State of California

AIR RESOURCES BOARD

ERRATA

PROPOSED HEAVY-DUTY ENGINE AND VEHICLE OMNIBUS REGULATION AND ASSOCIATED AMENDMENTS:

Proposed Amendments to the Exhaust Emissions Standards and Test Procedures for 2024 and Subsequent Model Year Heavy-Duty Engines and Vehicles, Heavy-Duty On-Board Diagnostic System Requirements, Heavy-Duty In-Use Testing Program, Emissions Warranty Period and Useful Life Requirements, Emissions Warranty Information and Reporting Requirements, and Corrective Action Procedures, In-Use Emissions Data Reporting Requirements, and Phase 2 Heavy-Duty Greenhouse Gas Regulations, and Powertrain Test Procedures

On June 23, 2020, the California Air Resources Board (CARB) released the Notice of Public Hearing for the Proposed Heavy-Duty Engine and Vehicle Omnibus Regulation and Associated Amendments. The comment period on the proposed amendments is from June 26, 2020 to August 25, 2020.

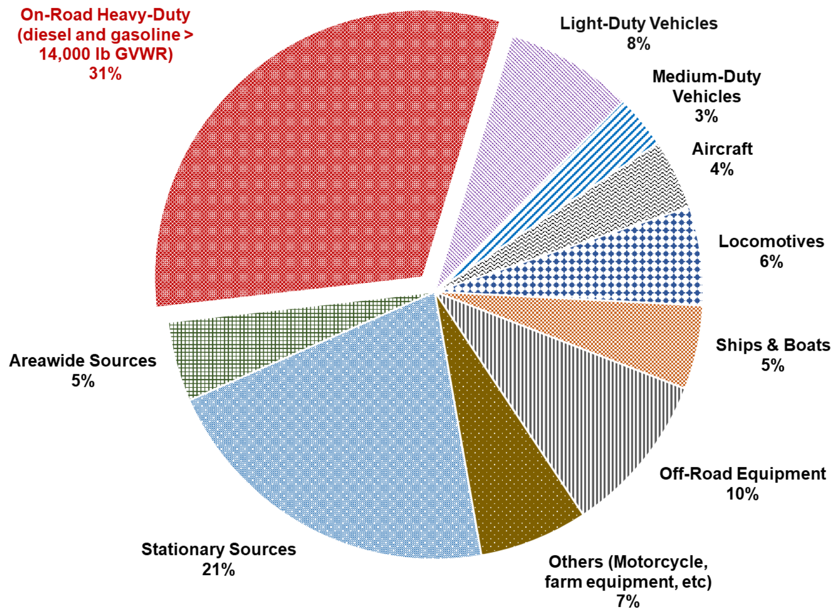
CARB staff has found and corrected several minor errors in the Initial Statement of Reasons (ISOR), as described below. The deadline for public comments on the proposed amendments will not be extended by these corrections because the revised ISOR will be available for the required comment period of 45 days.

These errata, including the corrected and updated ISOR, are available on CARB's website at the following address:
https://ww2.arb.ca.gov/rulemaking/2020/hdomnibuslownox

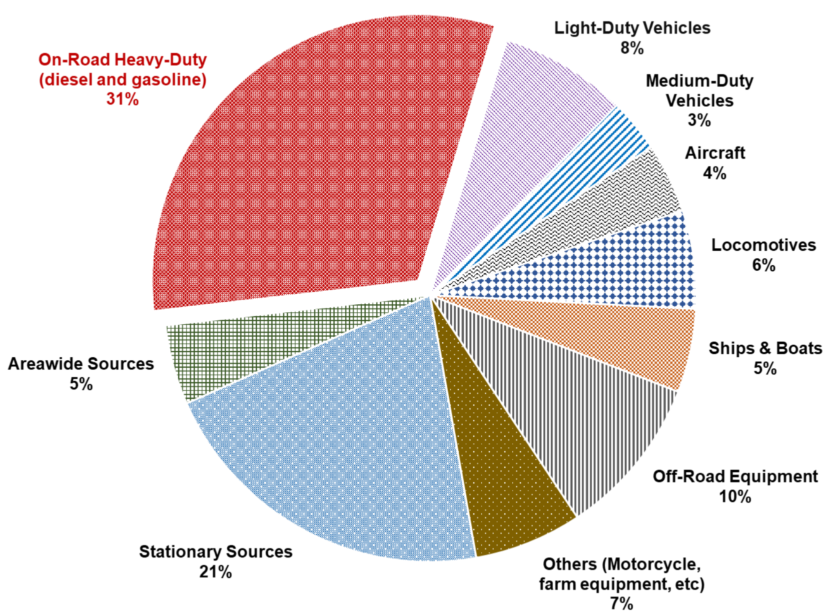
Errata for NOx Emissions Contribution from Heavy-Duty Vehicles

Figure ES-1 and Figure II-1 were labeled with the wrong gross vehicle weight cutoff. These errata correct Figure ES-1 and Figure II-1 showing the NOx emissions contribution from heavy-duty vehicles to the total statewide NOx emissions inventory. In these charts, "On-Road Heavy-Duty" was incorrectly labeled as "greater than 14,000 pounds." Thirty-one percent of the statewide NOx emissions is from heavy-duty vehicles greater than 8,500 pounds rather than from heavy-duty vehicles greater than 14,000 pounds.

- Original: NOx Emission Source Categories, ISOR, Executive Summary, Figure ES-1, page ES-2, and Chapter II, Figure II-1, page II-3.



- Corrected: NOx Emission Source Categories, ISOR, Executive Summary, Figure ES-1, page ES-2, and Chapter II, Figure II-1, page II-3.



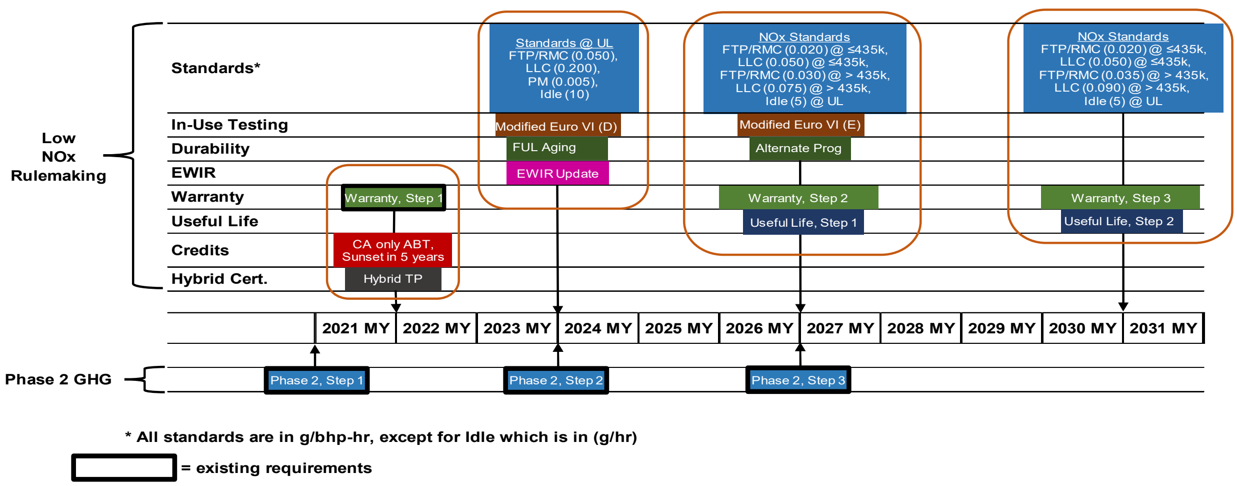
<u>Errata for Timeline – CARB Low NOx Rulemaking & Phase 2 Greenhouse Gas (GHG)</u>

Figure III-1 contained several typographical errors. These errata correct Figure III-1 showing CARB's Low NOx Rulemaking and Phase 2 GHG timeline. In the original figure, the proposed 2027-2030 model year FTP/RMC and LLC NOx standards of "(0.030) @

> 435k" and "(0.075) @ > 435k," respectively, are incorrect. The correct FTP/RMC and LLC NOx standards of "(0.035) for > 435k" and "(0.090) for > 435k," respectively, are shown in the corrected figure. Also, in the original figure, the proposed 2031 and subsequent model year FTP/RMC and LLC NOx standards of "(0.035) @ > 435k" and "(0.090) @ > 435k," respectively, are incorrect. The correct FTP/RMC and LLC NOx standards of "(0.040) for > 435k" and "(0.100) for > 435k," respectively, are shown in the corrected figure. Finally, the "@" signs in the original figure have been changed to "at" or "for" in the corrected figure, and the green boxes representing the "existing requirements" in the original figure have been changed to red boxes in the corrected figure. These changes make Figure III-1 consistent with the rest of the ISOR and the proposed regulations and test procedures.

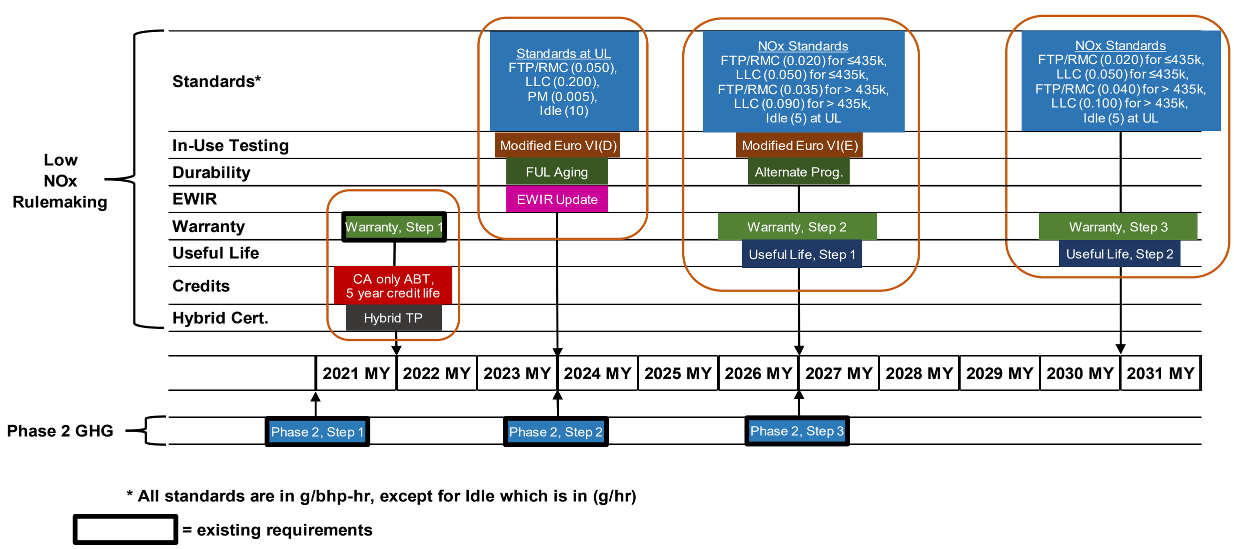
- Original: ISOR, Chapter III.A, Figure III-1, page III-3.

Timeline – CARB Low NOx Rulemaking & Phase 2 GHG



- Corrected: ISOR, Chapter III.A., Figure III-1, page III-3.

Timeline – CARB Low NOx Rulemaking & Phase 2 GHG

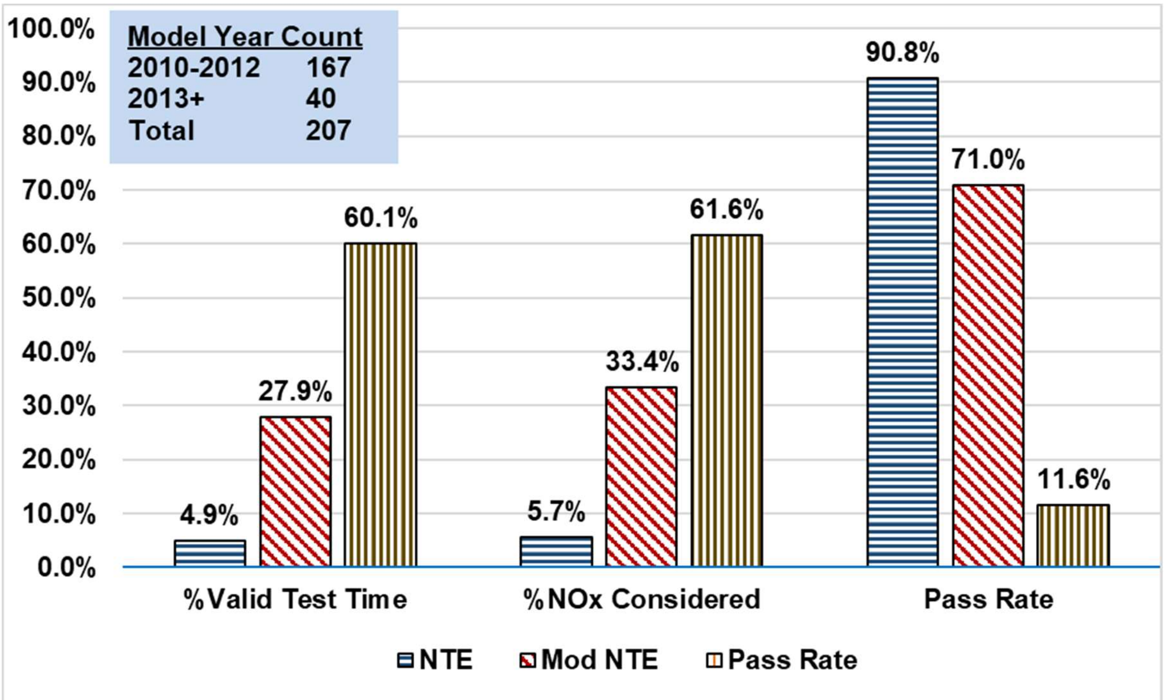


Errata for Heavy-Duty In-Use Test Procedures Amendments

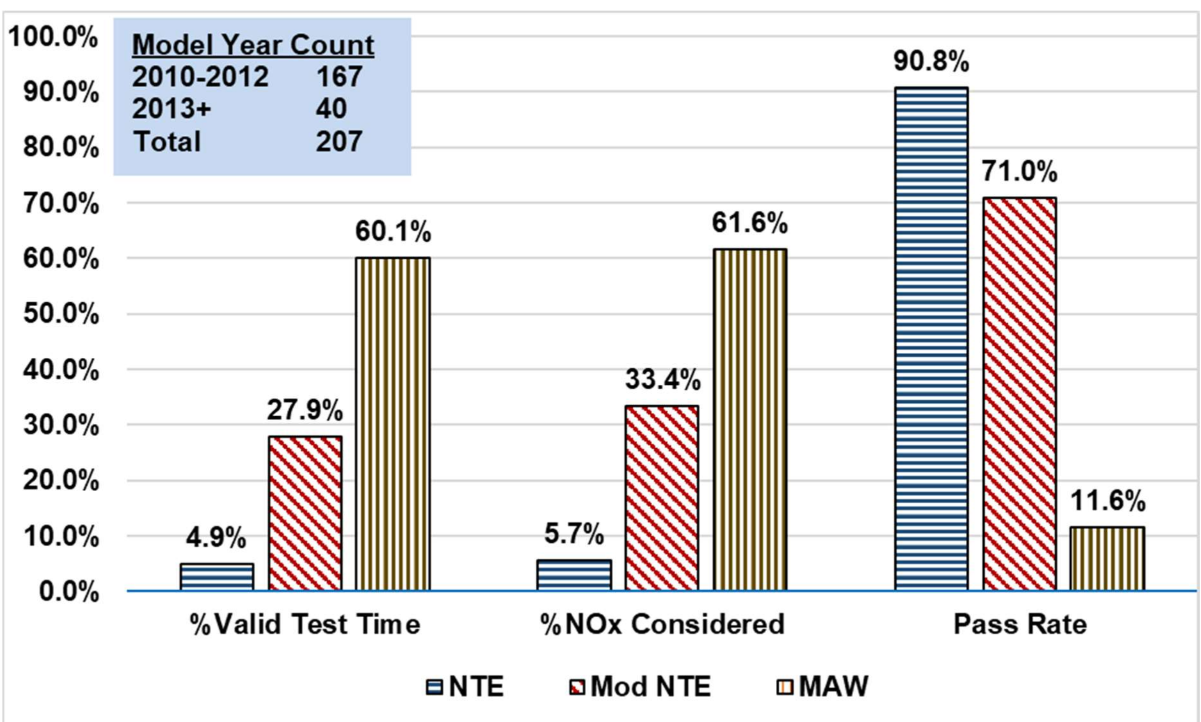
Figure II-6 contained an inadvertent error; the original figure's legend for the brown vertical lined bars has the label "Pass Rate." This has been changed to "MAW" in the corrected figure to reflect the MAW Euro VI regulations used in the analysis. Also, on page III-39 of the ISOR, "Equation III-2" is incorrectly shown to represent the calculations of all three bins. In the correction, the existing "Equation III-2" has been changed to "Equation III-2b" and is specified to represent the calculation of the low and med/high bin operation. "Equation III-2a" has been added to correctly represent the calculation of the idle bin because the sum-over-sum units of the idle bin calculations differ from the other two bins. Additional edits have been made to the text to be consistent with the changes made to the equations. These changes reflect the equations used in the proposed regulatory language.

Also, on page III-38 of the ISOR, the upper boundary of the normalized average window CO2 rate for the low load bin was incorrectly described as "less than 20 percent." The correct upper boundary is "less than or equal to 20 percent," as shown in the corrected text. Also, in Table III-8, the normalized average window CO2 rates for the idle, low, and med/high bins are incorrectly shown as "$CO2_{normalized} < 6\%$," "$6\% \leq CO2_{normalized} < 15\%$," and "$\geq 15\% < CO2_{normalized}$," respectively. These rates have been corrected for the idle, low, and med/high bins as "$CO2_{normalized} \leq 6\%$," "$6\% < CO2_{normalized} \leq 20\%$," and "$20\% < CO2_{normalized}$," respectively. These corrections to Table III-8 are consistent with the text on page III-38 and III-39 and the proposed regulatory text.

- Original: Performance Comparison of the NTE, MOD NTE, and the MAW Based on Euro VI on the HDIUT Data Set, ISOR, Chapter II.C.3.1, Figure II-6, page II-13.



- Corrected: Performance Comparison of the NTE, MOD NTE, and the MAW Based on Euro VI on the HDIUT Data Set, ISOR, Chapter II.C.3.1, Figure II-6, page II-13.



- Original: ISOR, Chapter III.A.3.1. 2024 to 2026 HDIUT Program Amendments, The MAW Test Procedure, page III-39.

In the Euro VI MAW method, the 90th percentile emissions are compared with an emissions threshold to determine compliance. In the Euro VI method, the top 10 percent of windows are totally unaccounted for. Emissions in this top 10 percent of windows can be very significant, sometimes greater than one hundred times the standards for NOx. The 90th percentile evaluation method also does not account for operation and emissions below the standard; for example, an engine with no emissions at all in 89 percent of windows but slightly over the standard in the 90th percentile window would still be considered non-compliant. To avoid the weaknesses of using 90th percentile to determine compliance, CARB staff is instead proposing a sum-over-sum approach, after discussing the approach with manufacturer representatives and U.S. EPA staff. A sum-over-sum approach would account for the emissions in all the windows at both the highest and lowest emission rates compared to the percentile method that focuses on a single value at the 90th percentile. In the proposed 3B-MAW method, the sum-over-sum emissions within each of the three bins would need to be at or less than their threshold values in Table III-8. Calculating the sum-over-sum window emissions would be done with the following equation:

$$e_{sos\ a,b} = \frac{\sum_{k=1}^{n} \dot{m}_a \times \Delta t}{\sum_{k=1}^{n} \dot{m}_{CO2} \times \Delta t} \times e_{CO2,FTP,FCL} \qquad \text{(Equation III-2)}$$

where:

$e_{sos\ a,b}$ is the sum-over-sum emissions

a is the criteria pollutant. Example (HC, CO, NOx, and PM)

b is the bin. Example (idle, low load, and medium high load)

$\dot{m}_a$ is the mass criteria pollutant per second emission

$\dot{m}_{CO2}$ is the mass CO2 per second emission

$e_{CO2,FTP,FCL}$ is the engine family FTP FCL work specific CO2 [g/bhp-hr CO2]

n is the length of the bin in seconds

Δt is equal to 1 second

- Corrected: ISOR, Chapter III.A.3.1. 2024 to 2026 HDIUT Program Amendments, The MAW Test Procedure, page III-39.

In the Euro VI MAW method, the 90th percentile emissions are compared with an emissions threshold to determine compliance. In the Euro VI method, the top 10 percent of windows are totally unaccounted for. Emissions in this top 10 percent of windows can be very significant, sometimes greater than one hundred times the standards for NOx. The 90th percentile evaluation method also does not account for operation and emissions below the standard; for example, an engine with no emissions at all in 89 percent of windows but slightly over the standard in the 90th percentile window would still be considered non-compliant. To avoid the weaknesses of using the 90th percentile to determine compliance, CARB staff is instead proposing a sum-over-sum approach, after discussing the approach with manufacturer representatives and U.S. EPA staff. A sum-over-sum approach would account for the emissions in all the windows at both the highest and lowest emission rates compared to the percentile method that focuses on a single value at the 90th percentile. In the proposed 3B-MAW method, the sum-over-sum emissions within each of the three bins would need to be at or less than their threshold values in Table III-8. The sum-over-sum window emissions would be calculated with Equation III-2a for the idle bin, and Equation III-2b for the low and medium high bin operation:

$$e_{sos\ NOx,idle} = \frac{\sum_{k=1}^{n} \dot{m}_{NOx} \times \Delta t}{\sum_{k=1}^{n} \Delta t} \times \frac{3{,}600\ sec}{1\ hr} \qquad \text{(Equation III-2a)}$$

$$e_{sos\ a,b} = \frac{\sum_{k=1}^{n} \dot{m}_{a} \times \Delta t}{\sum_{k=1}^{n} \dot{m}_{CO2} \times \Delta t} \times e_{CO2,FTP,FCL} \qquad \text{(Equation III-2b)}$$

where:

$e_{sos\ NOx,idle}$ is the sum over sum emissions for the idle bin for NOx

$\dot{m}_{NOx}$ is the mass of NOx per second emission

$e_{sos\ a,b}$ is the sum-over-sum emissions

a is the criteria pollutant. Example (HC, CO, NOx, and PM)

b is the bin. Example (idle, low load, and medium high load)

$\dot{m}_{a}$ is the mass criteria pollutant per second emission

$\dot{m}_{CO2}$ is the mass CO2 per second emission

$e_{CO2,FTP,FCL}$ is the engine family FTP FCL work specific CO2 [g/bhp-hr CO2]

n is the length of the bin in seconds

Δt is equal to 1 second

- Original: ISOR, Chapter III.A.3.1. 2024 to 2026 HDIUT Program Amendments, The MAW Test Procedure, page III-38.

The low load bin is intended to capture operation similar to operation found during development of the LLC by SwRI in the Low NOx Stage 2 testing program. Such operation is characterized by a decreased load on the engine after previous high load conditions, sustained low load operation, and increased load from engine idling to a well-loaded event (i.e., "return to service"). The emissions within the low load bin would be compared to the LLC emission standards for in-use compliance. Windows would be placed into the low load bin if the window's normalized average CO2 rate is greater than 6 percent and less than 20 percent. The 6 percent normalized average CO2 rate is chosen as a lower boundary because this is equivalent to the value of an engine tested on the LLC. Operation above 6 percent normalized average CO2 is expected to comply with the LLC emission standards.

- Corrected: ISOR, Chapter III.A.3.1. 2024 to 2026 HDIUT Program Amendments, The MAW Test Procedure, page III-38.

The low load bin is intended to capture operation similar to operation found during development of the LLC by SwRI in the Low NOx Stage 2 testing program. Such operation is characterized by a decreased load on the engine after previous high load conditions, sustained low load operation, and increased load from engine idling to a well-loaded event (i.e., "return to service"). The emissions within the low load bin would be compared to the LLC emission standards for in-use compliance. Windows would be placed into the low load bin if the window's normalized average CO2 rate is greater than 6 percent and less than or equal to 20 percent. The 6 percent normalized average CO2 rate is chosen as a lower boundary because this is equivalent to the value of an engine tested on the LLC. Operation above 6 percent normalized average CO2 is expected to comply with the LLC emission standards.

- Original: ISOR, Chapter III.A.3.1, Table III-8, page III-40.

Table III-1. Table of Bin Structure Definitions, Applicable Standards, and In-Use Thresholds

Bin	Engine Type	Normalized Average Window CO2 Rate	The Sum-Over-Sum Emissions In-Use Threshold[39]
Idle	Diesel Cycle	$CO2_{normalized}$ <6%	$e_{sos\ a,Idle}$ ≤ 1.5 x Idle standard
Low	Diesel Cycle	6% ≤ $CO2_{normalized}$ <15%	$e_{sos\ a,Low}$ ≤ 1.5 x LLC standard
Med/High	Diesel Cycle	≥ 15% < $CO2_{normalized}$	$e_{sos\ a,MedHigh}$ ≤ 1.5 x FTP/RMC-SET standard
All Operation	Otto-Cycle	na	$e_{sos\ a}$ ≤ 1.5 x FTP standard

Footnote 39: The applicable standards can be found in 13 CCR 1956.8.

- Corrected: ISOR, Chapter III.A.3.1, Table III-8, page III-40.

Table III-2. Table of Bin Structure Definitions, Applicable Standards, and In-Use Thresholds

Bin	Engine Type	Normalized Average Window CO2 Rate	The Sum-Over-Sum Emissions In-Use Threshold[39]
Idle	Diesel Cycle	$CO2_{normalized}$ ≤6%	$e_{sos\ a,Idle}$ ≤ 1.5 x Idle standard
Low	Diesel Cycle	6% < $CO2_{normalized}$ ≤20%	$e_{sos\ a,Low}$ ≤ 1.5 x LLC standard
Med/High	Diesel Cycle	20% < $CO2_{normalized}$	$e_{sos\ a,MedHigh}$ ≤ 1.5 x FTP/RMC-SET standard
All Operation	Otto-Cycle	na	$e_{sos\ a}$ ≤ 1.5 x FTP standard

Footnote 39: The applicable standards can be found in 13 CCR 1956.8.

Errata for Lengthened Warranty Amendments

These errata are to correct the language used in Chapter III, Section A.4 of the ISOR to be consistent with the proposed regulatory language in the heavy-duty Otto-cycle test procedures. For example, in one place, the term turbocharger was inadvertently used instead of catalytic converter bed. Additionally, CARB staff found an acronym, MEMA, that was not defined in the ISOR text. The acronym was defined and added to the list of acronyms in the ISOR.

- Original: ISOR, Chapter III.A.4. Warranty Period Amendments, page III-42.

5. Restricting the allowable scheduled repair or maintenance for turbochargers used on heavy-duty Otto-cycle engines because of their high cost and severe emission impacts upon failure.

- Corrected: ISOR, Chapter III.A.4. Warranty Period Amendments, page III-42.

5. Restricting the allowable scheduled repair or maintenance for catalytic converter beds used on heavy-duty Otto-cycle engines because of their high cost and severe emission impacts upon failure.

- Original: ISOR, Chapter III.A.4.1.2. Feasibility of Longer Warranties, page III-46.

Published durability information from the parts suppliers have proven difficult to obtain, but CARB staff received valuable input from MECA, the trade group representing leading manufacturers of emission control equipment for automobiles, trucks, and buses, and MEMA, the trade group representing manufacturers of motor vehicle components and systems for the original equipment and aftermarket segments of the light- and heavy-duty motor vehicle manufacturing industry.

- Corrected: ISOR, Chapter III.A.4.1.2. Feasibility of Longer Warranties, page III-46.

Published durability information from the parts suppliers have proven difficult to obtain, but CARB staff received valuable input from MECA, the trade group representing leading manufacturers of emission control equipment for automobiles, trucks, and buses, and Motor & Equipment Manufacturers Association (MEMA), the trade group representing manufacturers of motor vehicle components and systems for the original equipment and aftermarket segments of the light- and heavy-duty motor vehicle manufacturing industry.

- Original: ISOR, List of Acronyms and Abbreviations, page xviii.

Acronym/ Abbreviation	**Definition**
MAW	Moving Average Window
MDDE	Medium-Duty Diesel Engine
MDOE	Medium-Duty Otto-Cycle Engine
MECA	Manufacturers of Emission Controls Association
Mg	Magnesium
MHDD	Medium Heavy-Duty Diesel
MIL	Malfunction Indicator Light
MOD NTE	Modified Not-to-Exceed
mph	Miles Per Hour
MY	Model Year

(List truncated)

- Corrected: ISOR, List of Acronyms and Abbreviations, page xviii.

Acronym/ Abbreviation	**Definition**
MAW	Moving Average Window
MDDE	Medium-Duty Diesel Engine
MDOE	Medium-Duty Otto-Cycle Engine
MECA	Manufacturers of Emission Controls Association
MEMA	Motor & Equipment Manufacturers Association
Mg	Magnesium
MHDD	Medium Heavy-Duty Diesel
MIL	Malfunction Indicator Light
MOD NTE	Modified Not-to-Exceed
mph	Miles Per Hour
MY	Model Year

(List truncated)

- Original: ISOR, Chapter III.A.4.3. Updated Maintenance Intervals, Table III-12, page III-50.

Table III-12. Heavy-Duty Otto-Cycle Engine Maintenance Schedule (GVWR >14,000 lbs.)

Component or System	Minimum Maintenance Interval from Survey of Owner's Manuals (miles or years/hours)	California & Federal Minimum Maintenance Interval specified in §86.004-25 (miles or hours)	Proposed Minimum Repair or Replacement Interval (miles or years/hours)
Exhaust Gas Recirculation (EGR) System (filter & cooler – not including hoses)	None	50k or 1,500 hr	110k [a]
Exhaust Gas Recirculation (EGR) System (valve & tubing)	None	100k or 3,000 hr	110k
Crankcase Ventilation System	100k or 10 years	50k or 1,500 hr	50k or 10 years
Fuel Injectors	None	100k or 3,000 hr	110k
Turbochargers	None	100k or 3,000 hr	Not Replaceable [a,b]

(*Table truncated*)

- Corrected: ISOR, Chapter III.A.4.3. Updated Maintenance Intervals, Table III-12, page III-50.

Table III-12. Heavy-Duty Otto-Cycle Engine Maintenance Schedule (GVWR >14,000 lbs.)

Component or System	Minimum Maintenance Interval from Survey of Owner's Manuals (miles or years/hours)	California & Federal Minimum Maintenance Interval specified in §86.004-25 (miles or hours)	Proposed Minimum Repair or Replacement Interval (miles or years/hours)
Exhaust Gas Recirculation (EGR) System (filter & cooler – not including hoses)	None	50k or 1,500 hr	110k [a]
Exhaust Gas Recirculation (EGR) System (valve & tubing)	None	100k or 3,000 hr	110k
Crankcase Ventilation System	100k or 10 years	50k or 1,500 hr	50k or 10 years
Fuel Injectors	None	100k or 3,000 hr	110k
Turbochargers	None	100k or 3,000 hr	110k [a]

(*Table truncated*)

- Original: ISOR, Chapter III.A.4.5. Special Consideration for Catalytic Converters Used in Heavy-Duty Otto-Cycle Engines, page III-52.

4.5. Special Consideration for Catalytic Converters Used in Heavy-Duty Otto-Cycle Engines

As described above in Subsection 4.3, some components are designated as “not replaceable” because of their relatively high price and severe emission impact under failure. In the Proposed Amendments, CARB staff is proposing to designate catalytic converters as “not replaceable” for heavy-duty Otto-cycle engines because, like the diesel “not replaceable” components described above, Otto-cycle catalytic converters are high priced and cause severe emission increases when they fail as well. As Table III-13 shows, based on HD OBD certification durability demonstrations conducted for 2018 and 2019 MY heavy-duty Otto-cycle engines, if a catalytic converter fails, the emissions increase an average of 87 percent over baseline levels (CARB, 2020d), a severe impact. As Table III-13 also shows, catalytic converters are expensive, on average $2,500 for parts and labor to repair. (*Section truncated*)

- Corrected: ISOR, Chapter III.A.4.5. Special Consideration for Catalytic Converters Used in Heavy-Duty Otto-Cycle Engines, page III-52.

4.5. Special Consideration for Catalytic Converter Beds Used in Heavy-Duty Otto-Cycle Engines

As described above in Subsection 4.3, some components are designated as “not replaceable” because of their relatively high price and severe emission impact under failure. In the Proposed Amendments, CARB staff is proposing to designate catalytic converter beds as “not replaceable” for heavy-duty Otto-cycle engines because, like the diesel “not replaceable” components described above, Otto-cycle catalytic converters are high priced and cause severe emission increases when they fail as well. As Table III-13 shows, based on HD OBD certification durability demonstrations conducted for 2018 and 2019 MY heavy-duty Otto-cycle engines, if a catalytic converter fails, the emissions increase an average of 87 percent over baseline levels (CARB, 2020d), a severe impact. As Table III-13 also shows, catalytic converters are expensive, on average $2,500 for parts and labor to repair. (*Section truncated*)

Any questions regarding these corrections should be directed to Daniel Hawelti, Staff Air Pollution Specialist, On-Road Heavy Duty Diesel Section, at daniel.hawelti@arb.ca.gov or (626) 450-6149, or (designated back-up contact) Paul Adnani, Staff Air Pollution Specialist, at paul.adnani@arb.ca.gov or (626) 459-4476.

CALIFORNIA AIR RESOURCES BOARD

Richard W. Corey
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Date: 7/10/2020