

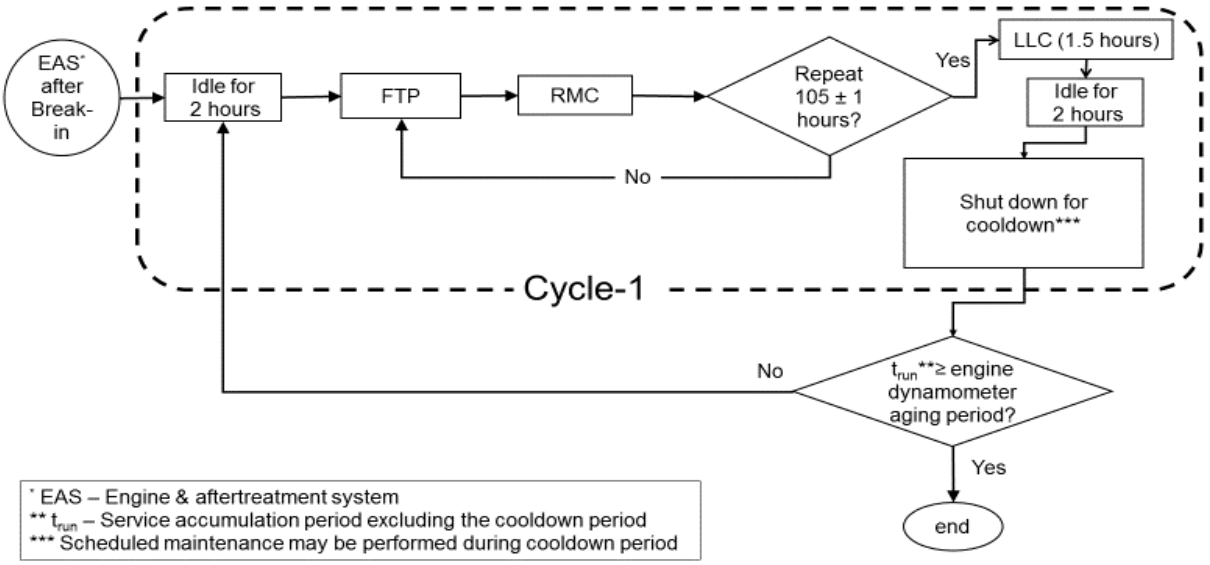
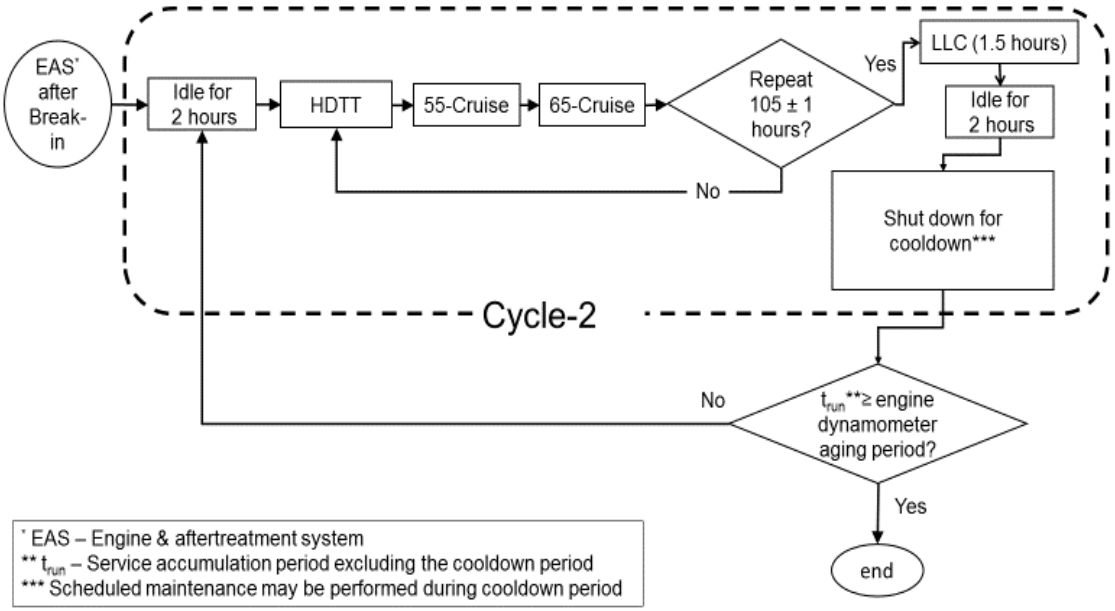


Figure III-2. Cycle-2 Service Accumulation Cycle



As indicated by Figures III-1 and III-2, Cycle-1 uses the standard engine certification cycles (FTP, RMC, and LLC) for aging the engine and aftertreatment system. Cycle-2 uses the standard chassis certification cycles specified in the Phase 2 Greenhouse gas

Emissions Model (GEM), which is used to demonstrate compliance with both the federal and California Phase 2 greenhouse gas emission standards for medium- and heavy-duty engines and vehicles (these cycles include the Heavy-Duty Transient Test Cycle (HDTT), a 55 mile per hour highway cruise cycle (55-cruise), and 65 mph highway cruise cycle (65-cruise).

The Regulation requires manufacturers to first use the Phase 2 GEM model to generate engine dynamometer cycles for the HDTT, 55-cruise, and 65-cruise cycles, then requires manufacturers to compare those cycles to the standard engine dynamometer certification cycles (FTP, RMC), and then to finally use the service accumulation cycle that generates the highest load factor, as calculated via the following equation:

$$Load\ Factor = \frac{\int_0^T P_i \cdot dt}{P_{max} \cdot D}$$

where:

P_i = Instantaneous engine power (hp)
D = Total duration of the cycle (seconds)
P_{max} = Maximum engine power rating (hp)
t = time (seconds)

3. Extension of Required Aging Hours to Full Useful Life

Heavy-duty diesel engine manufacturers currently use aging cycles that are intended to represent aging of the engine and aftertreatment system to approximately 35 to 50 percent of the applicable useful lives. After manufacturers complete their aging programs, they extrapolate the durability emissions data to the full useful lives of the engines and aftertreatment systems to calculate the deterioration factors for each durability data engine. Based on information regarding recent recalls and defects reporting for heavy-duty engines and vehicles, CARB concluded that the preexisting durability demonstration program (DDP) was not accurately simulating the factors that result in or contribute to engine and emission control system deterioration.

The Regulation accordingly extends the length of the preexisting DDP to the full useful life of the engine and aftertreatment system for 2024 and subsequent MY medium-duty diesel engines and HDDEs. As discussed in Section III.E, another element of the Regulation extends the useful lives of 2027 and subsequent MY HDDEs, 2024 and subsequent MY medium-duty engines used in medium-duty vehicles, and diesel hybrid and Otto hybrid powertrain families that are certified to the optional standards in 13 CCR section 1956.8, and therefore the requirements described in this section and in Section III.E collectively increase the minimum hours that medium- and heavy-duty diesel engines must be aged under the DDP. A more detailed description of this element of the Regulation is provided in Sections III.A.8.4, and 8.7 through 8.9 of the Staff Report (Enclosure 2), and in the Notice of Public Availability of Modified Text, pp. 45-50 (Enclosure 7)

a. Accelerated Aftertreatment Aging

The Regulation requires heavy-duty engines to accumulate a minimum percentage of the required aging cycles on an engine dynamometer, but also allows manufacturers to utilize a process that is designed to accelerate the aging of exhaust aftertreatment systems, and correspondingly reduce the duration of the DDP. CARB staff estimates that 1,000 hours of accelerated aftertreatment aging could represent approximately 435,000 miles of service accumulation (on a chassis dynamometer or approximately 9,800 hours of operation on an engine dynamometer). One possible method for accelerated aftertreatment aging is the Diesel Aftertreatment Accelerated Aging Cycle (DAAAC) which was developed by Southwest Research Institute (SwRI) to model aging of an aftertreatment systems by exposing such systems to thermal and chemical degradation.

i. Model year applicability

Only heavy heavy-duty and medium heavy-duty diesel engines are eligible to use accelerated aftertreatment aging beginning with the 2024 MY, light-heavy-duty diesel engines are eligible to use accelerated aftertreatment aging beginning with the 2027 MY, and the allowable number of hours such engine categories can utilize accelerated aftertreatment aging increase until the 2031 MY. The Regulation provides manufacturers options to utilize different amounts of accelerated aftertreatment aging, as well as the option of proposing alternative accelerated aging protocols.

ii. In-Use Vehicle Emissions Data Reporting

Manufacturers that elect to use accelerated aftertreatment aging must periodically submit data generated from in-use HDDEs to CARB. Such data includes engine run times, mass emissions of NOx from both the engine and the tailpipe, and the distance traveled. The data must be collected and stored in the engines' on-board computers, and will help CARB assess how accurately the accelerated aftertreatment aging simulates the real world emission deterioration of in-use engines. The reporting obligations only apply during the useful life of each engine. Manufacturers that submit in-use emissions reports for more than 50 percent of their California sales volumes of 2024 through 2030 MY engines, for three consecutive MYs, are eligible to use longer periods of accelerated aftertreatment aging for 2024 through 2030 engines. Manufacturers that submit in-use emissions reports for more than 50 percent of their California sales volumes of 2031 and subsequent MY engines, for five consecutive MYs, are eligible to use longer periods of accelerated aftertreatment aging for 2031 and subsequent MY engines.

D. Amendments to Heavy-Duty On-Board Diagnostic System (HD OBD) and OBD II System Requirements

Both the HD OBD and the OBD II Regulation specify malfunction emission thresholds for emissions critical components and systems that are based on emissions increases relative to the underlying emissions standard. For example, OBD systems must detect an exhaust gas recirculation (EGR) system malfunction when the EGR flow rate has decreased to the point that NMHC, CO, or NOx emissions are exceeding 2.0 times any of the applicable standards, or PM emissions are exceeding the applicable PM standard by more than 0.02 g/bhp-hr.

As discussed in Sections III.A and B, the Regulation establishes primary and optional NOx emission standards and primary PM exhaust emission standards that are more stringent than the preexisting NOx and PM exhaust emission standards. Engine manufacturers have requested that CARB grant them interim relief with respect to the HD OBD and OBD II Regulations by allowing them to use malfunction emission thresholds that are based on the preexisting exhaust emission standards, rather than the newly established exhaust emission standards. To accommodate those concerns, the Regulation allows HD OBD and OBD II systems in medium-duty and heavy-duty engines and vehicles that are certified to either the optional NOx emission standards or the primary NOx and PM emission standards to utilize malfunction emission thresholds that are based on the preexisting exhaust emission standards, rather than the otherwise applicable exhaust emission standards. The Regulation also incorporates conforming modifications to the HD OBD and OBD II Regulations "test-out" criteria, that allow manufacturers to demonstrate that a specific component has no or minimal impact on emissions, and is therefore exempt from OBD monitoring, and to the HD OBD Enforcement Regulation's nonconformance criteria, to accommodate engines that are certified to an FTP-based NOx emission standard of 0.10 g/bhp-hr or lower.

Based on past experience, CARB staff expects that the majority of OBD monitors are already capable of detecting faults at emission levels lower than the proposed thresholds, with minimal revisions. For example, many EGR systems can be designed with adaptive controls such that as exhaust gas passages become restricted and reduce the flow, the system automatically adjusts to command more flow until it achieves the desired flow amount. In such a system, essentially no degradation in emissions occurs until the system is so restricted that the system reaches its maximum control authority and can no longer achieve the desired flow. Appropriate sizing of the EGR system could then allow an OBD system to detect a fault at this same point of reaching the control limits, whether the engine meets a 0.20 or 0.020 g/bhp-hr standard and result in emission levels that are proportionally similar such as 2.0 times the standard itself. From the information submitted during OBD certification, staff would be able to verify both the emission level at which faults are actually being detected and the level of degradation of the component being detected. If manufacturers are able to calibrate the system to delay detection of faults until even more component degradation occurs than is typical of today's OBD systems, it will be a clear indication that the malfunction threshold relief is not needed and will support an immediate further tightening of the threshold. Accordingly, CARB staff expects to track manufacturers' progress with respect to designing OBD systems capable of detecting lower malfunction emission thresholds and will likely suggest that the Board adopt more stringent malfunction emission thresholds if warranted.

E. Extended Useful Life Periods for Heavy-Duty Engines Used in Heavy-Duty Vehicles

Manufacturers must demonstrate that their engines comply with applicable emission standards throughout specified periods of time or engine operation, commonly referred to “useful life periods.” Manufacturers must ensure that their engines comply with emission standards not only at the time they are seeking to certify new engines with CARB, but must also ensure that their production engines comply with in-use requirements throughout their useful life periods.

Historically, useful life periods for heavy-duty engines were developed to roughly align with the periods of time or periods of engine operation corresponding to when the engines were rebuilt or retired. Recent data indicates, however, that current heavy-duty engines are operating for periods that are significantly longer than their currently applicable useful life periods. The Regulation therefore phases in extended useful life periods for heavy-duty engines between the 2027 and the 2031 MYs, in order to both better account for the longer service lives of current heavy-duty engines, and to encourage manufacturers to produce durable engines and emissions control components.

Table III-5 shows the preexisting useful life periods and new useful life periods for 2027 and subsequent MY heavy-duty engines used in heavy-duty vehicles weighing greater than 14,000 lbs GVWR. The 2031 MY useful life periods are roughly equivalent to 80 percent of current heavy-duty engine service lives.

Table III-5 Preexisting and New Heavy-Duty Engine Useful Life Periods

Engine / Vehicle Category (GVWR)	Preexisting Useful Life Periods (Miles)	MY 2027 Useful Life Periods (Miles)	MY 2031 Useful Life Periods (Miles)
Heavy Heavy-Duty Diesel (HHDD)/ Class 8 >33,000 lbs	435,000 10 years 22,000 hours	600,000 11 years 30,000 hours	800,000 12 years 40,000 hours
Medium Heavy-Duty Diesel (MHDD) / Class 6-7 19,501 - 33,000 lbs	185,000 10 years	270,000 11 years	350,000 12 years
Light Heavy-Duty Diesel (LHDD) / Class 4-5 14,001 - 19,500 lbs	110,000 10 years	190,000 12 years	270,000 15 years
Heavy-Duty Otto (HDO) >14,000 lbs	110,000 10 years	155,000 12 years	200,000 15 years

The 2031 MY useful life periods for light heavy-duty diesel and medium heavy-duty diesel engines are equivalent to approximately 80 percent of their respective engine category current service lives. The 2031 MY useful life periods for heavy heavy-duty diesel engines and heavy-duty Otto-cycle engines are equivalent to approximately 94 and 92 percent of their engine category current service lives, respectively.

The heavy heavy-duty diesel engine category is the only engine category that specifies an operating hour limit in the useful life period. That hour limit was established to account for engines used in vehicle applications that typically travel at much lower speeds and accumulate miles much more slowly than line-haul trucks (e.g., urban buses) or that are used mainly in vehicle applications requiring numerous start/stop or extended idling operations (e.g., in refuse trucks). The preexisting hour limit of 22,000 hours is present in both the federal and California definitions for useful life, and was scaled to address the longer useful life requirements adopted in 2027 and 2031. As indicated in Table III-5, the Regulation increases the preexisting operating hour limit for heavy heavy-duty diesel engines by over 80 percent for 2031 MY engines.

1. Useful Life Periods for Heavy-Duty Hybrid Powertrains Used in Heavy-Duty Vehicles

2022 and subsequent MY diesel and Otto-cycle hybrid powertrains that are certified to the optional standards in 13 CCR 1956.8 are subject to the same useful life periods of the diesel and Otto-cycle engines that would typically be used in a comparably sized vehicle, respectively. For example, the useful life periods for diesel hybrid powertrains used in complete vehicles with GVWR ratings from 14,001 to 19,500 lbs, from 19,501 to

33,000 lbs, and greater than 33,000 lbs are identical to the useful life periods for light-heavy-duty, medium heavy-duty, and heavy heavy-duty diesel engines, respectively.

2. Useful Life Periods for 2024 and Subsequent MY Medium-Duty Diesel and Otto-cycle Engines Used in Medium-Duty Vehicles, and 2022 and Subsequent MY Hybrid Powertrains Certified to the Standards in 13 CCR Section 1956.8 for Use in Medium-Duty Vehicles With GVWRs From 10,001-14,000 lbs

The Regulation establishes that the useful life period for 2024 and subsequent MY medium-duty diesel and Otto-cycle engines used in medium-duty vehicles with GVWR from 10,001 to 14,000 lbs is 15 years or 150,000 miles, whichever first occurs. The preexisting useful life period for such engines was 11 years or 120,000 miles.

The Regulation also establishes that the useful life periods for 2022 and 2023 MY diesel and Otto-cycle hybrid powertrains used in incomplete vehicles with GVWR from 10,001 to 14,000 lbs are 10 years or 110,000 miles, whichever first occurs, and that 2024 and subsequent model diesel and Otto-cycle hybrid powertrains that are certified to the optional standards in 13 CCR section 1956.8 and used in incomplete vehicles with GVWRs from 10,001 to 14,000 lbs are now subject to useful life period of 15 years or 150,000 miles, whichever first occurs.

F. Emissions Averaging, Banking, and Trading Program Amendments

California's preexisting emission regulatory programs for medium and heavy-duty diesel and Otto-cycle engines include emissions averaging, banking, and trading (ABT) programs, which provide manufacturers the flexibility to comply with applicable emission standards on a corporate-wide basis, rather than on an individual engine family basis. The ABT program also provides manufacturers the option of trading or banking any excess emission credits generated under the ABT program; the quantity of any such credits is based on the difference between the applicable emissions standard and a specified average emissions level, the family emissions limit, for specified categories of engines. California's preexisting ABT program allows manufacturers to participate in the federal ABT program (i.e., to generate and use ABT credits generated from heavy-duty engines sold throughout the nation), because the preexisting California emissions standards for heavy-duty diesel and Otto-cycle standards are essentially aligned with the corresponding federal emission standards.

The preexisting regulations define the following separate ABT averaging sets (pools) of credits for heavy-duty engines:

- Heavy-Duty Otto (HDO) averaging set, which includes medium-duty and heavy-duty Otto-cycle engines.
- Light Heavy-Duty Diesel (LHDD) averaging set which includes medium-duty and light heavy-duty diesel engines.
- Medium Heavy-Duty Diesel (MHDD) averaging set, which includes medium heavy-duty diesel engines, and

- Heavy Heavy-Duty Diesel (HHDD) averaging set, which includes heavy heavy-duty diesel engines.

For the HDO averaging set, ABT is available for NOx and NMHC. For the LHDD, MHDD, and HHDD averaging sets, ABT is available for NOx and PM. Cross trading of emission credits between different ABT averaging sets is prohibited. This prevents manufacturers from producing high-emitting engines in a specific service class and counterbalancing that with production of lower-emitting engines in another service class.

As discussed above in Sections III.A and III.B, the Regulation establishes NOx and PM exhaust emission standards for medium- and heavy-duty diesel-cycle and Otto-cycle engines that are more stringent than comparable federal standards. The Regulation accordingly amends the California ABT program for medium- and heavy-duty engines to reflect the fact that the California and federal exhaust emission standards will not be aligned, beginning with the 2024 MY, and to incentivize manufacturers to certify engines to the optional NOx standards discussed in Section III.B, and to certify engines to the primary exhaust emission standards discussed in Section III.A earlier than required. The primary elements of the ABT amendments are discussed below. A more complete description of the elements is set forth in Section III.A.7 of the ISOR (Enclosure 2) and pages 81-84 of the 30-Day Notice of public availability of amendments (Enclosure 7) and pages 10-12 of the 15-Day Notice of public availability of amendments (Enclosure 8).

1. California-only ABT

Beginning with the 2022 MY, only qualifying 2022 and subsequent MY California certified medium-duty, heavy-duty, and optionally certified hybrid engine families may earn NOx and PM credits (or NOx and NMHC credits) under California's program, and participate in California's ABT program. Manufacturers may earn California credits by certifying engines to standards that are more stringent than the applicable primary exhaust emission standards or by certifying engines to the primary exhaust emission standards earlier than required. The equation used to calculate credits accounts for the useful life of the engine family or hybrid powertrain family that is generating the credit, and consequently requires manufacturers to accrue proportionally larger amount of credits from earlier MY engine or hybrid powertrain families to offset debits resulting from certifying engines to later MY standards.

Manufacturers may transfer a portion of their federal ABT credits that were earned from certifying 2010 through 2021 MY engine families into the California ABT program, but the federal ABT credits will be adjusted to reflect the percentage of California sales to 50-state sales during the 2019 to 2021 model years. Credits in the California-only ABT program will have a lifetime of five model years, and, with the exception of zero emission credits, may only be used within the averaging set associated with the engine, which is based on the primary intended service class of the engine (i.e., light, medium, or heavy heavy-duty engines). Manufacturers that delay participating in the California ABT program until the 2023 or 2024 MYs are not eligible to transfer any banked federal-ABT credits into the California ABT program.

a. Zero Emission Averaging Set

Manufacturers that certify 2022 through 2026 zero emission powertrain families used in class 4 through 8 vehicle models can earn NOx, PM (for diesel-cycle only), and NMHC (for Otto-Cycle only) credits under the CA-ABT program. The averaging sets for zero emission powertrain families are based on the weight class of the vehicles in which the zero emission powertrains are placed in. Zero-emission NOx, PM, and NMHC credits expire in the 2026 MY and do not qualify for any early compliance multipliers, but can be transferred to any engine averaging set to offset deficits generated by any engine family.

2022 through 2023 MY zero emission powertrains must be used in a heavy-duty zero-emission vehicle that is certified under title 17, CCR, section 95663, and 2024 through 2026 MY zero emission powertrains must be certified to CARB's Zero Emission Powertrain Certification Standards in 13 CCR § 1956.8(a)(8).

b. Early Compliance Multipliers

Manufacturers that elect to voluntarily certify engines to primary standards earlier than required are eligible for compliance multipliers that range from 1.5 to 2.5. 2022 through 2026 zero emission powertrain families cannot earn early compliance multipliers.

G. Emissions Warranty-Related Provisions for 2027 and Subsequent Model Year Heavy-Duty Engines and 2022 and Subsequent Model Year Hybrid Vehicles and Hybrid Powertrains

The Regulation establishes emissions warranty provisions requirements for 2027 and subsequent MY heavy-duty diesel and Otto-cycle engines and heavy-duty vehicles exceeding 14,000 lbs GVWR that are equipped with such engines, regardless of whether such vehicles are registered in California, for 2022 and subsequent MY hybrid powertrains that are optionally certified to the emissions standards in 13 CCR 1956.8, and for 2022 and subsequent MY hybrid vehicles powered by such powertrains.

1. Extended Emissions Warranty Periods

The Regulation significantly extends the emissions warranty periods for 2027 and subsequent MY heavy-duty diesel and Otto-cycle engines and for 2027 and subsequent MY heavy-duty vehicles exceeding 14,000 lbs GVWR that are equipped with such engines, as indicated below in Table III-6.

Table III-6. Emission Warranty Periods for 2027 and Subsequent Model Year Engines and Vehicles > 14,000 lbs GVWR

Engine / Vehicle Category (GVWR)	Preexisting CA*/ Current Federal Warranty (Miles) (Years) [whichever occurs first]	MY 2027 (Miles) (Years) (Operating Hours) [whichever occurs first]	MY 2031 (Miles) (Years) (Operating Hours) [whichever occurs first]
HHDD / Class 8 >33,000 lbs	CA: 350,000 /5	450,000 7 years 22,000 hours	600,000 10 years 30,000 hours
	Federal: 100,000/5		
MHDD / Class 6-7 19,501 - 33,000 lbs	CA: 150,000/5	220,000 7 years 11,000 hours	280,000 10 years 14,000 hours
	Federal: 100,000/5		
LHDD / Class 4-5 14,001 - 19,500 lbs	CA: 110,000/5	150,000 7 years 7,000 hours	210,000 10 years 10,000 hours
	Federal: 100,000/5		
HDO >14,000 lbs	CA and Federal: 50,000/5	110,000 7 years 6,000 hours	160,000 10 years 8,000 hours

* The preexisting California emission warranty periods reflect the lengthened emissions warranty periods established by a separate rulemaking action that amended California's emissions warranty provisions for heavy-duty diesel engines and vehicles in 2018 (the 2018 HD Warranty Amendments). CARB has submitted a separate waiver request for that rulemaking action.

The extended emissions warranty periods are expressed in terms of both temporal and operational limits, and the operational limits are further expressed in terms of both mileage traveled and engine operating hours. The extended emissions warranty mileage limits are equivalent to approximately 75 to 80 percent of the useful life mileage periods of each heavy-duty vehicle category, as discussed above in Section III.E.

The Regulation primarily incorporates engine hourly operational limits within the emissions warranty periods to ensure that the lengthened warranty periods reasonably accommodate heavy-duty vocational vehicles. Vocational vehicles, such as refuse haulers and cement trucks, typically idle for many hours and/or are primarily driven at low speeds, and accordingly do not accumulate mileage as quickly as other categories of heavy-duty vehicles. In the absence of hourly operational limits, vocational vehicles could be subject to disproportionately lengthy emissions warranty coverage, compared to other categories of heavy-duty vehicles. For example, a Class 8 vocational vehicle

that operates mostly at idle or low speed, for 16 hours a day and 5 days per week, would accumulate approximately 4,160 hours per year at significantly less mileage accumulation, but similar wear and tear, than a cross country line haul truck operated the same number of hours. The hourly operational limits, therefore, serve to normalize warranty coverage for vehicle applications that do not accumulate mileage as quickly as line haul trucks. The hourly operational periods are only effective as limits to warranty when an accurate hour meter is provided by the engine manufacturer and is reasonably expected to operate properly over the useful life of the engine.

2. Extended Emissions Maintenance Intervals

a. 2027 and Subsequent Model Heavy-Duty Otto Engines and 2022 and Subsequent Model Year Heavy-Duty Otto-cycle Hybrid Powertrain Families Optionally Certified for Use in Hybrid Vehicles Pursuant to 13 CCR § 1956.8

The Regulation establishes minimum allowable maintenance intervals for emissions control components in 2027 and subsequent model year heavy-duty Otto engines in vehicles with a GVWR exceeding 14,000 lbs, and in 2022 and subsequent model year Otto-cycle hybrid powertrains that are optionally certified for use in hybrid vehicles pursuant to title 13, CCR § 1956.8. The minimum allowable repair or replacement maintenance intervals are shown in Table III-7 below.

The amendments to the maintenance schedules reduce the frequency of allowable maintenance involving the repair or replacement of emissions-related components in 2027 and subsequent model year heavy-duty diesel-cycle, otto-cycle, and engines used in hybrid powertrains. Table III-7 outlines the minimum allowable maintenance intervals for 2027 and subsequent model year heavy-duty Otto-cycle engines.

Amended maintenance schedules are needed to ensure that the lengthened warranty periods described in Section III.G.1 are not circumvented by the manufacturer. Unless the maintenance schedules had been amended, a manufacturer could have scheduled replacements of emissions related components at intervals that are more frequent than the newly lengthened warranty periods, and thereby minimized or completely avoided its obligations to comply with the lengthened warranty periods described in Section III.G.1.

Table III-7. Heavy-Duty Otto-Cycle Engine and Otto-Cycle Hybrid Powertrain Minimum Repair/Replacement Emissions Maintenance Schedule

Component or System	Preexisting California & Federal Minimum Maintenance Interval specified in §86.004-25 (miles or hours)	Minimum Repair or Replacement Interval (miles or years/hours)
Exhaust Gas Recirculation (EGR) System (filter & cooler – not including hoses)	50k or 1,500 hr	110k[a]
Exhaust Gas Recirculation (EGR) System (valve & tubing)	100k or 3,000 hr	110k
Crankcase Ventilation System	50k or 1,500 hr	50k or 10 years
Fuel Injectors	100k or 3,000 hr	110k
Turbochargers	100k or 3,000 hr	110k[a]
ECU, Sensors, Actuators (excluding Oxygen Sensors)	100k or 3,000 hr	110k
Oxygen Sensor	80k or 2,400 hr	110k
Carburetors	100k or 3,000 hr	110k
Evaporative Emission Canisters	100k or 3,000 hr	110k
Air Injection System Components	100k or 3,000 hr	110k [a]
Emission-related Hoses and Tubes	50k or 1,500 hr	110k
Ignition Wires	50k or 1,500 hr	100k or 4,000 hr
Catalytic Converter (bed only)	Not Replaceable [a]	Not Replaceable [a]
Catalytic Converter (other than catalyst bed)	100k or 3,000 hr	110k
Any other add-on or new technology emission related component or system whose primary purpose is to reduce emissions or whose failure will significantly degrade emissions control	NA	110k [c]

k – 1,000 miles; hr – hours

[a] Sensors and actuators are included only if they are integral to these assemblies and cannot be repaired without removing or replacing the assembly. Otherwise sensors and actuators would be subject to the maintenance intervals specified in the table for Electronic Control Units, Sensors, and Actuators.

[b] For components or systems designated in the table as "Not Replaceable," manufacturers would not be allowed to schedule any repair or replacement maintenance intervals throughout the applicable useful life of the heavy-duty Otto-cycle engine.

[c] Manufacturers may request more frequent repair / replacement maintenance intervals for add-on or new technology emission-related components provided that they demonstrate that such intervals are technologically necessary and appropriate.

b. 2022 and Subsequent Model Alternative-Fueled Heavy-Duty Diesel Engines, Heavy-Duty Diesel Engines Certified for Use in Hybrid Vehicles, and 2022 and Subsequent Model Diesel Hybrid Powertrains

The Regulation also establishes minimum allowable maintenance intervals for emissions control components in 2022 and subsequent MY heavy-duty diesel hybrid powertrains optionally certified for use in hybrid vehicles pursuant to title 13, CCR section 1956.8, and for alternative-fueled HDDEs and HDDEs used in hybrid vehicles. Those maintenance intervals are equivalent to the maintenance intervals established in a separate rulemaking action in which CARB amended provisions of the California emissions warranty for HDDEs and heavy-duty vehicles,[36] and are shown below in Table III-8. The current federal minimum maintenance intervals for repairing or replacing emission control components in heavy-duty diesel engines are set forth below in Table III-9 for comparative purposes.

[36] The 2018 HD Warranty Amendments. CARB has submitted a separate waiver request for that rulemaking action.

Table III-8: 2022 and Subsequent Model Year Alternative Fueled Heavy-Duty Diesel Engine, Heavy-Duty Diesel Engines Certified for Use in Hybrid Vehicles, and 2022 and Subsequent Model Year Diesel Hybrid Powertrain Minimum Repair/Replacement Emissions Maintenance Schedule

Component or System	Minimum Repair / Replacement Interval		
	Light Heavy-Duty Diesel Engine **14,000 lbs. < GVWR ≤ 19,500 lbs.**	**Medium Heavy-Duty Diesel Engine** **19,500 lbs. < GVWR ≤ 33,000 lbs.**	**Heavy Heavy-Duty Diesel Engine** **GVWR > 33,000 lbs.**
Exhaust Gas Recirculation (EGR) System (valves & cooler - not including hoses)	Not Replaceable[1,2]	Not Replaceable[1,2]	Not Replaceable[1,2]
Exhaust Gas Recirculation (EGR) System (other than valves & cooler)	110,000 miles, or 3 years	185,000 miles	435,000 miles
Crankcase Ventilation System	50,000 miles	60,000 miles, or 2,000 hours, or 1 year	60,000 miles, or 2,000 hours, or 1 year
Diesel Exhaust Fluid (DEF) Filter	110,000 miles, or 2 years	125,000 miles, or 3,000 hours, or 10 years	125,000 miles, or 3,000 hours
Fuel Injectors	110,000 miles	185,000 miles	435,000 miles
Turbochargers	Not Replaceable[1,2]	Not Replaceable[1,2]	Not Replaceable[1,2]
Electronic Control Unit, Sensors, and Actuators	100,000 miles, or 3,000 hours	150,000 miles, or 4,500 hours	150,000 miles, or 4,500 hours, or 5 years
Diesel Particulate Filter System (element only)	Not Replaceable[1]	Not Replaceable[1]	Not Replaceable[1]
Diesel Particulate Filter System (other than element)	110,000 miles	185,000 miles, or 3 years	435,000 miles, or 3 years
Catalytic Converter (bed only)	Not Replaceable[1]	Not Replaceable[1]	Not Replaceable[1]
Catalytic Converter (other than catalyst bed)	110,000 miles	185,000 miles	435,000 miles
Any other add-on or new technology emission-related component or system whose primary purpose is to reduce emissions or whose failure will significantly degrade emissions control	110,000 miles, or 3,300 hours[3]	185,000 miles, or 5,550 hours[3]	435,000 miles, or 13,050 hours[3]

1. For components or systems designated in the table as “Not Replaceable,” manufacturers shall not schedule any repair / replacement maintenance intervals throughout the applicable useful life of the heavy-duty diesel engine, defined in § 86.004-2 of the California Exhaust Emission Standards and Test Procedures for 2004 and Subsequent Model Heavy-Duty Diesel Engines and Vehicles, last amended April 18, 2019, except as noted in section § 86.004-25 (i).

2. Sensors and actuators are included only if they are integral to these assemblies and cannot be repaired without removing or replacing the assembly. Otherwise sensors and actuators are subject to the maintenance intervals specified in the table for Electronic Control Units, Sensors, and Actuators.

3. Manufacturers may request more frequent repair / replacement maintenance intervals for add-on or new technology emission-related components provided that the manufacturer demonstrates to the Executive Officer’s satisfaction that such intervals are technologically necessary and appropriate.

Table III-9 Current Federal Minimum Repair/Replacement Intervals for Heavy-Duty Diesel Engines

Component or System	Federal Minimum Maintenance Repair/Replacement Interval for Heavy-Duty Diesel-Cycle Engines (40 CFR § 86.004-25)
Exhaust Gas Recirculation (EGR) System (filters & cooler – not including hoses)	50,000 miles or 1,500 hours
Crankcase Vent. Valve & Filter	50,000 miles or 1,500 hours
Fuel Injectors	100,000 miles or 3,000 hours
Turbocharger	100,000 miles or 3,000 hours
Engine Control Unit (ECU), Sensors, Actuators	100,000 miles or 3,000 hours
Exhaust Gas Recirculation (EGR) System (including all related control valves and tubing)	100,000 miles or 3,000 hours
Catalytic Converter (other than catalyst bed)	100,000 miles or 3,000 hours
Catalyst bed only	None
Any other add-on or new technology emission related component or system whose primary purpose is to reduce emissions or whose failure will significantly degrade emissions control	NA

3. Other Warranty-Related Amendments

a. Allowances for Additional Scheduled Maintenance During Transitional Model Years

Manufacturers may request approval from CARB's Executive Officer to perform maintenance at a more frequent schedule than set forth above, during the model years in which the exhaust emission standards discussed in Section III.A become more stringent (2024, 2027, and 2031). This provision therefore provides manufacturers sufficient time to evaluate whether the specified maintenance schedules sufficiently ensure the proper operation of their emission component systems and components over the applicable useful life periods. However, this provision does not apply to specified emission control components and systems that are relatively high priced and can result in significant emissions impacts when they fail (e.g., EGR systems, turbochargers, DPF systems, and catalytic converter beds).

b. Linking OBD MIL Illumination to Emissions Warranty

OBD systems must monitor all emission-related components and systems for proper operation, and are therefore essential for ensuring that emission-related components and systems are functional and free from defects, and for immediately alerting vehicle operators of defective emission-related components and systems.

Manufacturers of 2027 and subsequent MY heavy-duty vehicles greater than 14,000 lbs GVWR equipped with 2027 and subsequent MY heavy-duty engines, and the 2027 and subsequent MY heavy-duty engines used in such vehicles, must warrant that such vehicles and engines are free from defects in materials or workmanship that cause the OBD system's malfunction indicator light to illuminate.[37]

c. Removal of the California-registration Requirement for the Applicability of the Warranty Coverage

The Regulation specifies that the California emissions warranty provisions extend to California-certified 2027 and subsequent model heavy-duty vehicles and the engines used in such vehicles, irrespective if such vehicles or engines are registered in California.

[37] CARB previously adopted this requirement for 2022 and subsequent model year heavy-duty diesel engines and vehicles in a 2018 rulemaking action. CARB has submitted a separate waiver request for that rulemaking action. The elements of the Regulation described in Section III.G3.b extends the previously adopted requirement to heavy-duty Otto-cycle engines and 2022 and to 2022 and subsequent MY hybrid powertrains optionally certified pursuant to title 13, CCR section 1956.8, and the hybrid powertrains used in such vehicles.

d. Emissions Warranty Requirements for Hybrid Vehicles and Optionally Certified Hybrid Powertrains

In conjunction with other elements of the Regulation that establish optional certification test procedures for heavy-duty hybrid powertrains (see Section III.J), the Regulation also generally extends the provisions discussed in Section III.G to 2022 and subsequent MY heavy-duty hybrid vehicles greater than 14,000 lbs GVWR, 2022 and subsequent MY incomplete hybrid vehicles from 10,001 to 14,000 lbs GVWR equipped with 2022 and subsequent MY hybrid powertrains optionally certified pursuant to title 13, CCR section 1956.8, and the hybrid powertrains used in such vehicles. Hybrid vehicles and powertrains must generally be warranted for the warranty periods applicable to category of heavy-duty diesel or heavy-duty Otto-cycle engines that power the same weight class of heavy-duty vehicles.

H. Amendments to Emissions Warranty Information and Reporting and Corrective Action Procedures

1. Amendments to Emissions Warranty Reporting Procedures

California's Emissions Warranty Information and Reporting (EWIR) Program requires manufacturers to track and to report to CARB, on a quarterly basis, the number of unscreened warranty claims they receive for each emission control component, by engine family. Unscreened warranty claims include all parts replaced during an emissions warranty period for any reason, regardless of whether the part actually experienced a failure. For example, a dealership may elect to replace a fully functional part solely to maintain good customer relations. The current EWIR program requires manufacturers to submit EWIR reports to CARB once a component reaches an unscreened warranty claim rate of 1 percent or 25 claims, whichever is greater, to submit Field Information Reports (FIRs) if unscreened warranty claims rate reach 4 percent or 50 claims (whichever is greater), and to file an Emissions Information Report (EIR) if screened warranty claims rate for a specific emissions control component (i.e., a warranty repair rate excluding claims for parts that did not experience failures) reaches 4 percent or 50 claims (whichever is greater).

The Regulation changes those reporting thresholds to the thresholds shown below in Table III-10, beginning in the 2024 MY, to ensure that warranty claims for engine families with sales of less than 2,500 engines are tracked and reported in a more timely manner, and establishes additional reporting thresholds for 2027 and subsequent model engines, to align the emissions warranty reporting obligations with the other elements of the Regulation that extend the emissions warranty obligations, as discussed in Section III.G.1

Table III-10. Emissions Warranty Reporting and Corrective Action Thresholds

MYs	EWIR Threshold	FIR Threshold	EIR Threshold	Corrective Action Threshold
Current	1% or 25 Unscreened Claims	4% or 50 Unscreened Claims	4% or 50 Failures	4% or 50 Failures
2024-2026	1% or 12 Unscreened Claims	4% or 25 Unscreened Claims	4% or 25 Failures	4% or 25 Failures
2027-2030	1% or 12 Unscreened Claims	Years 1-5 4% or 25 Unscreened Claims Years 6-7 5% or 30 Unscreened Claims Years 8-10 7% or 50 Unscreened Claims	Years 1-5 4% or 25 Failures Years 6-7 5% or 35 Failures	Years 1-5 4% or 25 Failures Years 6-7 5% or 35 Failures
2031 and subsequent	1% or 12 Unscreened Claims	Years 1-5 4% or 25 Unscreened Claims Years 6-7 5% or 35 Unscreened Claims Years 8-10 7% or 50 Unscreened Claims	Years 1-5 4% or 25 Failures Years 6-7 5% or 35 Failures Years 8-10 7% or 50 Failures	Years 1-5 4% or 25 Failures Years 6-7 5% or 35 Failures Years 8-10 7% or 50 Failures

2. Amendments to Corrective Action Procedures

California's current corrective action procedures specify that an engine family, test group, or a test subgroup is subject to a recall when the number of failures of a specific emission-related component exceeds specified failure levels, unless CARB's Executive Officer determines from the EIR that a recall is unnecessary. CARB's Executive Officer must consider a number of criteria in deciding whether to issue a recall order, including the validity of the data, the emission impact of the failure on individual engines/vehicles,

and possibility of increased tampering. If a manufacturer can demonstrate that the failure is limited to a less-than-substantial percentage of vehicles and does not represent a "pervasive defect . . . likely to affect a substantial number" of components during the useful life of the vehicles, and the defect is likely to be corrected under warranty, then no recall is required.

If CARB's Executive Officer determines a recall is warranted, he or she may issue a recall order if he or she determines that a substantial number of a class or category of properly maintained vehicles or engines contain defective emission-related components that if uncorrected, "may result in the vehicles' or engines' failure to meet applicable standards over their useful lives", or whenever "a class or category of vehicles or engines within their useful lives, on average," do not conform to applicable standards. California Code of Regulations title 13, section 2123 (a). Once CARB's Executive Officer makes these findings, exceedance of the emission standards is presumed, unless the manufacturer provides evidence that it either tested properly maintained vehicles containing the defect according to the regulation's requirements and the average emissions of the tested vehicles comply with applicable emission standards or the manufacturer performs an engineering analysis, or bench or laboratory testing to demonstrate the failure will not cause properly maintained vehicles containing the defect to exceed applicable emission standards. California Code of Regulations title 13, Section 2147.

a. Corrective Actions Linked to Emissions Warranty Reporting Thresholds

The Regulation primarily amends California's existing corrective action procedures by specifying that corrective actions for defective emission control components in 2024 and subsequent model heavy-duty engines and heavy-duty vehicles powered by such engines are required based solely on whether the failure rates of emission-related components meet or exceed the corrective action thresholds discussed above in Section III.H.2. In other words, corrective actions for defective emission control components identified through CARB's existing emissions warranty reporting requirements are now based solely on if the failure rate of a specific emissions control component meets or exceeds the applicable corrective action thresholds.

b. Mandated recall and extended warranty for specified emissions related parts

Manufacturers must recall specific defective emissions-critical components and systems, and must also provide extended warranties for the components used to address the failures of such components and systems, including exhaust aftertreatment devices, on-board computers, urea dosers, EGR valves, turbochargers, and fuel injectors.

Manufacturers must additionally recall non emissions-critical components and systems that exhibit defect rates of 25 percent or greater of sales volumes within a five year period, and must also provide extended warranties for the components used to replace such defective components and systems.

I. Heavy-Duty In-Use Compliance Program Amendments

CARB's current in-use compliance program for on-road HDDEs and vehicles requires HDDE manufacturers to screen, procure, and test 2007 and newer in-use heavy-duty engines in motor vehicles with gross vehicle weight ratings greater than 8,500 lbs. Testing is performed using portable emission measurement systems (PEMS) to assess the compliance of such engines with specified criteria, as measured using Not-To-Exceed (NTE) test procedures. CARB can also independently test engine families. The requirements and elements of CARB's existing in-use compliance program are essentially identical to the corresponding federal heavy-duty engine in-use compliance requirements.

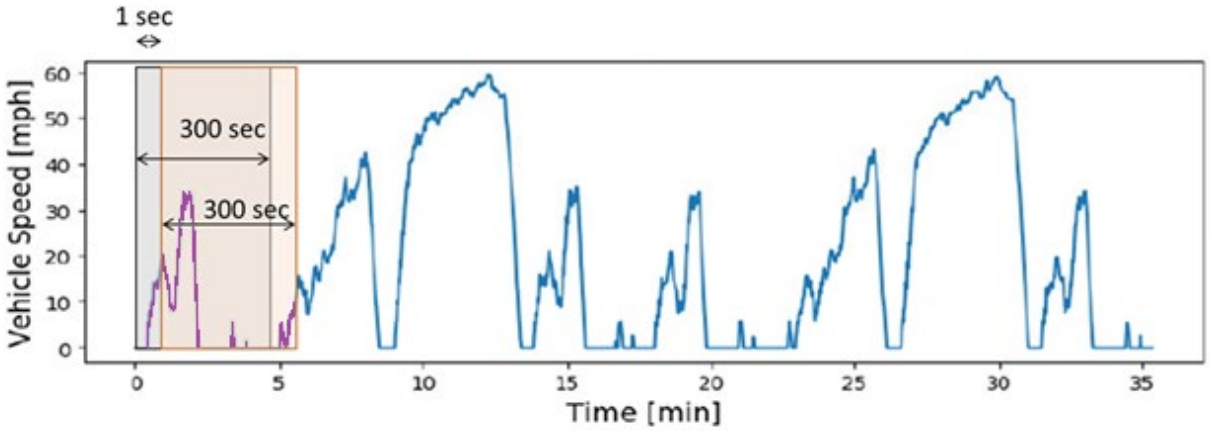
The NTE test procedure was developed to ensure that heavy-duty diesel engine emissions are controlled over a large range of speed and load combinations and environmental conditions commonly experienced during everyday use of heavy-duty vehicles. However, the procedure allows manufacturers to exclude certain test data from the evaluation of compliance with the test criteria, such as test data generated under extreme ambient temperatures and altitudes, and test data when engines fail to continuously operate within NTE control boundaries for 30 or more seconds. CARB's experience in conducting the in-use compliance program has led CARB to conclude that the current NTE test procedure is not capable of accurately representing either the real world operating conditions of heavy-duty engines or the emissions generated by such engines. In fact, 2010 to 2014 data submitted by manufacturers indicates that valid test data comprised less than six percent of the total data from that 2010 to 2014 data set and furthermore, 24 percent of the 207 manufacturer-submitted in-use tests contained no valid NTE events and passed the tests by default.

The Regulation accordingly establishes a new test procedure and new in-use compliance criteria that utilizes a moving-average window (MAW) approach to assess the real world, in-use emissions compliance of both heavy-duty diesel and heavy-duty Otto-cycle engines. The European Union standards for heavy-duty diesel and Otto-cycle engines also utilize a MAW approach to evaluate in-use compliance; because the MAW method allows fewer exclusions to invalidate test data than the NTE method, it is able to evaluate an engine's compliance with emission standards over a broader range of engine operations, compared to the current NTE-based compliance program.

A window is specified period of time (300 consecutive seconds) during which the measured emissions are averaged. Windows are overlapping, with a time increment equivalent to a data sampling rate of at least one Hertz (Hz).

Engine emissions are evaluated using a moving average. Windows are segregated into different "bins" based on the percentage engine load corresponding to different engine operating modes. The exhaust emissions reflected in each bin are then evaluated against specified emission standards that are, in turn defined using a MAW approach. The MAW approach relies on PEMS devices to measure and record exhaust emissions, and to record engine and vehicle operational parameters via connection to vehicle's OBD system. The new MAW test procedures and in-use compliance criteria apply to 2024 and subsequent model year heavy-duty engines. A schematic of the overlapping windows and the MAW approach is provided below in Figure III-3.

Figure III-3 ***Representation of the 300 Second Overlapping Windows of the 3B-MAW Method***



1. In-Use Compliance Requirements for Heavy-Duty Diesel Engines

The MAW approach for HDDEs segregates emissions windows into three distinct "bins" based upon the window's percent engine load corresponding to different engine operating modes– idle, low load, and medium/high load operations. Measured CO2 emissions are normalized against the product of the engines' Family Certification Level for CO2 emissions, as measured over a FTP test cycle, and the maximum power output of an engine, as defined in 40 CFR § 1065.510.

The "idle" bin is intended to capture emissions generated during periods of engine idling or operation during extremely low engine loads, and is used to determine compliance with the in-use idling emission standards.

The "low load" bin is intended to capture emissions generated during modes of engine operation including periods of reduced engine loads following periods of engine operation at high engine loads, periods of sustained low engine load operation, and periods of operation at increased engine loads following engine idling (i.e., representing a "return to service"). The low load bin is used to determine compliance with in-use low load cycle (LLC) emission standards.

The “medium/high” load bin is intended to capture emissions generated during modes of engine operation during engine modes included in the FTP and the RMC cycles. The medium/high load bin is used to determine compliance with in-use FTP and RMC standards.

An in-use compliance test consists of a minimum of 2,400 valid windows in each of the bins (idle, low, and medium/high), which corresponds to a minimum of 40 minutes of valid engine operation in each of the three bins. An engine complies with the in-use compliance standards if the arithmetic mean of the sum-over-sum (SOS) emissions for each pollutant, in each of the three bins, is equal to or less than the specified limits as shown below in Table III-8.

Table III-2. In-Use Compliance Standards for Heavy-Duty Diesel Cycle Engines

Bin	Percent Engine Load (PEL)	Sum-over-sum (SOS) Emissions In-use Threshold
Idle	PEL ≤6%	$e_{sos\ a,Idle} \leq CF^{B}$ x Idle standard[A]
Low	6% < PEL ≤20%	$e_{sos\ a,Low} \leq CF^{B}$ x LLC standard[A]
Medium/High	20% < PEL	$e_{sos\ a,MedHigh} \leq CF^{B}$ x FTP/RMC standard[A]

[A] The applicable standards can be found in title 13, CCR, § 1956.8

[B] For 2024 through 2029 MY engines, the conformity factor, CF, is equal to 2.0. For 2030 and subsequent MY engines, the conformity factor, CF, is equal to 1.5.

2. In-Use Compliance Requirements for Heavy-Duty Otto-Cycle Engines

Heavy-duty Otto-cycle engines are currently not subject to CARB’s PEMS-based heavy-duty in-use compliance program. The Regulation now subjects 2024 and subsequent model heavy-duty Otto-cycle engines to a PEMS-based in-use compliance program. However, because heavy-duty Otto-cycle engines are not required to certify to idle, LLC, or RMC standards, they are not subject to the 3 bin MAW approach outlined above for heavy-duty diesel engines, but are only subject to only an in-use emission standard based on the FTP test cycle.

J. Optional Powertrain Certification Test Procedures for Heavy-Duty Hybrid Vehicles

In 2014, CARB amended California’s Interim Certification Procedures for 2004 and Subsequent Model Hybrid-Electric and Other Hybrid Vehicles, to provide hybrid vehicle manufacturers the option to test heavy-duty hybrid vehicles on a chassis dynamometer, in lieu of testing hybrid powertrains on an engine dynamometer. Hybrid vehicle manufacturers have not utilized these preexisting procedures, possibly because those

procedures require testing of both the hybrid vehicle and its equivalent conventional internal combustion engine powered counterpart.

In 2018, CARB adopted the California Phase 2 GHG Regulation, which largely aligns California's GHG standards for 2021 and subsequent MY heavy-duty engines and heavy-duty vehicles with the corresponding federal Phase 2 GHG standards.[38] Both the California and federal Phase 2 GHG Regulations provide manufacturers the option to certify hybrid vehicles to the GHG emission standards using powertrain testing. Powertrain testing allows manufacturers to quantify the emissions benefits attributable to vehicle technologies such as hybridization, that cannot be easily quantified by testing on an engine dynamometer. However, both CARB and EPA's Phase 2 GHG powertrain test procedure can only be used to calculate GHG emissions.

The Regulation now establishes optional powertrain-based test procedures for 2022 and subsequent model diesel hybrid powertrains and Otto-cycle hybrid powertrains used in both incomplete vehicles with a gross vehicle weight rating (GVWR) from 10,001 to 14,000 lbs and in heavy-duty vehicles over 14,000 lbs GVWR that can be used to certify such powertrains to applicable criteria pollutant emission standards. The new test procedures are based upon EPA's technical amendments to the Phase 2 GHG that facilitate certifying hybrid powertrains to both GHG and criteria pollutant emission standards. The new test procedures will provide manufacturers greater test flexibility than the preexisting Interim Certification Procedures for Hybrid-Electric and Other Hybrid Vehicles, because the new test procedure does not require testing a conventional internal combustion engine powered vehicle in addition to the hybrid powertrain.

The new powertrain test procedures require that complete hybrid powertrains, including combustion engines, hybrid systems, and exhaust aftertreatment systems be tested as a unit on a powertrain dynamometer, and the certified exhaust emission levels are then determined from the test results. Hybrid powertrains must comply with all applicable certification requirements, including, but not limited to, useful life, emissions warranty, and OBD system requirements.

K. Amendments to California Heavy-Duty Vehicle Idling Requirements

California's preexisting Heavy-Duty Diesel Engine Idling Regulation requires new 2008 and subsequent MY HDDEs in heavy-duty vehicles with a GVWR greater than 14,000 lbs to be equipped with a system that automatically shuts down the engine after five minutes of continuous idle operation, or to be certified to a NOx idling emission standard of 30 grams of NOx per hour, without also increasing emissions of other criteria pollutants. Heavy-duty diesel engines produced for use in buses (commercial buses as well as school buses), recreational vehicles, medium-duty vehicles, military tactical vehicles, authorized emergency vehicles, armored cars, and workover rigs are exempted from these new engine requirements.

[38] CARB will submit a separate waiver request for the California Phase 2 GHG Regulation.

1. More Stringent NOx Idling Emission Standards for 2024 and Subsequent Model Engines

As discussed in Section III.A.1, the Regulation establishes engine idling NOx emission standards of 10 grams/hr and 5 grams /hr for 2024 through 2026 MY engines, and 2027 and subsequent MY engines, respectively. The Regulation accordingly incorporates the newly established idling NOx emission standards into the preexisting optional NOx idling emission standard of 30 g NOx/hr. Several 2019 MY heavy-duty engines have already demonstrated the capability to certify to NOx idling emissions below 10 g/hr, and manufacturers will be able to utilize control strategies including EGR and air-fuel ratio controls, or increasing exhaust temperatures in conjunction with SCR control and cylinder deactivation, to meet the 5 g NOx/hr idling standard.

2. Limiting New Engine Exemptions from California's Heavy-Duty Vehicle Idling regulation

The Regulation sunsets the preexisting exemptions for heavy-duty diesel engines used in buses, recreational vehicles, medium-duty vehicles, armored cars, and workover rigs starting in the 2024 model year. When CARB promulgated the initial Heavy-Duty Diesel Engine Idling Regulation in 2005, it anticipated that manufacturers would comply with the regulation by equipping new engines with automatic idling shutdown systems, and accordingly exempted the subject vehicle categories because those shutdown systems were not appropriate for those categories of vehicles. However, to date engine manufacturers have instead complied with that regulation by certifying engines to the NOx idling standard by using EGR and air-fuel ratio controls. These control strategies can be feasibly installed in engines powering buses, recreational vehicles, medium-duty vehicles, armored vehicles, and workover rigs, and accordingly there is no longer a factual basis that justifies exempting engines used in such vehicles from the HDDE Idling Regulation.

3. Aligning California's Emission Standards for 2004 and Subsequent Model Year APUs With the Corresponding Federal Emission Standards for APUs

The federal Phase 2 GHG Regulation requires diesel-fueled APUs that are installed on new 2024 and subsequent MY on-road tractors to be certified to a PM emission standard of 0.02 g/kW-hr. This emission standard is more stringent than the current 0.40 g/kW-hr PM emission standard for diesel fueled APUs in California's existing HDDE Idling Regulation.

The California Phase 2 GHG Regulation includes the same emission requirements for diesel-fueled APUs as specified in the federal Phase 2 GHG Regulation; however, CARB inadvertently failed to incorporate the specific PM emission standard into the associated California off-road diesel test procedures when it adopted the California Phase 2 GHG Regulation in 2018. The Regulation accordingly addresses that oversight by specifically incorporating the 0.02 g/kW-hr PM emission standard (40 CFR

§1039.699) into both California's Heavy-Duty Vehicle Idling Regulation and off-road test procedures for diesel-fueled APUs.

As discussed in Section I.A.6, California's Heavy-Duty Diesel Engine Idling Regulation requires truck owners that elect to install diesel-fueled APUs in new or in-use trucks powered by 2007 and subsequent model year heavy duty diesel engines to ensure that the diesel engines powering the APUs comply with the California or federal off-road emission standards and test procedures applicable to the horsepower category of the engines and to either: (1) route the exhaust from the APU into the truck's exhaust system, (2) equip the APU with a level 3 verified PM control strategy (i.e., achieve an 85 percent PM reduction efficiency), or (3) use other procedures that achieve an equivalent level of emissions compliance as the first two options. The Regulation now adds an additional compliance option – using a 2024 and subsequent MY diesel-fueled APU that is certified to a PM emission standard of 0.02 g/bhp-hr.

L. Amendments to California Phase 2 GHG Regulation

In 2018, CARB adopted the California Phase 2 GHG Regulation. That regulation primarily aligned California's GHG emission standards and other emissions-related requirements for 2021 and subsequent MY medium- and heavy-duty engines and vehicles with the corresponding GHG emission standards and test procedures in the federal Phase 2 GHG Regulation that EPA adopted in 2016. The Regulation includes several amendments to the Phase 2 GHG Regulation that largely clarify or amend elements of the Phase 2 GHG Regulation. With the exception of the elements of the Regulation described in Section I.K.3, those elements of the Regulation are expressly not included in this waiver request, but will be submitted as a component of CARB's subsequent waiver request for the California Phase 2 GHG Regulation.

M. Amendments to Medium-Duty Engine Provisions

The California LEV III Regulation currently allows manufacturers to certify heavy-duty vehicles greater than 14,000 lbs GVWR within a medium-duty vehicle certification test group (which requires certification to chassis-based standards and test procedures) if the heavy-duty vehicles meet the most stringent standards applicable to any vehicle in that test group. As described in Section III.A of this document, the Regulation establishes NOx exhaust emission standards for heavy-duty engines that are significantly more stringent than the current chassis-based NOx exhaust emission standards for medium-duty vehicles. The Regulation accordingly sunsets the applicability of this provision beginning in the 2024 MY, to ensure that all 2024 and subsequent MY heavy-duty vehicles greater than 14,000 lbs GVWR and the heavy-duty engines used in such vehicles are certified to the more stringent engine-based NOx emission standards.

N. Compliance Flexibilities/Exemptions

The Regulation establishes compliance flexibilities for specified categories of heavy-duty engines and heavy-duty vehicles.

1. 2024-2026 Heavy-Duty Engines Rated At or Above 525 bhp

2024 through 2026 MY heavy-duty diesel engines rated at or above 525 bhp maximum power are exempted from the exhaust emission standards discussed in Section III.A. These engines are typically used in heavy-haul applications and have relatively few sales in California. The manufacturers of these engines may therefore find it difficult to allocate resources to redesign such engines while also allocating resources and managing design changes for more popular engine families. This provision accordingly provides manufacturers the flexibility to continue to develop and certify more popular engine families which otherwise may not have been possible without this provision.

Manufacturers utilizing this exemption must demonstrate that qualifying engines comply with preexisting exhaust emission standards, engine idling requirements as specified in 13 CCR 1956.8(a)(6), and applicable California emissions warranty requirements applicable to the MY specified in 13 CCR 2036. In addition, this provision is only available to manufacturers that certified and sold in California 2018 or 2019 MY heavy heavy-duty engines meeting the horsepower rating criteria, and the provision limits the number of qualifying engines to 110 percent of a manufacturer's 2018 or 2019 MY sales of heavy heavy-duty engines, whichever is greater.

2. 2024-2025 Heavy-Duty Diesel Engines Rated Below 525 bhp

To further ease the transition to the new primary NOx emission standards, the Regulation also provides manufacturers the option to certify 2024 and 2025 MY HDDEs rated below 525 bhp to the preexisting NOx and PM exhaust emission standards (hereinafter, legacy engines), provided they offset any resulting NOx or PM deficits with credits obtained from the heavy-duty zero-emission averaging set, and provided the engines otherwise comply with specified regulatory requirements. If a sufficient number of credits from the zero-emission averaging set is not available, or such credits are not available below a specified cost threshold, a manufacturer may use credits from the combustion engine averaging set corresponding to the classification of the engine.

If a sufficient quantity of credits from the same combustion engine averaging set is not available, a manufacturer may carryover its NOx or PM deficit balance until the end of the 2026 MY, but must then offset that deficit balance by 125 percent. Manufacturers that fail to offset their deficit balances by the end of the 2026 MY must provide documentation substantiating that they attempted to, but were unable to purchase credits at a price below a specified threshold, and must submit a plan demonstrating that any deficits will be offset in five years and that such reductions would primarily benefit disadvantaged communities.

This provision limits the number of qualifying engines to 45 percent of a manufacturer's total HDDE sales in California in the 2024 MY, and 25 percent of a manufacturer's total California sales in the 2025 MY. Furthermore, a manufacturer must certify one or more diesel engine families to the primary NOx standards specified in 13 CCR § 1956.8(a)(2)(C)1 in the same year it is utilizing this option to certify legacy engines.

This limited exemption is intended to avoid any market disruption as manufacturers adjust to the more stringent NOx emission standards and should wholly address any supply needs during this period.

3. Transit Agency Exemption

The California Innovative Clean Transit (ICT) Regulation primarily requires public transit agencies that operate urban bus fleets to begin acquiring increasing numbers of zero emitting buses (ZEBs), beginning January 1, 2023 for large transit agencies and January 1, 2026 for smaller transit agencies. Affected transit agencies have the flexibility to purchase buses powered by diesel or alternative-fueled engines, provided that they acquire the requisite numbers of ZEBs.

Shortly before CARB's August 2020 public hearing, transit agencies informed CARB staff that the only manufacturer of diesel-fueled urban bus engines informed them it would cease producing California compliant urban bus engines beginning in 2024. This development creates an obstacle for the transit agencies subject to the ICT Regulation that were relying on the provisions in that regulation to purchase diesel-fueled engines. In addition, the global pandemic has adversely impacted transit agencies by reducing ridership, which has led to service cuts that most directly affect vulnerable groups in the greatest need of transit services. In the absence of compliance flexibility, transit agencies would need to further reduce services and jeopardize their ability to comply with their future ICT Regulation obligations.

The Regulation therefore allows qualifying transit agencies to request exemptions to purchase, rent, or lease buses, contract for service with bus service providers to operate buses, or to re-power buses with medium heavy-duty or heavy heavy-duty diesel engines used in urban buses that are certified to preexisting 2022 and subsequent MY criteria and GHG emission standards, instead of engines certified to the California standards as discussed in Sections III.A and B. Limiting the exemption to the medium and the heavy heavy-duty engine classifications ensures that the exemption is narrowly tailored to only include the classes of engines powering urban buses that would be directly affected by decision driving this provision.

To be eligible for the exemption, transit agencies must be subject to the ICT Regulation, must have completed specified ICT Regulation reporting requirements, must have purchased or been exempted from purchasing zero-emission buses, and if they have alternative-fueled buses in their fleets, must consider expanding the number of alternative-fueled buses in their fleets or explain why it is cost prohibitive to do so.

IV. WAIVER CRITERIA AND PRINCIPLES

A. Criteria for Granting Waivers of Preemption Under CAA Section 209(b) and Authorizations Under CAA Section 209(e)

Section 209(a) of the CAA provides:

No State or any political subdivision thereof shall adopt or attempt to enforce any standard relating to the control of emissions from new motor vehicles or any new motor vehicle engines subject to this part. No State shall require certification, inspection, or any other approval relating to the control of emissions from any new motor vehicle or new motor vehicle engine as condition precedent to the initial sale, titling (if any), or registration of such motor vehicle, motor vehicle engine, or equipment.

Section 209(b) of the CAA sets forth the protocol for granting California[39] a waiver from the preemption of section 209(a). Under section 209(b), the Administrator must grant a waiver to California if the state has determined that its standards will be, in the aggregate, at least as protective of public health and welfare as applicable federal standards, unless the Administrator finds that (1) the state's protectiveness determination is arbitrary and capricious, (2) California does not need separate state standards to meet compelling and extraordinary conditions, or (3) the state's standards and accompanying enforcement procedures are not consistent with section 202(a) of the CAA.

Section 209(e)(2) of the CAA sets forth the protocol for the Administrator to grant California an authorization to adopt and enforce standards and other requirements relating to controlling emissions from new and in-use nonroad engines that are not conclusively preempted by section 209(e)(1) – new engines less than 175 hp used in farm and construction equipment and vehicles and new engines used in new locomotives and locomotive engines.

Closely tracking the new motor vehicle waiver process, section 209(e)(2) directs the Administrator to grant an authorization to California for emissions standards and other emissions-related requirements for all other nonroad engines if California determines that the state's standards will be, in the aggregate, at least as protective of public health and welfare as applicable federal standards, unless he or she finds that: (1) the protectiveness finding of the state is arbitrary and capricious; (2) California does not need separate state standards to meet compelling and extraordinary conditions; or (3) the state standards and accompanying enforcement procedures are not consistent with

[39]CAA section 209(b) provides for granting a waiver to "any State that has adopted standards (other than crankcase emission standards) for the control of emissions from new motor vehicles or new motor vehicle engines prior to March 30, 1966." California is the only State that meets this eligibility criterion. *See, e.g.*, S. Rep. No. 90-403, at 632 (1967) and *Motor and Equipment Manufacturers Association v. EPA (MEMA I)*) 627 F.2d 1095, 1101 fn. 1 (D.C. Cir. 1979).

section 209 of the CAA.[40] The criteria for reviewing a California request for authorization under section 209(e)(2) are nearly identical to the criteria that the Administrator must consider under section 209(b). In light of these almost identical protocols, EPA has confirmed that it would similarly interpret sections 209(b) and (e) where the language is similar.[41]

One deviation in language is that CAA section 209(e)(2) requires the Administrator to consider consistency with other subsections of section 209. In its *209(e) Final Rule,* EPA interpreted this provision to require that California's standards and accompanying enforcement provisions must also be consistent with sections 209(a) and 209(e)(1).[42] As the Administrator has stated:

> "In [o]rder to be consistent with section 209(a), California's [nonroad] standards and enforcement procedures must not apply to new motor vehicles or new motor vehicle engines. Secondly, California's nonroad standards and enforcement procedures must be consistent with section 209(e)(1), which identifies the categories permanently preempted from state regulation. California's nonroad standards and enforcement procedures would be considered inconsistent with section 209 if they applied to the categories of engines or vehicles identified and preempted from State regulation in section 209(e)(1). Finally, and most importantly in terms of application to nonroad [authorization requests], California's nonroad standards and enforcement procedures must be consistent with section 209(b)(1)(C). EPA will review nonroad authorization requests under the same "consistency" criteria that are applied to motor vehicle waiver requests. Under section 209(b)(1)(C), the Administrator shall not grant California's motor vehicle waiver if she finds that California 'standards and accompanying enforcement procedures are not consistent with section 202(a)' of the [CAA]…."[43]

B. Principles Followed in Granting CAA Section 209(b) Waivers and 209(e) Authorizations

1. The Burden Is on the Opponents Challenging the Request

In considering a waiver or authorization request, California is presumed to have satisfied the criteria for granting a waiver or authorization, and the burden to show

[40] 82 Fed. Reg. 6525, 6256 (Jan. 19, 2017).

[41] *Air Pollution Control; Preemption of State Regulation for Nonroad Engine and Vehicle Standards (Final 209(e) Rule)*, 59 Fed. Reg. 36969 (July 20, 1994), Decision Document accompanying 60 Fed. Reg. 37440 (July 20, 1995) at p. 11; 65 Fed. Reg. 69763, 69764 (Nov. 20, 2000).

[42] 59 Fed. Reg. 36969, 36983 (July 20, 1994).

[43] 65 Fed. Reg. 69763, 69764 fn. 5 (Nov. 20, 2000).

otherwise is on those persons challenging the request.[44] This has long been EPA's approach,[45] and that approach has been upheld by the D.C. Circuit and ratified by Congress.[46]

Given the identical structure and near identical language of sections 209(b) and 209(e)(2), the opponents of an authorization request bear a similar burden of proof when arguing that authorization should be denied.[47]

2. The Scope of the Waiver/Authorization Proceeding Is Limited

The scope of the Administrator's inquiry in considering a waiver or authorization request is limited by the express terms of CAA sections 209(b)(1) and (e)(2)(A). Once California determines that its standards are, in the aggregate, at least as protective of public health and welfare as applicable federal standards, the Administrator must grant the waiver or authorization unless one of the three specified findings can be made.

This reading of the statute is consistent with the decision in *MEMA I* and prior EPA waiver decisions interpreting CAA section 209(b), which hold that the review of California's decision to adopt separate standards is a narrow one.[48] In granting the waiver for the OBD II regulation in 1996, Administrator Carol Browner concluded that she must grant a waiver if she could not find sufficient evidence in the record to support any of the criteria that would allow a denial.[49] Much earlier Administrator William D. Ruckleshaus stated:

> The law makes it clear that the waiver request cannot be denied unless the specific findings designated in the statute can properly be made. The issue of whether a proposed California requirement is likely to result in only marginal improvement in air quality not commensurate with its cost or

[44] *MEMA I*, 627 F.2d 1095, 1121.

[45] See e.g., 36 Fed. Reg. 17,458-17,459 (Aug. 31, 1971); 40 Fed. Reg. 23,102, 23,103 (May 28, 1975); Decision Document accompanying 61 Fed. Reg. 53371 at p. 15-16.

[46] *MEMA I*, 627 F.2d 1095, 1121. When Congress amended Section 209(b)(1) in 1977 to expand California's discretion, it expressly approved EPA's application of the waiver provision. H.R. Rep. No. 95-294, at 301 (1977). Then, in 1990, Congress further ratified EPA's approach to Section 209(b)(1) by re-enacting virtually identical text in Section 209(e)(2).

[47] See, e.g., Decision Document accompanying 60 Fed. Reg. 37440 (July 20, 1995) at p. 14; Decision Document accompanying 61 Fed. Reg. 69093 (Dec. 31, 1996) at pp. 16-17; 76 Fed. Reg. 77521, 775223 (Dec. 13, 2011); 82 Fed. Reg. 6525, 6528 (Jan. 19, 2017).

[48] *See* 40 Fed. Reg. 23102, 23103 (May 28, 1975).

[49] 61 Fed. Reg. 53371 (Oct. 11, 1996); *Motor & Equip. Mfrs Ass'n v. Nichols*, ("MEMA II") 142 F.3d 449 (D.C. Cir. 1998).

> is otherwise an arguably unwise exercise of regulatory power is not legally pertinent to my decision under section 209 . . . . [50]

3. Deference Must Be Accorded to California's Policy Judgments

In granting waivers to California's motor vehicle program, EPA has repeatedly and routinely deferred to the policy judgments of California's decision-makers. EPA has recognized that the intent of Congress in creating a limited review of California's waiver requests was to ensure that the federal government did not second-guess the wisdom of state policy.[51] Administrators have recognized that the deference is wide-ranging:

> The structure and history of the California waiver provision clearly indicate both a Congressional intent and an EPA practice of leaving the decision on ambiguous and controversial matters of public policy to California's judgment.
>
> * * * * * *
>
> It is worth noting . . . I would feel constrained to approve a California approach to the problem which I might also feel unable to adopt at the federal level in my own capacity as a regulator. The whole approach of the Clean Air Act is to force the development of new types of emission control technology where that is needed by compelling the industry to "catch up" to some degree with newly promulgated standards. Such an approach . . . may be attended with costs … and by risks that a wider number of vehicle classes may not be able to complete their development work in time. Since a balancing of these risks and costs against the potential benefits from reduced emissions is a central policy decision for any regulatory agency under the statutory scheme outlined above, I believe *I am required to give very substantial deference to California's judgments on this score.*[52]

By authorizing California to adopt its own emission standards for nonroad vehicles and engines, and by establishing almost identical requirements for EPA review of authorizing requests under section 209(e)(2) as it requires for waiver decisions under

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[50] 36 Fed. Reg. 17158 (Aug. 31, 1971). See also 40 Fed. Reg. 23102, 23104; Decision Document accompanying 58 Fed. Reg. 4166 (Jan. 7, 1993) at pp. 20-21; 74 Fed. Reg. 32744, 32748 (July 8, 2009).

[51] See also, e.g., 74 Fed. Reg. 32744, 32748 (July 8, 2009).

[52] 40 Fed. Reg. 23102, 23104 (emphasis added). See also Decision Document accompanying 58 Fed. Reg. 4166 (Jan. 17, 1993) at p. 64.

section 209(b), Congress unmistakably intended that the EPA accord similar deference to California's decisions under 209(e)(2).[53]

V. THE CALIFORNIA OMNIBUS REGULATION MEETS THE CRITERIA FOR A NEW WAIVER

CARB submits that for the reasons set forth below, and in the documents associated with the California Omnibus regulation's rulemaking action, the Administrator must grant California a new waiver, as the Administrator has no basis under the criteria of CAA section 209(b) to deny California's request.

A. Protectiveness

In reviewing CARB's protectiveness determination, EPA traditionally evaluates the stringency of California's newly adopted or amended emissions standards to comparable EPA emission standards, and that comparison has been undertaken in the broader context of the previously waived California program, which relies upon protectiveness determinations that EPA has previously determined were not arbitrary and capricious.[54]

That evaluation tracks the two discussions of protectiveness in the text of section 209(b). Specifically, section 209(b)(2) states: "[i]f each State standard is at least as stringent as the comparable applicable Federal standard, such State standard shall be deemed to be at least as protective of health and welfare as such Federal standards for purposes of [209(b)(1)]." But that does not require each state standard to be at least as stringent as comparable federal standards because section 209(b)(1) requires EPA to deferentially review California's "determin[ation] that the State standards will be, *in the aggregate,* at least as protective of public health and welfare as applicable Federal standards." EPA properly considers the individual standards in a given waiver request under section 209(b)(2) because that text provides that determination as one path to satisfying the protectiveness critierion. However, in order to give meaning to the phrase "in the aggregate" in Section 209(b)(1), EPA also considers whether California's standards are *collectively* at least as protective as federal standards—an inquiry that requires EPA to consider whether the standards in the waiver request could somehow undermine the protectiveness of the existing California standards for which EPA has already granted a waiver.[55] In so doing, EPA considers whether the entire California

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[53] *See* discussion in *Engine Manufacturers Association v. U.S. EPA (EMA)*, 88 F.3d 1075, 1090 (D.C. Cir. 1996), wherein the court recognized California's leadership in emission control regulation in both new motor vehicles and new and in-use nonroad engines.

[54] 74 Fed. Reg. 32744, 32749 (July 8, 2009); 70 Fed. Reg. 50322 (Aug. 26, 2005); 77 Fed. Reg. 9239 (Feb. 16, 2012).

[55] 44 Fed. Reg. 38,660 38,661 (July 2, 1979) ("[T]he public record did not contain any evidence that this regulation would cause the California standards, in the aggregate, to be less protective of public health and welfare than the applicable Federal standards.")

new motor vehicle emissions program- including the standards for which the waiver is requested—is at least as protective as the federal program.[56]

Congress directed that EPA review California's protectiveness determination under the deferential arbitrary and capricious standard. EPA has correctly understood that this would require " 'clear and compelling evidence' to show that proposed [standards] undermine the protectiveness of California's standards."[57]

In adopting the Omnibus Regulation, the Board approved Resolution 20-23 (Enclosure 5), in which it expressly declared:

> BE IT FURTHER RESOLVED that the Board hereby determines that the regulations adopted herein will not cause California motor vehicle and off-road engine emission standards, in the aggregate, to be less protective of public health and welfare than applicable federal standards.

No basis exists for the Administrator to find that the Board's determination is arbitrary or capricious. As previously discussed, the Administrator has already determined that California's preexisting emission standards and emissions-related requirements, generally, and for heavy-duty diesel and Otto-cycle engines and vehicles, specifically, are, in the aggregate, at least as protective of public health and welfare as applicable federal standards,[58] and as demonstrated below, the Omnibus Regulation establishes emission standards and emissions-related requirements[59] that are significantly more stringent than corresponding federal emission standards and emissions related requirements, and consequently only increases the relative stringency of California's motor vehicle emissions control program compared to the federal motor vehicle emissions control program. Thus, there is no basis to deny this waiver request under the protectiveness criterion—under either the analysis undertaken pursuant to section 209(b)(2) or the aggregate analysis undertaken pursuant to section 209(b)(1).

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[56] 74 Fed. Reg. 32744, 32749 (July 8, 2009).

[57] 74 Fed. Reg. 32744, 32749 (July 8, 2009)*; MEMA I*, 627 F.2d 1095, 1122.

[58] Those determinations also extend to the emissions standards and associated test procedures for medium-duty engines optionally certified to the heavy-duty engine-dynamometer based emission standards in 13 CCR 1956.8. See footnote 28, infra.

[59] The elements of the Omnibus regulation that: impose more rigorous durability demonstration program requirements (Section III.C), extend the useful life periods of engines (Section III.E), establish a separate averaging, banking and trading program for California certified engines and powertrains (Section III.F), establish extended emissions warranty requirements for engines and vehicles (Section III.G), establish more stringent emissions warranty reporting and recall provisions and in-use testing procedures (Sections III.H and III.I, respectively) are properly characterized as accompanying enforcement procedures, because they constitute criteria designed to determine compliance with applicable standards and are accordingly relevant to a manufacturer's ability to produce vehicles and engines that comply with applicable standards for their useful lives. *MEMA I* at 1111-1113; Decision Document accompanying 51 Fed. Reg. 12391 (Apr. 10, 1986), at p.3.

The primary NOx and PM exhaust emission standards and associated test procedures for 2024 and subsequent model year medium-duty and heavy-duty engines are more stringent than the corresponding federal NOx and PM exhaust emission standards[60], and the exhaust emission standards for nonmethane hydrocarbons, carbon monoxide, and formaldehyde (for Otto-cycle engines) are not reduced in stringency from their previously waived levels. In addition, the Regulation establishes new exhaust emissions standards for NOx that are measured over two new test cycles (the low load cycle and the idle test) for medium and heavy-duty diesel cycle engines, and establishes optional NOx exhaust emission standards that are even more stringent than the primary NOx emission standards. The federal emission standards do not contain either the more stringent primary NOx or PM exhaust emission standards as measured over the FTP or RMC test cycles, the new exhaust emission standards for NOx as measured over the LLC or the idle test cycles, or the optional NOx emission standards.

The Regulation's accompanying enforcement procedures are more stringent than comparable federal accompanying enforcement procedures. California's durability demonstration program requires medium and heavy-duty demonstration engines to accumulate 300 hours of engine operation before conducting an emission test, while the federal test procedures only require 125 hours of operation. In addition, California's durability demonstration program requires manufacturers to use standardized aging cycles and to extend the length of the durability demonstration program to the full useful life of the engine[61], which will be 800,000 miles, 12 years, or 40,000 hours of engine operation for 2031 MY heavy heavy-duty diesel engines. The comparable federal durability demonstration program allows manufacturers to use customized aging cycles and requires manufacturers to age engines and aftertreatment system to approximately 35 to 50 percent of the applicable useful lives – approximately 217,000 miles, 5 years, or 11,000 hours of engine operation for heavy heavy-duty diesel engines.

California's useful life periods and emissions warranty periods for medium and heavy-duty engines are clearly longer than the comparable federal useful life and emission warranty periods. For example, the California useful life period for 2031 and subsequent model year heavy heavy-duty diesel engines is 800,000 miles, 12 years, or 40,000 hours of engine operation; the comparable federal useful life period is 435,000 miles, 10 years, or 22,000 hours of engine operation. The California emissions warranty period for 2031 and subsequent model heavy heavy-duty diesel engines is 600,000 miles, 10 years, or 30,000 hours, while the comparable federal emissions warranty period is 100,000 miles or 5 years; furthermore, the California minimum allowable maintenance schedules for emissions-related parts in heavy-duty Otto-cycle

[60] The current federal NOx and PM exhaust emission standards for both diesel-cycle and Otto-cycle heavy-duty engines are 0.20 and 0.01 g/bhp-hr, respectively.

[61] The Regulation increases the useful life periods for HDDE and HDO engines starting in the 2027 MY and medium-duty diesel and Otto-cycle engines used in medium-duty vehicles starting in the 2022 MY; the newly extended California useful life periods are longer than comparable federal useful life periods. See Section III.E.

engines are more restrictive regarding allowable repairs or replacements of emissions-related parts than the corresponding federal allowable maintenance schedules.

California's ABT program reinforces the stringency of the primary NOx and PM emission standards by only allowing manufacturers to earn credits if they certify engines to emission standards that are more stringent than the primary exhaust emission standards, and by restricting manufacturers' ability to utilize previously generated federal ABT credits.

California's amended heavy-duty in-use compliance program is more stringent than the current federal heavy-duty in-use test program because the California program is more capable of assessing the ability of engines to maintain emissions throughout a wider range of in-use conditions. As explained in Section III.I, CARB specifically amended the preexisting program (which was equivalent to the current federal heavy-duty in-use program) because it concluded that the NTE test procedure is not capable of accurately representing either the real world operating conditions of heavy-duty engines or the emissions generated by such engines. California's amended heavy-duty in-use compliance program now bases compliance determinations on the 3B-MAW method that is more capable than the NTE test method of assessing the ability of engines to maintain emissions throughout a wider range of in-use conditions, including at low engine load and idling modes.

The elements of the Regulation that amend California's emissions warranty reporting and recall provisions, California's Heavy-Duty Truck Idling requirements, and California's LEV III Regulation's provisions allowing heavy-duty vehicles to be included within a medium-duty vehicle test group will individually and collectively ensure that the primary NOx and PM emission standards and the optional NOx emission standards are effectively maintained, both when new engines and vehicles are certified, and as they are operated in the real world, throughout their useful lives. The amendments additionally only increase the stringency of previously waived requirements.[62]

California's optional criteria pollutant certification procedures for hybrid powertrains do not exist in the federal heavy-duty motor vehicle program[63] but any hybrid powertrains certified under these provisions are subject to emission standards and emissions warranty provisions that, as demonstrated in Section V.A, are more stringent than comparable federal emissions requirements.

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[62] 55 Fed. Reg. 28823 (July 13, 1990); 77 Fed. Reg. 9239 (Feb. 16, 2012); 82 Fed. Reg. 4867 (Jan. 17, 2017).

[63] Although California's hybrid test procedures are based upon EPA's technical amendments to the Phase 2 GHG regulation, EPA has expressly indicated that those federal procedures do not allow hybrid powertrains to demonstrate compliance with criteria pollutant emission standards. "Note that the procedures EPA proposed and is finalizing regarding hybrid powertrain testing as described in Chapter II.A of the preamble only apply to GHG certification at this time. EPA, Response to Comments, Improvements for Heavy-Duty Engine and Vehicle Test Procedures, and other Technical Amendments, EPA-420-R-20-026 , p. 20.

The Regulation does contain provisions that provide limited compliance flexibilities for specified categories of engines and vehicles. However, those provisions narrowly limit the scope and extent of those flexibilities, and notably essentially allow manufacturers and vehicle fleets to produce and purchase, respectively, limited quantities of heavy-duty engines and vehicles that comply with previously waived exhaust emission standards and other emission-related requirements, which the Administrator has already determined are, in the aggregate, at least as protective of public health and welfare as applicable federal standards.

For the foregoing reasons, it is clear that the emission standards, associated test procedures, and accompanying enforcement procedures established by the Omnibus Regulation will not cause California's motor vehicle emissions standards, in the aggregate, to be less protective of the public health and welfare than applicable federal standards. Accordingly, the Board's determination of protectiveness is clearly well founded.

B. Compelling and Extraordinary Circumstances

The Administrator has consistently recognized that California satisifies the second criterion for waivers and authorizations —that the State has "compelling and extraordinary conditions" and therefore continues to need its own motor vehicle and motor vehicle engine, and nonroad engine and equipment emisisons control programs, respectively.

EPA has traditionally interpreted CAA sections 209(b)(1)(B) and 209(e)(2)(A)(ii) as requiring an inquiry regarding California's need for a separate motor vehicle and nonroad engine and equipment emissions control program, respectively, to meet compelling and extraordinary conditions, and not whether any given standard is necessary to meet such conditions. EPA has expressed this as an inquiry into "the existence of 'compelling and extraordinary" conditions' of the kind for which a separate state program of controls remains warranted.[64] In other words, "review … under section 209(b)(1)(B) is not based on whether California has demonstrated a need for the

[64] 41 Fed. Reg. at 23,103; see also *id.* at 23,104 (concluding "[c]ompelling and extraordinary conditions continue to exist in the State of California"). See also 41 Fed. Reg. 44,209 44,210 (Oct. 7, 1976) ("[T]he question of whether *these particular standards* are actually required by California all fall within the broad area of public policy [left to] California's judgment … consistent with the Congressional intent behind the California waiver provision.").

particular regulations, but upon whether California needs standards to meet compelling and extraordinary conditions."[65,66,67]

In adopting Resolution 20-23, CARB found that "California still has the most severe air pollution problems in the United States,"[68] and that CARB needs to seek emission reductions from all sources under its authority to meet federal emission reduction requirements.[69] California, particularly in the South Coast and San Joaquin Valley Air Basins, continues to experience some of the worst air quality in the nation and the

[65] 44 Fed. Reg. at 38,660, 38,661 (July 2, 1979).

[66] The Administrator has recognized that even if such a standard by standard test were applied to California, it "would not be applicable to its fullest stringency due to the degree of discretion given to California in dealing with its mobile source pollution problems." 41 Fed. Reg. 44209, 44213, (October 7, 1976); 49 Fed. Reg. 18887, 18892 (May 3, 1984) (finding Congressional intent precludes EPA from viewing adopted California vehicular particulate matter standard in isolation).

[67] On September 27, 2019, EPA, in conjunction with NHTSA, published "The Safer Affordable Fuel-Efficient (SAFE) Vehicles Rule Part One: One National Program" (SAFE 1), 84 Fed. Reg. 51310 (Sept. 27, 2019). In that action, EPA withdrew a portion of the waiver it had previously granted for California's Advanced Clean Cars (ACC) program – specifically, the waiver for California's zero emission vehicle (ZEV) mandate and the GHG emission standards within California's ACC program. EPA based its action, in part, on its determination that California did not need these emission standards to meet compelling and extraordinary conditions, within the meaning of section 209(b)(1)(B) of the CAA. That determination was in turn based on EPA's adoption of a new, GHG-pollutant specific interpretation of section 209(b)(1)(B). EPA is now reconsidering that action. In any event, EPA expressly stated that its new interpretation of section 209(b)(1)(B) only applies to waiver requests for GHG emission-reducing standards, 84 Fed. Reg. 51341, and n. 263, and consequently EPA's traditional interpretation of 209(b)(1)(B) applies to this request.

Even in the event that EPA determines that its SAFE 1 interpretation of section 209(b)(1)(B) applies to this waiver request, CARB satisfies that interpretation of the criterion. The on-road heavy-duty vehicles regulated by the Omnibus Regulation are significant sources of harmful air pollutants, especially oxides of nitrogen (NOx) and particulate matter (PM). (ISOR, pp. ES-1 and ES-2), and constitute the largest source of NOx emissions in California. (ISOR, ES-1). California needs to achieve reductions of both NOx and PM to attain the national ambient air quality standards for ozone and particulate matter, and in fact the Omnibus Regulation will achieve approximately half of the NOx commitments in California's State Implementation Plan (ISOR, p. ES-2). In addition, NOx emissions pose serious risks to the health and welfare of Californians, because NOx emissions not only cause lung irritation and aggravate lung diseases, they also react in the atmosphere to form additional pollutants - ozone and particulate matter, which additionally pose serious risks to the health and environment of Californians, including increased risks of lung and heart diseases and premature death. (Appendix E to ISOR). The Omnibus Regulation is expected to reduce the total number of incidents for premature mortality, cardiovascular hospitalization, acute respiratory hospitalization, and emergency room visits by 4,494 between 2022 through 2050, which is equivalent to the monetized health benefits of approximately $23.4 billion (FSOR, p. 247). EPA has never disputed California's need to reduce emissions of criteria pollutants. 79 Fed. Reg. 46256, 46261-262 (Aug. 7, 2014).

[68] Resolution 20-23 at p. 18

[69] Ibid.

South Coast and San Joaquin Valley Air Basins, in particular, continue to be in extreme non-attainment with national ambient air quality standards for ozone and in serious non-attainment with national ambient air quality standards for particulate matter.[70] These challenges moved Congress to authorize California to establish separate on-road motor vehicle standards in 1967 and still exist today.[71] EPA has long confirmed this remains true and affirmed CARB's judgment, on behalf of the State of California, on this matter.[72]

Nothing in these conditions has changed to warrant a change in EPA's confirmation, and therefore there can be no doubt of the continuing existence of compelling and extraordinary conditions justifying California's need for its own motor vehicle emissions control program.

C. Consistency with Clean Air Act Section 202(a)

The third criterion "relates in relevant part to technological feasibility and to federal certification requirements."[73] "The 'technological feasibility' component of section 202(a) obligates California to allow sufficient lead time to permit manufacturers to develop and apply the necessary technology."[74] "The federal certification component ensures that the Federal and California test procedures do not 'impose inconsistent certification requirements.'"[75] "Neither the court nor the agency has ever interpreted compliance with section 202(a) to require more."[76]

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[70] 78 Fed. Reg. 2112, 2130 (Jan. 9, 2013); 82 Fed. Reg. 4867, 4871 (Jan. 17, 2017).

[71] See 74 Fed. Reg. 32744, 32762-32763 (July 8, 2009); 79 Fed. Reg. 6584, 6588-590 (Feb. 4, 2014); 82 Fed. Reg 6540, 6543 (Jan. 19, 2017). In 2007, 19 of California's air quality districts were in nonattainment with the eight-hour ozone 0.08 ppm NAAQs. Currently, 37 California counties are in nonattainment with the 2015 eight-hour ozone 0.070 ppm NAAQs, and 26 of California's counties are in nonattainment with the 2006 PM 2.5 NAAQS. https://www3.epa.gov/airquality/greenbook/ancl.html (last accessed Oct. 28, 2021).

[72] *California State Motor Vehicle Pollution Control Standards; Waiver of Federal Preemption – Notice of Decision,* 70 Fed. Reg. 50322, 50323 (Aug. 26, 2005); 74 Fed. Reg. 32744, 32762-763 (July 9, 2009); 79 Fed. Reg. 46256, 46262 (Aug. 7, 2014); 82 Fed. Reg. 4867, 4871 (Jan. 17, 2017).

[73] *Motor & Equip. Mfrs. Ass'n v. Nichols*, 142 F.3d 449, 463 (D.C. Cir. 1998) (quoting *Ford Motor Co. v. EPA,* 606 F.2d 1293, 1296 n. 17 (D.C.Cir.1979)).

[74] *Id.*

[75] *Id.* (quoting 46 Fed.Reg. 26,371, 26,372 (1981)).

[76] *Id.* See also Decision Document accompanying 61 Fed.Reg. 53371 (Oct. 11, 1996) at p.2; Even where there is incompatibility between the California and federal test procedures, EPA has granted a waiver under circumstances where EPA accepts a demonstration of federal compliance based on California test results, thus obviating the need for two separate tests. 43 Fed. Reg. 1829, 1830 (Jan. 12, 1978); 40 Fed. Reg. 30311, 30314 (July 18, 1975).

As demonstrated below, the Omnibus Regulation's requirements for engines and vehicles themselves satisfy these requirements and therefore their addition to California's program will not alter that program's already-determined consistency with section 202(a) of the CAA.

1. Technological Feasibility and Lead Time

CARB evaluated the technical feasibility of the emission standards and accompanying enforcement procedures and concluded that those standards and accompanying enforcement procedures were attainable within the specified lead times because the technologies that manufacturers will likely use to comply with the 2024 model year emission standards are presently commercially available at reasonable costs within the specified lead times. CARB further determined that manufacturers will have sufficient time to develop and implement future technologies or to refine existing emission control technologies needed to comply with the 2027 and subsequent model year emission standards.

This section briefly outlines the technologies that manufacturers will likely utilize to comply with the Omnibus Regulation's emission standards and accompanying enforcement standards. More detailed descriptions of these provisions are provided in the Staff Report: Initial Statement of Reasons (Staff Report, Enclosure 2), the Notices of Public Availability of Modified Text (Enclosures 7 and 8), and the Final Statement of Reasons (FSOR, Enclosure 9).

a. Technical Feasibility of New NOx and PM Emission Standards and Lead Time Considerations

Engine manufacturers will likely utilize a combination of emission control strategies to provide improved thermal management of exhaust temperatures and improved SCR conversion efficiency during cold starts and at lower engine loads to comply with the NOx and PM standards described in Sections III.A and III.B. Such strategies will likely include engine calibration strategies, such as higher exhaust gas recirculation (EGR) rates to reduce engine-out NOx, and higher idle speeds to reduce engine warm-up time to better control cold start emissions. In addition, SCR system improvements such as a combination of larger SCR catalyst volumes and improved catalyst substrates will likely be needed. Improvements in thermal management of SCR systems will also likely be needed, such as improved packaging of the aftertreatment system and improved urea dosing strategies, such as heating urea dosing systems. Descriptions of the emission control strategies and the likely combinations of those strategies are discussed in greater detail below.

i. Compliance Technologies for Heavy-Duty Engines

(1) Diesel Engines

For medium- and heavy-duty diesel engines, CARB has identified the following technologies as compliance strategies that manufacturers will likely utilize to comply with the newly established NOx and PM exhaust emission standards:

Engine Calibration Strategies:
Elevated idle speed, intake and exhaust throttling, and multiple fuel injection strategies can be used to increase exhaust gas temperatures and accelerate aftertreatment warm-up during cold start events. Increased EGR rates can also be used during cold starts to reduce engine-out NOx emissions.

Bypass Valves for EGR Cooler, Charge Air cooler, and Turbocharger:
The EGR and charge air cooler bypasses allow hot EGR and uncooled charge air to be routed from the intake manifold into the combustion chamber to increase the exhaust gas temperatures during certain engine operating conditions such as cold starts. A turbocharger bypass allows the exhaust to remain hot at the SCR by avoiding heat loss across the turbine walls.

Cylinder Deactivation (CDA):
CDA involves selectively shutting down one or more cylinders by cutting fuel injection as well as deactivating the intake and exhaust valves of the selected cylinders. CDA in diesel engines provides improved fuel efficiency through reduced pumping losses and friction as well as increased exhaust gas temperatures for faster warm-up and to keep warm the exhaust aftertreatment system during idle and sustained low load operation with additional benefits of reducing CO2 emissions.

Dynamic CDA is a variant of CDA that selectively and dynamically fires and skips each cylinder on an event-by-event basis to meet the torque demand from the engine creating optimal engine efficiency and reduced emissions while avoiding noise, vibration, and harshness (NVH) generation under all driving conditions.

Variable Valve Actuation (VVA):
Variable valve actuation (VVA) involves changing the timing of closing and opening the intake or exhaust valves independent from the crankshaft angle to improve combustion efficiency while also providing improved thermal management of the exhaust during different engine operating conditions.

Other Engine Technologies
Other engine technologies such as the 48-volt electric motor driven EGR pump and electric turbochargers (or e-turbo) may also be used to improve engine efficiency and manage emissions.

Opposed Piston Engine
The opposed piston (OP) engine, currently under development by Achates Power, Inc., has two opposed pistons facing each other that share the same cylinder and a

combustion chamber between the two pistons. Combustion occurs when the two pistons are closest to each other near the end of the compression stroke and the in-cylinder pressure continues to rise as the fuel gets burned pushing the two pistons opposite to each other. The engine is without the traditional cylinder head, valvetrain, cams, and camshaft. Compared to the conventional 4-storke engine, the OP engine has better thermal efficiency, less friction, and lighter weight.

SCR Catalyst Formulations
To improve the temperature operating window as well as accelerate warm-up, catalysts with high cell density and thinner, durable, substrate walls are continuously being developed. Other catalyst formulations such as combined-SCR systems consisting of both iron and copper catalysts benefit from the characteristics of both copper and iron, allowing improved NOx reduction over a wider range of operating temperatures.

Advanced Aftertreatment System Architectures
Advanced low NOx aftertreatment system architectures such as coating the SCR catalyst on the DPF and the dual SCR with dual dosing systems may also be used in place of the traditional SCR-DPF arrangement to improve thermal management and reduce NOx emissions significantly under the majority of the engine operating conditions.

Coating the SCR catalyst on the porous walls of the DPF substrate reduces system size as well as thermal mass, enabling the combined system to be close coupled to the DOC for faster light-off and improved cold start emissions performance.

The dual SCR with dual dosing architecture consists of a close coupled light-off SCR catalyst located upstream of the DOC to take advantage of the hot exhaust coming out of the engine to effectively reduce NOx during cold starts and low load operations, until the downstream SCR temperature reaches its ideal operating state for maximum NOx control.

Additional Improvements to the SCR Aftertreatment System
Additional improvements to the SCR system such as heated DEF dosing, model-based DEF management controls, exhaust system heat retention including insulation and packaging of the aftertreatment system can be employed to improve thermal management of the exhaust and increase NOx conversion efficiency.

Ammonia Slip Catalyst (ASC)
An ASC is a precious metal-based oxidation catalyst that is used to oxidize excess unreacted ammonia that may have slipped through the SCR catalyst and would otherwise be exhausted to the environment. ASCs are designed to have high selectivity for ammonia, oxidizing ammonia to form nitrogen and water.

(2) Otto-Cycle Engines

For medium- and heavy-duty Otto-cycle engines, CARB has identified the following technologies as compliance strategies that manufacturers will likely utilize to comply with the newly established NOx and PM exhaust emission standards:

Improvements to TWC
Higher cell density and thinner wall design can provide increased geometric surface area per unit TWC volume for effective catalyst distribution, small flow channels for fast heat transfer, and reduced substrate thermal mass for faster heat up during cold starts. Adding a close-coupled catalyst also minimizes exhaust system heat losses and accelerates catalyst light-off.

Passive Heat Retention
Insulating the exhaust system including the exhaust manifold, exhaust pipeline, and TWC minimizes heat loss across the walls and accelerates catalyst light-off at cold start resulting in high conversion efficiency of the TWC.

High Oxygen Storage Material:
High oxygen storage capacity is critical for maintaining high catalytic conversion. The latest generation of ceria zirconia added to the washcoat of TWCs provide higher thermally stable oxygen storage capacity and allows a broader window of catalytic operation, improves catalyst light-off, and enables significant reductions of NOx emissions.

Advanced Air/Fuel (A/F) Ratio Controls:
Because a TWC operates within a very narrow window of A/F ratio, maintaining accurate A/F ratio in cylinders is critical to achieving maximum catalytic conversion efficiency. Maintaining accurate A/F ratio control allows for better fuel economy, lower NOx emissions, and better engine performance. A zirconia-based wideband oxygen sensor widely used in gasoline passenger cars could be used for Otto-cycle heavy-duty engines for accurate A/F ratio control.

ii. Technical Feasibility Determinations of the 2024 – 2026 Model Year NOx Emission Standards

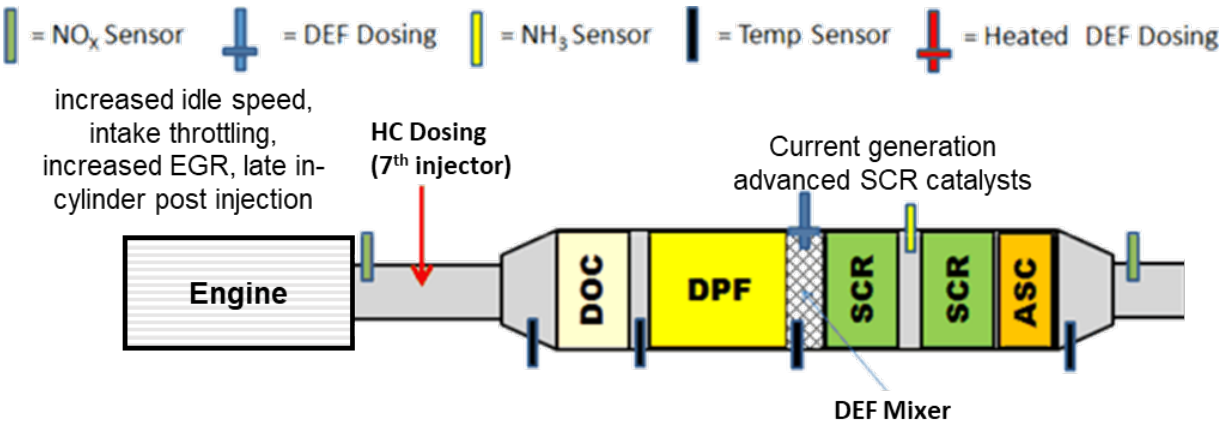
(1) Diesel Engines

CARB determined that medium and heavy-duty diesel engines could comply with the MY 2024 through 2026 NOx emissions standards without needing to redesign existing engines, but could comply by implementing engine calibration strategies to reduce cold start emissions in conjunction with currently available exhaust aftertreatment systems described above in Section V.C.1.a.i.(1). Specifically, compliant engines would likely incorporate engine calibration strategies such as elevated idle speed, increased EGR rates, intake or exhaust throttling, late in-cylinder post injection, or EGR cooler bypass, in combination with heated DEF dosing, advanced thin-walled catalyst substrates,

ammonia slip catalysts, and/or insulating or packaging exhaust aftertreatment system. Each of these technologies can be readily incorporated into existing engines.

CARB described four combinations of possible compliance technologies for 2024 through 2026 MY diesel engines in the Staff Report.[77] The "Stage 1" research program by the Southwest Research Institute (SwRI) evaluated a number of technology packages to demonstrate the feasibility of attaining a 0.02 g/bhp-hr tailpipe NOx emission standard on modern heavy-duty diesel engines. The program (including a follow-up "Stage 1b" program) was funded in partnership with the Manufacturers of Emission Controls Association (MECA), EPA, the South Coast Air Quality Management District (SCAQMD), and Volvo who supplied the diesel engine and engineering support to the program. Figure IV-1 below displays one of those technology packages screened during that program and later modeled by MECA.

Figure IV-1. Technology Package for Proposed MY 2024 Standards



In this program, SwRI demonstrated a 36 percent reduction in FTP NOx from baseline levels solely with engine calibration strategies that included elevated idle speed, intake throttling, increased EGR rates, and late in-cylinder post injection, in combination with stock exhaust aftertreatment technologies that was available on 2014 MY engines. MECA subsequently modeled the engine-out NOx emissions from the SwRI engine with modified calibration in conjunction with SCR catalyst technologies available in 2019 MY engines and projected tailpipe NOx emissions of 0.03 g/bhp-hr on the FTP cycle.[78] Modeling using next generation commercially available ASC, MECA demonstrated 0.02 g/bhp-hr NOx on the composite FTP, providing significant compliance margin relative to the 2024 MY standard. The components modeled in MECA's analysis are commercially available, and can be implemented into 2024 MY engines. Moreover, to the extent that manufacturers may elect to utilize different compliance strategies, the components and

[77] ISOR, pp. III-23 through III-26.

[78] ISOR p. III-24

technology packages needed to comply with the 2024 through 2026 NOx standards are commercially available.

(2) Otto-cycle Engines

CARB determined that heavy-duty Otto-cycle engines could comply with the MY 2024 through 2026 NOx emissions standards using combinations of existing compliance technologies discussed in Section V.C.1.a.i.(2) Manufacturers have already certified existing CNG and LPG-fueled heavy-duty Otto-cycle engines to 0.02 g NOx/bhp-hr standards,[79] and minor incremental improvements to three-way catalysts, air-fuel ratio controls and other engine calibration strategies will enable gasoline-fueled Otto-cycle engines to comply with the MY 2024 through 2026 NOx emissions standards.

iii. Technical Feasibility Determinations of the 2024 and Subsequent MY 0.005 g/bhp-hr PM Standard

Medium and heavy-duty diesel and Otto-cycle engines could comply with the 2024 and subsequent MY PM emissions standards without any, or only limited modifications since existing engines already certify to PM emission levels below 0.005 g /bhp-hr. CARB certification data indicates that 93 percent of 2019 MY heavy-duty diesel engine families certified to PM levels at or below 0.004 g/bhp-hr PM, and that 7 percent of 2019 MY heavy-duty diesel engine families certified to levels at 0.01 g/bhp-hr PM.[80]

Moreover, technology currently exists that will enable heavy-duty Otto-cycle engines to comply with the 2024 and subsequent MY PM emission standards. For instance, Roush Industries has certified a 2021 MY heavy-duty Otto-cycle engine family that is equipped with a sequential fuel injection system to PM emissions level of 0.004 g/bhp-hr.[81] Furthermore, analysis of 2019 MY certification data indicate approximately 92 percent of the 2019 MY heavy-duty Otto-cycle engine families certified to the optional low NOx standards of 0.10, 0.05, and 0.02 g/bhp-hr have PM certification levels below 0.005 g/bhp-hr, indicating the feasibility of the 2024 MY PM standard.

[79] ISOR, p. I-6

[80] FSOR, p. 22.

[81] https://ww2.arb.ca.gov/sites/default/files/classic/msprog/nvepb/executive_orders/EO%20Files/MDE-HDE/2021/ROUS%20-%20ROUSH/roush_hdoe_a-344-0130__year--2021__mfrcarb--rous__ver--orig__uid--7-2203__itr--1__fam--mriie07.3bw7.pdf

iv. Technical Feasibility Determinations of the 2027 MY and Subsequent MY NOx Standards

(1) Diesel Engines

CARB determined that medium and heavy-duty diesel engines could comply with the 2027 and subsequent MY NOx emissions standards by utilizing combinations of the existing compliance technologies described above in Section V.C.1.a.iv.(1), primarily, combinations of improved engine calibration strategies (e.g., elevated idle speed, increased EGR rates, late in-cylinder post injection); hardware strategies (e.g., CDA, SuperTurbo™, or EGR cooler bypass); insulation and packaging of exhaust aftertreatment components; and advanced aftertreatment system architectures (e.g., SCR systems with close coupled light-off catalysts, heated DEF dosing systems, and ammonia storage management control systems).

SwRI tested an engine equipped with a technology package (the SwRI "Stage 3 Rework Low NOx Technology Package") that included:

- Engine calibration strategies such as increased idle speed, increased EGR rates, and multiple fuel injection to accelerate catalyst light-off;
- Cylinder deactivation for rapid warm-up and to keep the exhaust warm under sustained low temperature operation; and
- An advanced aftertreatment system that included dual SCR catalysts with dual dosing with the upstream light-off SCR catalyst close-coupled to the engine and a downstream DOC-DPF-SCR and ammonia slip catalysts in a "One Box" system.

The testing demonstrated NOx emissions of 0.020 g/bhp-hr NOx on the composite FTP cycle, 0.019 g/bhp-hr NOx on the RMC cycle, and 0.029 g/bhp-hr NOx on the LLC cycle after the engine and technology package was chemically and thermally aged for 435.000 miles.[82,83] That technology package additionally demonstrated NOx emissions of 0.1 and 0.3 g/hr when tested at curb idle speeds of 600 rpm and 1100 rpm, respectively.[84]

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[82] FSOR, p. 116

[83] These emission test results also support CARB's determination that heavy heavy-duty diesel engines can comply with the Full Useful Life NOx standards for the 2027 and 2031 model years, when the full useful lives of the engines are 600,000 and 800,000 miles, respectively. CARB staff used the same methodology that manufacturers currently use to demonstrate compliance with the applicable emissions standards at full useful life; aging the engine-aftertreatment system to a portion of useful life (typically 35-50 percent of full useful life), measuring the tailpipe emissions for a minimum of three emissions test points (using equally spaced intervals), and then using a linear regression model in conjunction with the emissions data to extrapolate the emission test results at full useful life. FSOR, p. 46.

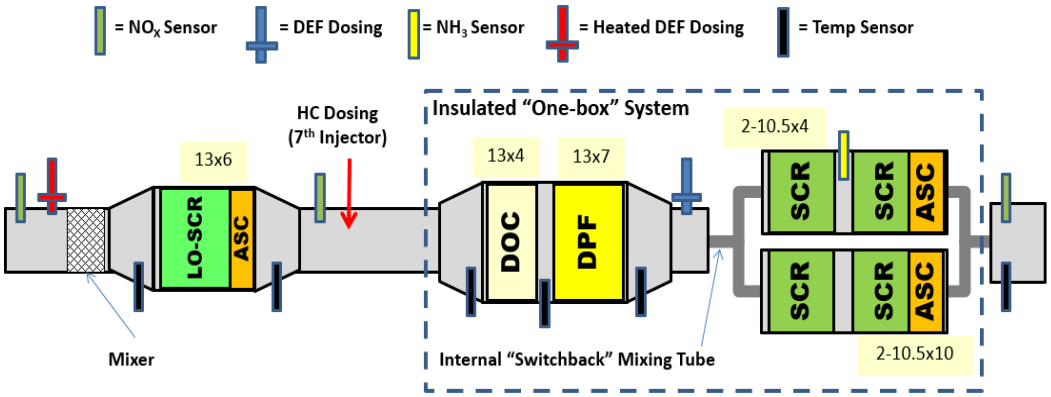
[84] FSOR, p.53

These results indicate that manufacturers can attain significantly lower NOx emissions by developing further improvements of compliance strategies within the 2022 through 2027 and 2028 through 2030 time periods, such as:

- Improved DEF mixing on the downstream system.
- Using a slightly larger (i.e., approximately ten percent larger) downstream catalyst volumes, to provide more durability reserve.
- Improvements in light-off SCR formulations to better resist chemical poisoning.
- Improvements in downstream SCR formulations to retain selectivity of the ammonia oxidation function over time.
- Calibration of the aging model algorithm in the controller, which could allow the models to better track storage and performance changes over time.
- Further refinement of long-term trim algorithms.

Figure IV-2 outlines the emissions control technologies associated with the SwRI “Stage 3 Rework” technology package

Figure IV-2. SwRI Stage 3 Rework Low NOx test program Technology Package



Figures IV-3 and IV-4 below provides other examples of possible configurations of advanced aftertreatment architectures that would allow 2027 and subsequent MY medium- and heavy-duty diesel vehicles to comply with the 2027 MY and 2031 and subsequent MY NOx emissions standards.

Figure IV-3. Dual SCR-Dual Dosing System
Downstream System: DOC Zone Coated on DPF and the SCR in a One Box System

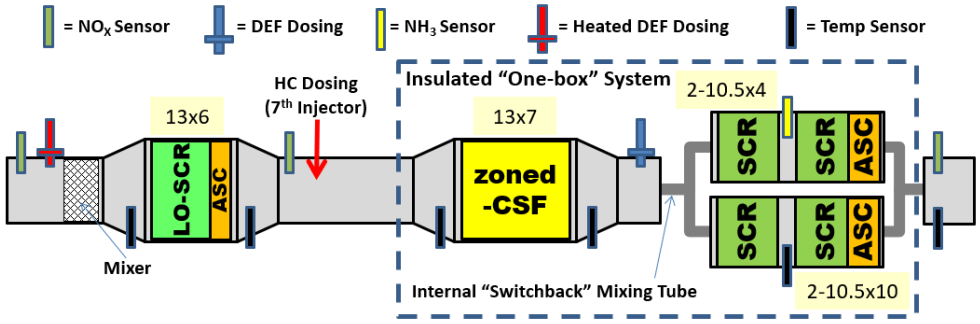
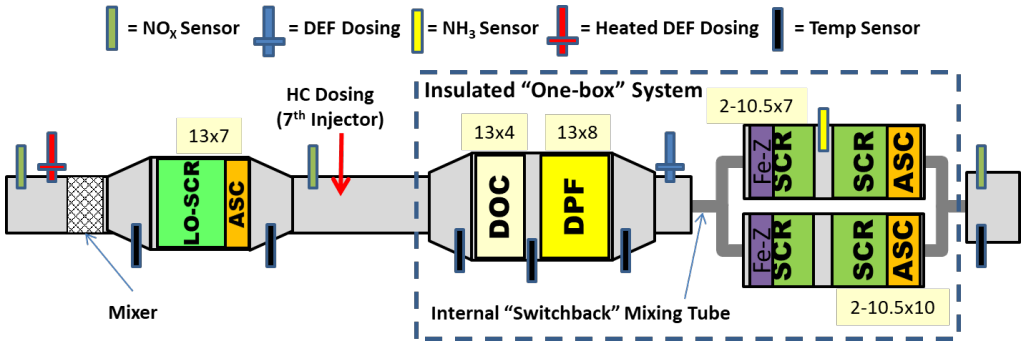


Figure IV-4. Dual SCR-Dual Dosing System
Downstream SCR based on Iron/Copper Zeolite Formulation



Several commenters claimed that the NOx standards would require engines to incorporate engine hardware, such as mini burners on SCR systems, that would cause increases of GHG emissions. However, CARB determined these claims were unfounded, because technology packages, including the technologies used in the SwRI Stage 3 Low NOx Technology Package, or bypassing EGR coolers, demonstrated the ability to meet the NOx standards with minimal or no increases of GHG emissions.[85] CARB also noted that optimizing engine calibration strategies (such as increased idle speed, increased EGR flow, intake or exhaust air throttling, and post injection), or using EGR bypass, heated urea dosing, together with improved catalysts can minimize overall increases of GHG emissions.[86]

[85] FSOR, p. 25-26;75

[86] Id. at p. 33-37, 46

Achates Power continues to develop its OP engine and has demonstrated the capability of the engine to meet the 2027 NOx and CO2 standards. Achates reported that based on engine measurements and analysis, its 10.6 L OP diesel engine generated 0.02 g/bhp-hr NOx on the FTP, 0.021 g/bhp-hr NOx over the LLC (60% below the 2027 LLC limit) and 4 grams per hour NOx at idle (20% below the 2027 optional idling NOx standard), and 422 g/bhp-hr CO2, lower than the 2027 Heavy-Duty Phase 2 CO2 standards of 432 grams/bhp-hr over the Supplemental Emissions Test (SET) cycle. This emission performance was achieved with conventional underfloor aftertreatment system providing a significant reduction in cost and complexity compared to the dual SCR dual dosing SCR system. It is believed that the Achates OP engine could become commercially available by 2027 and provide an alternative solution to the conventional heavy-duty diesel engine architecture.

(2) Otto-Cycle Engines

Existing heavy-duty Otto cycle engines fueled on natural gas and propane are certifying to NOx emissions standards of 0.02 g/bhp-hr by using improved three-way catalysts and feedback fuel control metering systems.[87] In addition, some 2020 MY heavy-duty Otto-cycle engines fueled on gasoline are currently certified to a family emission limit of 0.12 g/bhp-hr NOx with a certification level of 0.05 g/bhp-hr NOx and 0.002 g/bhp-hr PM.[88] CARB therefore believes that heavy-duty Otto-cycle engines that incorporate minor refinements to existing compliance technologies, such as the technologies described in Section V.C.1a.iv.(2) will be able to demonstrate compliance with the 2027 and subsequent MY NOx standards. Unlike diesel engines, LLC, RMC, and Idling NOx standards do not apply to these engines.

v. Technical Feasibility Determinations of the Optional Low NOx Standard

Heavy-duty Otto cycle engines are currently certifying to the optional low NOx standard of 0.02 g/bhp-hr NOx standard on the FTP and the associated PM emissions are significantly lower than the PM standard of 0.005 g/bhp-hr. With further improvements in aftertreatment systems, including catalyst formulations, improvements in air-fuel ratio controls, and other engine calibration strategies, heavy-duty Otto-cycle engines could reduce emissions further to achieve certification levels of 0.01 g/bhp-hr NOx standards.[89]

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[87] ISOR, p. III-26

[88] CARB Executive Order. A-006-2249-2

[89] As demonstrated by this document and the rulemaking record for the Omnibus Regulation, the primary NOx standards and associated test procedures for 2024 and subsequent MY heavy-duty diesel engines described in Section III.A.1 meet the criteria for a new waiver, and accordingly no issue of technical feasibility is presented for the Optional Low NOx standard. See *Motor and Equipment Mfrs. Ass'n, Inc. v.*

vi. Additional Flexibility Provided Through Exemptions and Compliance Provisions

The exemptions and compliance provisions described in section III.N provide manufacturers increased flexibility to comply with the requirements applicable to new 2024 and subsequent model year medium- and heavy-duty engines and vehicles. Moreover, to address manufacturers' concerns regarding lead time, CARB established a number of flexibilities relevant to the time needed to develop and certify engines by the 2024 MY, including options that reduce the time needed to demonstrate durability (Section III.C.3.a.), provisions to accrue credits by certifying engines to standards that are more stringent than the applicable primary exhaust emission standards or by certifying engines to the primary exhaust emission standards earlier than required (Section III.F.1), creation of the zero-emission averaging set (Section III.F.1), and allowing manufacturers to use OBD II and HD OBD malfunction emission thresholds that are based on the preexisting exhaust emission standards, rather than the newly established exhaust emission standards (Section III.D).

vii. Lead Time Comments Received During Rulemaking Action

During the rulemaking action, manufacturers asserted that CARB would not be able to obtain a waiver pursuant to section 209(b) of the CAA because the Omnibus Regulation does not provide manufacturers the four years of lead time specified by section 202(a)(3)(C) of the CAA. Section 202(a)(3)(C) of the CAA requires that in adopting emissions standards for heavy-duty vehicles or heavy-duty engines, EPA's Administrator must provide specified periods of lead time and stability:

> Any standard promulgated or revised under this paragraph and applicable to classes or categories of heavy-duty vehicles or engines shall apply for a period of no less than 3 model years beginning no earlier than the model year commencing 4 years after such revised standard is promulgated.

As detailed below in CARB's response to the commenter, the commenter's claim is not valid, and does not preclude a finding that the emissions standards promulgated by the Regulation are consistent with section 202(a) within the meaning of section 209(b)(1)(C). See MEMA II. "In the waiver context, section 202(a) 'relates in relevant part to technological feasibility and to federal certification requirements.' (Citation omitted). The 'technological feasibility' component of section 202(a) obligates California to allow sufficient lead time to permit manufacturers to develop and apply the necessary technology. (Citation omitted). The federal certification component ensures that the Federal and California test procedures do not 'impose inconsistent certification

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Environmental Protection Agency, 627 F.2d 1128, 1132 (D.C. Cir. 1979) (a regulatory compliance option is only a mandate that can result in a denial of a waiver if the regulation does not specify another technically feasible compliance option.)

requirements.' (Citation omitted). Neither the court nor the agency has ever interpreted compliance with section 202(a) to require more."[90]

> The lead time and stability provisions of section 202(a)(3)(C) of the CAA do not apply to emission standards and other emission requirements applicable to new engines that are established in this rulemaking action. Section 202(a)(3)(C) only applies to standards "promulgated or revised under this paragraph [section 202(a) of the CAA]," that is, to standards promulgated by the Administrator of the U.S. EPA. CARB adopted the emission standards and other emission requirements applicable to new engines and new motor vehicles pursuant to authority of California state law, and the waiver provisions of section 209(b) of the CAA, and therefore the lead time and stability requirements of section 202(a)(3)(C) are inapplicable. …
>
> Also, since 1970, U.S. EPA has typically applied a "two-pronged" test of whether California standards are consistent with CAA section 202(a) as required by section 209(b)(1)(C). The standards first must be technologically feasible in the lead time provided considering the cost of compliance, and second must be compatible with the federal test procedures so that a single vehicle could be subjected to both tests. No more should be required. This is in accord with the legislative history of section 209. When the California waiver provisions and the "consistent with section 202(a)" language were first placed in the CAA in 1965, section 202(a) consisted of just one sentence requiring adequate lead time in consideration of technological feasibility and economic costs. In the 1977 CAA amendments, Congress amended section 209 "to afford California the broadest possible discretion in selecting the best means to protect the health of its citizens and the public welfare." (H. R. Rep. No. 294, 95th Cong., 1st Sess. 301 (1977), reprinted in 4 Leg. Hist., at 2768.) At the same time, Congress expanded section 202(a) to add several directives to U.S. EPA regarding its adoption of emission standards, including the four-year lead time requirement for HD vehicles. Given Congress's expressed intent to strengthen the waiver provisions, it is clear that Congress did not intend to apply the specific four-year requirement to California, which would effectively narrow the deference provided to the state.

FSOR, pp. 353-354.

[90] *Motor & Equip. Mfrs. Ass'n v. Nichols*, (MEMA II), 142 F.3d 449, 463 (D.C. Cir. 1998).

Indeed, the absence of any congressional intent to apply specific, quantitative lead-time requirements to California's adoption of its own standards is evident from Congress's decision to expressly specify those limits for EPA.

As discussed throughout this request, the Administrator cannot find California's requirements are inconsistent with section 202(a), and must accordingly grant California the requested waiver actions.

vii. Conclusion on Technological Feasibility and Lead Time for 2024 and Subsequent Model Year NOx and PM Emission Standards

As demonstrated by this document and the rulemaking record for the Omnibus Regulation, the Regulation's requirements for the 2024 and subsequent model year primary and optional NOx standards and primary PM emissions standards and associated test procedures for 2024 and subsequent MY medium- and heavy-duty diesel and Otto-cycle engines described in Sections III.A and III.B are technologically feasible, within the lead time provided. It is also notable that Cummins and PACCAR expressed their intentions to certify engines to the 2024 MY standards during CARB's August 27, 2020 public hearing.

b. Technical Feasibility of HDDE Durability Program

The elements of the Regulation that establish the more stringent durability demonstration program requirements described in Section III.C are technologically feasible within the lead time provided. The durability demonstration program does not require manufacturers to utilize newly developed testing equipment, and provides manufacturers several options to utilize accelerated aging demonstrations, and accordingly demonstrate compliance with the program's requirements, especially in the 2024 through 2026 model years.[91]

c. Technical Feasibility of OBD II and HD OBD Requirements

As described in Section III.D, the Regulation does not establish stricter malfunction emission thresholds for NOx or PM emissions for OBD II or HD OBD systems, but instead allows such systems to utilize malfunction emission thresholds that are based on the preexisting exhaust emission standards rather than the otherwise applicable primary or optional NOx and primary PM exhaust emission standards. Consequently, no issues of technical infeasibility are presented since manufacturers can utilize their existing OBD II and HD OBD systems.

[91] See FSOR, p. 454. (No accelerated aging options were established for medium-duty and light heavy-duty engines because CARB determined the durability periods for those engine categories could be completed within the time provided without accelerated aging.)

d. Technical Feasibility of Extended Useful Life Periods

The extended useful life periods described in Section III.E present no issues of technical feasibility, because the technical feasibility of the underlying emission standards has been demonstrated above in Section V.C.1.a.

As discussed in Section V.C.1.a., the SwRI Stage 3 Low NOx technology Package has demonstrated the feasibility of complying with the 2027 NOx emission standards for 435,000 miles, and as discussed in Section V.C.1.e (discussing warranty provisions, below), manufacturers may elect to either: (1) design and utilize emission components that are more durable than existing emission control components to comply with the extended useful life periods, or to (2) utilize existing components, specify in their emissions maintenance intervals that such components must be repaired or replaced at intervals that are shorter than the designated useful life periods, and pay for any emissions related parts that are designated not replaceable (i.e., the EGR system, turbochargers, DPFs, and catalytic converter beds).

For example, a manufacturer could elect to comply with the 800,000 mile/12 year/40,000 hour useful life of a heavy heavy-duty diesel engine by either utilizing more durable components that are capable of controlling emissions throughout that useful life period without needing repairs or replacements, or by using existing components (which are subject to existing useful life periods of 435,000 miles/10 years/22,000 hours), specifying that eligible parts must be repaired and replaced no less frequently than the intervals shown in Table III-8, in Section III.G.2 and pay for the designated repairs and replacements. Since the latter option is technically feasible, CARB does not need to establish technical feasibility of the former option.[92]

e. Technical Feasibility of Emissions Warranty-Related Provisions

i. Feasibility of Lengthened Emissions Warranty Periods

The elements of the Omnibus Regulation described in Section III.G.1 that lengthen the emissions warranty periods present no issues regarding technical feasibility or lead

[92] *Motor and Equipment Mfrs. Ass'n, Inc. v. Environmental Protection Agency*, 627 F.2d 1128, 1132 (D.C. Cir. 1979) (a regulatory compliance option is only a mandate that can result in a denial of a waiver if the regulation does not specify another technically feasible compliance option.)

time. Both manufacturers[93] and third-party warranty providers[94] currently offer emissions warranties that are longer than the warranty periods established by CARB's 2018 rulemaking action that amended emissions warranty provisions for on-road heavy-duty diesel engines and vehicles (the "2018 HD Warranty Amendments"),[95] and emission warranties with coverage periods for up to one million miles are available, provided vehicles satisfy initial inspection requirements and are maintained in accordance with OEM recommendations.[96] CARB staff estimates that 40 percent of Class 8 vehicles will be covered by an emissions warranty of 500,000 miles, and that 40 percent of Class 6 and 7 vehicles will be covered by emissions warranties of 185,000 miles by model year 2022, when CARB's 2018 HD Warranty Amendments become effective.[97]

ii. Feasibility of Maintenance Schedules for Emissions-Related Components

(1) Otto-cycle engines

The maintenance schedules for emissions-related components on Otto-cycle engines present no technical feasibility concerns. As described above in Section V.C.1.a.ii(2) manufacturers of heavy duty Otto-cycle engines will be able to comply with the 2024 to 2026 NOx emission standards by implementing adjustments to calibration strategies and minor refinements of existing compliance technologies. The newly established maintenance schedules for heavy duty Otto-cycle engines reflect the most frequent interval to repair or replace existing emissions-related components, including catalytic converter beds, specified by any heavy-duty engine manufacturer for 2018 model year California certified on-road heavy duty Otto-cycle engines,[98] and are therefore clearly technically feasible.

The maintenance schedules are also feasible for 2027 and subsequent MY heavy-duty Otto-cycle engines since, as described above in Section V.C.1.a.iv(2), manufacturers of such heavy duty Otto-cycle engines will be able to comply with the 2027 and

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[93] Manufacturers are offering lengthened emissions warranties for up to 7 years or 700,000 miles. ISOR p. II-45.

[94] Third-party providers are offering lengthened emissions warranties for up to one million miles, provided that vehicles satisfy initial inspection requirements and are maintained in accordance with OEM recommendations. ISOR at II-45 to II-46.

[95] The 2018 HD Warranty Amendments establish minimum emissions warranty periods and emissions maintenance schedules for new 2022 and subsequent model year heavy-duty diesel engines and heavy-duty diesel vehicles over 14,000 lbs GVWR powered by such engines. CARB has submitted a separate waiver request for the 2018 HD Warranty Amendments.

[96] See footnote 91.

[97] ISOR, p. III-46.

[98] ISOR, pp.III-49 to III-51, and III-53.

subsequent MY NOx emission standards by incorporating minor refinements to existing compliance technologies. Moreover, as explained in Section III.G.3.a, the Regulation provides manufacturers the option to request approval from CARB's Executive Officer to utilize more frequent maintenance schedules during the model years in which the exhaust emission standards discussed in Section III.A become more stringent (2024, 2027, and 2031), which provides manufacturers sufficient time to evaluate whether the specified maintenance schedules are sufficient to ensure the proper operation of emission component systems and components over the applicable useful life periods.[99]

(2) Alternative Fueled Diesel Engines, Diesel Engines Certified for Use in Hybrid Vehicles, and 2022 and Subsequent Model Diesel Hybrid Powertrains

The maintenance schedules for emissions control components in 2022 and subsequent MY heavy-duty diesel hybrid powertrains optionally certified for use in hybrid vehicles pursuant to title 13, CCR section 1956.8, and in alternative fueled HDDEs and HDDEs used in hybrid vehicles are equivalent to the maintenance intervals established in a separate rulemaking action in which CARB amended provisions of the California emissions warranty for HDDEs and heavy-duty vehicles.[100] Those maintenance intervals in turn reflect the most frequent interval to repair or replace emissions-related components, including turbochargers and EGR systems, specified by any heavy-duty diesel engine manufacturer for 2016 model year California certified on-road heavy-duty diesel engines. The maintenance intervals pose no issues for emissions control components in hybrid powertrains. Specifically, the batteries used in heavy-duty vehicle applications have demonstrated impressive increases in battery life and durability, and manufacturers are providing warranties of up to 12 years for batteries used in transit buses.[101] Therefore, no issues of technical feasibility arise for 2022 through 2023 MY affected engines, because manufacturers can use existing compliance technology that is subject to the preexisting maintenance schedules to comply with the maintenance schedules.

For 2024 and subsequent MY affected engines, which may need to utilize redesigned components or entirely new compliance technologies that may adversely affect maintenance schedules, manufacturers are provided the option described in Section Section III.G.3.a to request approval to utilize more frequent maintenance schedules during the model years in which the exhaust emission standards discussed in Section III.A become more stringent (2024, 2027, and 2031). The new maintenance schedules therefore do not present technical feasibility or lead time concerns.

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[99] The option is not available for specified emission control components and systems that are relatively high priced and can result in significant emissions impacts when they fail (e.g., EGR systems, turbochargers, DPF systems, and catalytic converter beds).

[100] See footnote 92.

[101] ISOR p. III-56

f. Technical Feasibility of Heavy-Duty In-Use Compliance Program Amendments

i. Diesel Engines

The elements of the Regulation described in Section III.I present no issues of technical feasibility because they only require the use of commercially available hardware, portable emission measurement systems (PEMS) to measure and record exhaust emissions, and to record engine and vehicle operational parameters via connection to vehicle's OBD system. PEMS devices have been utilized by manufacturers to comply with CARB's preexisting heavy-duty in-use compliance program since the 2007 model year.[102] The calculations needed to bin exhaust emissions windows based on the percent engine load and to average the emissions data in each bin based on a sum-over-sum approach do not require separate hardware, but can be accomplished by implementing software changes to engine computers.

Some commenters asserted that the in-use program was infeasible because it did not retain the preexisting NOx-measurement adjustment factor for PEMS devices. However, CARB staff determined that adjustment factor is not needed because the uncertainty associated with NOx emissions measurements (resulting from instrument measurement errors) is lower than the conformity factor (which also provides a compliance margin). In fact, the conformity factor specified in the in-use program provides manufacturers a higher amount of compliance margin than the NOx-measurement adjustment factor.[103] However, notwithstanding this determination, CARB modified the initially proposed Regulation to increase the conformity factor to 2.0, which provides an additional compliance margin of 50 percent for 2024 through 2029 MY engines.[104] CARB also modified the initially proposed Regulation to provide additional compliance margins for 2024 through 2026 MY engines.[105]

Several commenters also asserted the in-use program was infeasible because current PEMs devices are not capable of accurately measuring NOx emissions at the levels needed to determine compliance with the in-use program, and that the measurement drift of current PEMS devices are close to the NOx levels needed to determine compliance with the in-use program. Those assertions are not true. Studies have been conducted evaluating PEMS to laboratory NOx sensors down to 1 ppm.[106] In addition,

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[102] See Section I.A.4

[103] FSOR, p. 131.

[104] FSOR, p. 119.

[105] Specifically, cold-start emissions are excluded, the LLC standards are increased to 4 times the FTP standard, and average engine loads must be no less than 10 percent of engine maximum power. FSOR, p. 106.

[106] Verella et al. (2018), Comparison of Portable Emissions Measurement Systems (PEMS) with Laboratory Grade Equipment. https://publications.jrc.ec.europa.eu/repository/handle/JRC112932

the conformity factor allows for the measurement variability and current PEMS are capable of measuring NOx emissions at the levels associated with the in-use program's 3B-MAW approach.[107] Furthermore, both CARB staff and manufacturers have developed measures to reduce measurement drift from PEMS, such as environmental and vibrational protection chambers, the new 3B-MAW test methods which use CO2 emissions measurements for load/work calculations dramatically increase the accuracy of the calculations at lower engine loads, and the 3B-MAW method's extensive averaging of windows reduces the compliance determination susceptibility to certain forms of measurement noise.[108]

ii. Otto-cycle Engines

The in-use program incorporates modifications that CARB enacted to address manufacturers' concerns that the initially proposed program could be infeasible for Otto-cycle engines. Specifically, manufacturers can exclude up to 5 percent of the highest emission levels of 2024 through 2026 MY heavy-duty Otto-cycle engines if such engines activate fuel enrichment modes. This provision provides manufacturers an additional three years to develop and further refine engines and compliance strategies to account for emissions generated during sustained high engine loads.

g. Technical Feasibility of Optional Powertrain Certification Test Procedures for Heavy-Duty Hybrid Vehicles

The elements of the Regulation described in Section III.J present no issues regarding technical feasibility. Because manufacturers are not required to utilize the newly established optional powertrain test procedures, but may still certify 2022 through 2023 MY diesel engine and Otto-cycle hybrid powertrains pursuant to previously waived standards and associated test procedures for conventionally fueled heavy-duty diesel or Otto-cycle engines, the findings of adequate technical feasibility and lead time supporting EPA's issuance of waivers for California's emission standards and associated test procedures for 2007 and subsequent MY heavy-duty diesel engines and vehicles and 2008 and subsequent MY heavy-duty Otto-cycle engines and vehicles remain applicable and dispositive.[109]

h. Additional Flexibility Provided Through Exemptions and Compliance Provisions

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[107] FSOR, pp. 135, 137

[108] FSOR, pp. 132, 134.

[109] *See Motor and Equipment Mfrs. Ass'n, Inc. v. Environmental Protection Agency*, 627 F.2d 1128, 1132 (D.C. Cir. 1979) (a regulatory compliance option is only a mandate that can result in a denial of a waiver if the regulation does not specify another technically feasible compliance option.)

The exemptions and compliance provisions described in section III.N provide manufacturers increased flexibility to comply with the requirements applicable to new 2024 and subsequent model year medium- and heavy-duty engines and vehicles. Moreover, to address manufacturers' concerns regarding insufficient lead time, CARB established a number of flexibilities that provide manufacturers sufficient time needed to develop and certify engines by the 2024 MY, including options that reduce the time needed to demonstrate durability (Section III.C.3.a.), provisions to accrue credits by certifying engines to standards that are more stringent than the applicable primary exhaust emission standards or by certifying engines to the primary exhaust emission standards earlier than required (Section III.F.1), and allowing manufacturers to use OBD II and HD OBD malfunction emission thresholds that are based on the preexisting exhaust emission standards, rather than the newly established exhaust emission standards (Section III.D).

2. Considerations of Cost

CARB appropriately considered the cost of compliance of the Regulation by estimating the costs and savings associated with every element of the Regulation that affects the costs of affected engines and vehicles; i.e., it conducted an “all-in” cost analysis of the elements of the Regulation that: establish the more stringent NOx and PM emission standards, amend the durability demonstration program, extend the useful life periods, establish the CA ABT program, lengthen the emissions warranty periods, amend the EWIR and corrective action procedures, and amend the heavy-duty in-use test procedures.[110]

After CARB’s August 27, 2020 public hearing, it updated the cost analysis to include the adopted Advanced Clean Truck Regulation into the legal baseline, and to reflect the effects associated with amendments to the initially proposed Regulation (which include the exemptions discussed in Section III.N).[111] The updated cost analysis indicates that the incremental lifetime costs associated with all elements of the Regulation constitute a small fraction of the purchase prices of new engines and vehicles. Specifically, the incremental lifetime cost for a heavy-duty vehicle powered by a 2031 MY heavy-duty Otto-cycle engine is $710, representing 0.7 percent of the purchase price;[112] the incremental lifetime cost for a medium-duty vehicle powered by a 2031 MY medium-duty diesel engine is $4355, which represents 8.3% of the purchase price,[113] and the incremental lifetime costs for light-, medium-, and heavy-duty diesel engines are $5773,

[110] A detailed description of all factors included in CARB’s cost analysis is fully set forth in Section IX of the ISOR.

[111] FSOR, pp. 245-248.

[112] The net lifetime cost of a heavy-duty vehicle powered by a 2031 MY heavy-duty Otto-cycle engine is $383.

[113] The net lifetime cost of a medium-duty vehicle powered by a 2031 MY medium-duty diesel engine is $4591.

$6347, and $6057, respectively, representing 10%, 6.1%, and 3.5% of the purchase prices of light-, medium-, and heavy heavy-duty diesel vehicles, respectively.[114]

The cost effectiveness of the Regulation is estimated to be $4.51 per pound NOx reduction.

3. Conclusion on Technological Feasibility and Lead Time

In conclusion, the Regulation's requirements are technologically feasible, considering the cost of compliance within the lead time provided.

4. Test Procedure Consistency

CARB is not aware of any instances in which a manufacturer is precluded from conducting one set of tests on a medium-duty or heavy-duty engine or vehicle to determine compliance with both California and federal requirements. The Regulation establishes emissions standards and associated test procedures that only apply to California-certified medium and heavy-duty engines and vehicles, but those California-specific requirements do not preclude a manufacturer from complying with both California and federal test requirements with one test engine or vehicle.[115]

VI. THE AMENDMENTS THAT ALIGN CALIFORNIA's EMISSION STANDARDS FOR 2004 AND SUBSEQUENT MODEL YEAR AUXILIARY POWER UNITS USED ON HEAVY-DUTY TRACTOR VEHICLES WITH THE CORRESPONDING FEDERAL EMISSION STANDARDS MEET THE CRITERIA FOR AN AUTHORIZATION

As discussed in Section I.A.6, California's Heavy-Duty Diesel Engine Idling Regulation requires truck owners that elect to install diesel-fueled APUs in new and in-use trucks powered by 2007 and subsequent MY HDDEs to ensure that the diesel engines powering the APUs comply with the California or federal off-road emission standards and test procedures applicable to the horsepower category of the engines and to either: (1) route the exhaust from the APU into the truck's exhaust system, (2) equip the APU with a level 3 verified PM control strategy (i.e., achieve an 85 percent PM reduction efficiency), or (3) use other procedures that achieve an equivalent level of emissions compliance as the first two options.

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[114] The net lifetime costs of heavy-duty vehicles powered by light-, medium- and heavy-heavy duty diesel engines are: $5,634, $5,896, and $6,580, respectively.

[115] Even where there is incompatibility between the California and federal test procedures, EPA has granted a waiver under circumstances where EPA accepts a demonstration of federal compliance based on California test results, thus obviating the need for two separate tests. (43 Fed .Reg. 1829, 1830 (Jan. 12, 1978); 40 Fed. Reg. 30311, 30314 (July 18, 1975).).

As also discussed in Section III.K.3, the federal Phase 2 GHG regulation requires 2024 and subsequent MY diesel-fueled APUs installed in 2024 and newer on-road tractors to be certified to a PM emission standard of 0.02 grams per kilowatt-hour (g/kW-hr), and the elements of the Omnibus Regulation described in Section III.K.3 now align the California emission requirements for diesel-fueled APUs installed on 2024 and subsequent model California on-road tractors with the corresponding federal requirements, and additionally establish an additional compliance option for California's Heavy-Duty Diesel Engine Idling Regulation – using a 2024 and subsequent MY diesel-fueled APU that is certified to a PM emission standard of 0.02 g/bhp-hr.

CARB submits that for the reasons set forth below, and in the documents associated with the Regulation's rulemaking action, the Administrator must grant California a new authorization for these elements of the Regulation.

A. Protectiveness

In adopting the Omnibus Regulation, the Board approved Resolution 20-23 (Enclosure 5), in which it expressly declared:

> BE IT FURTHER RESOLVED that the Board hereby determines that the regulations adopted herein will not cause California motor vehicle and off-road engine emission standards, in the aggregate, to be less protective of public health and welfare than applicable federal standards.

The Administrator has no basis to find that the Board's determination is arbitrary or capricious. The Amendments fully align California's emission standards and associated test procedures for 2024 and subsequent MY diesel-fueled engines in APUs that are installed on 2024 and subsequent MY California on-road tractors with the corresponding federal emissions standards and associated test procedures, and also establish an additional, more stringent compliance option for California's previously waived Heavy-Duty Diesel Engine Idling Regulation[116] that ensures that regulation is more protective, in the aggregate, of public health and welfare than comparable federal requirements.[117] Accordingly, the Board's determination of protectiveness is clearly well founded.

[116] 77 Fed. Reg. 9239 (Feb. 16, 2012), 82 Fed. Reg. 4867 (Jan. 17, 2017). Note that the newly added compliance option is only an option for 2008 through 2023 MY diesel-fueled APUs, because 2024 and subsequent MY diesel fueled APUs must be certified to the 0.02 g PM/kW-hr emission standard.

[117] Notably, the federal requirements in 40 CFR § 1037.106(g)(1) require 2021 through 2023 MY diesel fueled APUs used in tractors to meet a PM emissions standard of 0.15 g/kW-hr. Options (2) and (3) of the California Heavy-Duty Engine Idling Regulation require 2008 and subsequent MY diesel-fueled APUs to meet a PM emissions standard of 0.06 g/Kw-hr, and the new option requires new 2024 and subsequent MY diesel-fueled APUs to meet a PM emissions standard of 0.02 g/kW-hr.

B. Compelling and Extraordinary Circumstances

As discussed above in Section V.B, EPA interprets section 209(e)(2)(A)(ii) consistently with its interpretation of section 209(b)(1)(B), i.e, section 209(e)(2)(A)(ii) requires an inquiry whether California still has compelling and extraordinary conditions and therefore continues to need its own nonroad engine and equipment emissions control program. As demonstrated in Section V.B, California satisfies both EPA's traditional interpretation of this criterion and EPA's interpretation of this criterion as set forth in its SAFE 1 action.

As also discussed in Section V.B, in adopting Resolution 20-23, CARB found that "California still has the most severe air pollution problems in the United States,"[118] and that CARB needs to seek emission reductions from all sources under its authority to meet federal emission reduction requirements.[119] California and the South Coast and San Joaquin Valley air basins in particular continue to experience some of the worst air quality in the nation, and the South Coast and San Joaquin Valley Air Basins, in particular, continue to be in extreme non-attainment with national ambient air quality standard for ozone and in serious non-attainment with the national ambient air quality standard for particulate matter.[120]

In the California Clean Air Act of 1988, the California Legislature found that:

> [D]espite the significant reductions in vehicle emissions which have been achieved in recent years, continued growth in population and vehicle miles traveled throughout California have the potential not only to prevent attainment of the state standards, but in some cases, to result in worsening of air quality.[121]

In response to the undisputed severe air quality problems in California, the California Legislature authorized CARB to consider adopting, *inter alia*, standards and regulations for nonroad engines.[122] Given the serious air pollution problems California faces and the resultant need to achieve the maximum reductions in emissions, the California

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[118] Resolution 20-23 at p. 18

[119] Ibid.

[120] See 74 Fed. Reg. 32744, 32762-32763 (July 8, 2009); 79 Fed. Reg. 6584, 6588-590 (Feb. 4, 2014); 82 Fed. Reg 6540, 6543 (Jan. 19, 2017). See 74 Fed. Reg. 32744, 32762-32763 (July 8, 2009); 79 Fed. Reg. 6584, 6588-590 (Feb. 4, 2014); 82 Fed. Reg 6540, 6543 (Jan. 19, 2017). In 2007, 19 of California's air quality districts were in nonattainment with the eight-hour ozone 0.08 ppm NAAQs. Currently, 37 California counties are in nonattainment with the 2015 eight-hour ozone 0.070 ppm NAAQs, and 26 of California's counties are in nonattainment with the 2006 PM 2.5 NAAQS. https://www3.epa.gov/airquality/greenbook/ancl.html (last accessed Oct. 28, 2021).

[121] California Health and Safety Code section 43000.5.

[122] California Health and Safety Code sections 43013 and 43018.

Legislature and CARB believe it is necessary to develop emission controls for nonroad sources as well as for motor vehicles.[123] By adding federal and state authority to regulate nonroad engines, Congress and California's Legislature, respectively, acknowledged the increasing importance of reducing emissions from all mobile sources, including off-road nonroad engines. The Administrator has repeatedly agreed with CARB that California's continuing extraordinary conditions justify separate California off-road emission control programs.[124] Nothing in these conditions has changed to warrant a change in this determination. Accordingly, for all the aforementioned reasons, there can be no doubt of the continuing existence of compelling and extraordinary conditions justifying California's need for its own off-road vehicle and engine emissions control program.

C. Consistency with CAA Section 209

As previously stated, section 209(e)(2) requires consistency with the several subsections of section 209; that is the Administrator must consider not only consistency with section 202(a) – as required under section 209(b)(1)(C) – but also other subsections of section 209. In its *209(e) Final Rule,* EPA interpreted this provision to require that California's standards and accompanying enforcement provisions must also be consistent with sections 209(a) and 209(e)(1).[125]

1. Consistent with CAA Section 209(a)

The Amendments are consistent with CAA section 209(a) because APUs are neither new motor vehicles nor new motor vehicle engines. Although the affected APUs are installed on heavy-duty diesel vehicles, they do not propel the vehicles, and therefore cannot be considered a motor vehicle engine.[126]

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[123] *See* California Health and Safety Code sections 41750, 41754, 43000.5, 43013 and 43018.

[124] 60 Fed. Reg. 37440 (July 20, 1995); 61 Fed. Reg. 69093 (Dec. 31, 1996); 71 Fed. Reg. 29623 (May 23, 2006); 76 Fed. Reg. 77521 (Dec. 13, 2011).

[125] *Air Pollution Control; Preemption of State Regulation for Nonroad Engine and Vehicle Standards ("Section 209(e) Rule"),* 59 Fed. Reg. 36969, 36983 (July 20, 1994).

[126] *See* CAA section 216(2).

2. Consistent with CAA Section 209(e)(1)

The Amendments are not inconsistent with section 209(e)(1) because they do not adopt or enforce any standard or other requirement relating to the control of emissions of new engines used in farm and construction equipment smaller than 175 hp, new locomotives, or engines used in new locomotives.

3. Consistent with CAA Section 209(b)(1)(C)

CAA section 209(b)(1)(C) provides that no waiver (authorization) shall be granted if the Administrator finds that California's standards and accompanying enforcement procedures are not consistent with section 202(a) of the CAA. As discussed above in Section V.C, "[t]he 'technological feasibility' component of section 202(a) obligates California to allow sufficient lead time to permit manufacturers to develop and apply the necessary technology."[127]

The Amendments present no issues regarding technical feasibility or lead time. EPA evaluated the technical feasibility of the requirement that diesel-fueled APUs meet a PM standard of 0.02 g/bhp-kW-hr in its Phase 2 GHG rulemaking action, and determined that standard was attainable within the specified lead time. EPA specifically cited the current availability of a Yanmar engine paired with a ThermoKing electronic regenerative diesel particulate filter that has certified to a PM emission level that is below 0.014 g/kW-hr.[128] EPA additionally determined that the costs associated with that compliance option were reasonable.[129] EPA also stated that the standard "is also voluntary in the sense that tractor manufacturers can use other types of idle reducing technologies, or use a Phase 2 compliance path not involving idle control."[130]

The Amendments are accordingly clearly technically feasible because they mirror the requirements that EPA has adopted and necessarily determined were technically feasible, after considering the cost of compliance in the specified lead time. To the extent that the Amendments affect APUs subject to the preexisting Heavy Duty Diesel Engine Idling Regulation, EPA's findings of adequate technical feasibility and lead time

[127] Motor & Equip. Mfrs. Ass'n v. Nichols, 142 F.3d 449, 463 (D.C. Cir. 1998) (quoting Ford Motor Co. v. EPA, 606 F.2d 1293, 1296 n. 17 (D.C.Cir.1979)).

[128] Final Rule, Greenhouse Gas Emission Standards and Fuel Efficiency Standards for Medium- and Heavy-Duty Engines and Vehicles, 81 Fed. Reg. 73478, 73578 (Oct. 25, 2016).

[129] *Id.* at 73579. EPA projected the incremental costs for an actively regenerating DPF as $2,000,while cost of APU is presumably $8000.

[130] Id at 73579, 73580.

supporting its issuance of prior authorizations for that regulation remain applicable and dispositive.[131]

The costs of compliance associated with the requirements for 2024 and subsequent MY APUs are approximately $2,000, which constitutes approximately 25 percent of the price of a diesel-fueled APU, and CARB determined that these costs are not expected to have a substantive impact on California businesses.[132]

The Amendments do not raise any issue regarding incompatibility between California and federal test procedures, because the Amendments harmonize California's certification test requirements for 2024 and subsequent model diesel-fueled APUs with the corresponding federal certification test requirements.

X. CONCLUSION

Based on the foregoing, CARB respectfully requests that the Administrator grant California's requests for the waiver and authorization actions as described in this document pursuant to CAA section 209. To assist you in reviewing the requests, CARB is enclosing a CD-ROM that contains the following referenced documents to be included in the record of this waiver proceeding.

Reference Materials from Omnibus Rulemaking

1. Notice of Public Hearing and Attachments to Notice (Enclosure 1)

2. Staff Report: Initial Statement of Reasons for Proposed Rulemaking dated June 23, 2020 (Enclosure 2)

3. Appendices A-I to Staff Report (Enclosure 3)

4. Errata to Staff Report, dated July 10, 2020 (Enclosure 4)

5. Resolution 10-23, dated August 27, 2020 and Attachments A and B (Enclosure 5)

6. Transcript of August 27, 2020 Public Hearing, agenda item number 20-8-2 (Enclosure 6)

7. 30 Day Notice of Availability of Modified Text, and Appendices, posted May 5, 2021 (Enclosure 7)

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[131] *See Motor and Equipment Mfrs. Ass'n, Inc. v. Environmental Protection Agency*, 627 F.2d 1128, 1132 (D.C. Cir. 1979) (a regulatory compliance option is only a mandate that can result in a denial of a waiver if the regulation does not specify another technically feasible compliance option.)

[132] ISOR, pp. 15-16.

8. Second Notice of Availability of Modified Text and Appendices, posted June 18, 2021 (Enclosure 8)

9. Final Statement of Reasons for Rulemaking, Including Summary of Comments and Agency Response (Enclosure 9)

10. Executive Order R-21-007 dated September 9, 2021 (Enclosure 10)

11. Updated Informational Digest (Enclosure 11)

12. Final Regulation Order (Enclosure 12)

13. Final Test Procedure (Enclosure 13)

14. Addendum to Final Statement of Reasons (Enclosure 14)

15. Notice of Decision (Enclosure 15)

16. Request for Early Effective Date (Enclosure 16)

17. Fully endorsed STD 400 face sheet as approved by OAL and filed with the Secretary of State DATE (Enclosure 17)

CARB Contacts:

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