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# EPA Heavy-Duty Engine Criteria Pollutant Compliance Report

(Model Year 2022)

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Implementation, Analysis and Compliance Division  
Office of Transportation and Air Quality  
U.S. Environmental Protection Agency

## *NOTICE*

*This technical report does not necessarily represent final EPA decisions or positions. It is intended to present technical analysis of issues using data that are currently available. The purpose in the release of such reports is to facilitate the exchange of technical information and to inform the public of technical developments.*

## **EPA Heavy-Duty Engine Criteria Pollutant Compliance Report (Model Year 2022)**

### **1. Executive Summary**

This report is part of the U.S. Environmental Protection Agency's (EPA's) commitment to provide the public with information regarding the performance of Heavy-Duty (HD) engine manufacturers in meeting the Agency's criteria pollutant emission standards. HD on-highway engines are certified to the requirements of 40 CFR Parts 86 and 1036. This report summarizes credit balances in the voluntary Averaging, Banking and Trading (ABT) program for both oxides of nitrogen (NOx) and particulate matter (PM). This report takes into account the provisions of the recently published HD On-Highway criteria pollutant rule titled "Control of Air Pollution from New Motor Vehicles: Heavy-Duty Engines and Vehicle Standards," signed in December 2022.

This report summarizes the credit balances available after model year (MY) 2022 for those manufacturers participating in the voluntary ABT program and certifying HD On-Highway Engines in this sector. EPA recognizes significant stakeholder interest in the compliance status of manufacturers subject to the regulatory programs. We are providing this supplemental data summary in advance of the next full report, which we anticipate will be published in late 2025 or early 2026.

This report documents that all certifying HD on-highway engine manufacturers are not merely compliant, but that each of the manufacturers participating in the ABT program has generated a positive banked credit balance showing compliance through MY2022 in each of the three NOx averaging sets and four PM averaging sets. As stated above, participation in the ABT program is optional and not utilized by all manufacturers. If a manufacturer chooses not to participate in ABT, compliance is determined based on the applicable standards, meaning that each of the manufacturer's engine products must meet the applicable criteria pollutant standards. For those manufacturers participating in the ABT program, the tables below demonstrate compliance with the criteria pollutant regulatory requirements.

The rule entitled "New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards" was adopted in December 2022 and will be fully implemented in MY2027. EPA considered credit balances in the previous regulatory ABT program (40 CFR 86.007-15) and decided that manufacturers will not be allowed to carry any NOx or PM credit balances into the new program starting in MY2027. However, some flexibilities were adopted to allow manufacturers to generate early NOx credits beginning in MY2022 that may be used in MY2027 and later. No similar flexibility was included in the rule for PM credit generation. PM credits may be generated and used through and including MY 2026 but will not be included in the Averaging, Banking and Trading program for MY 2027 and beyond.

### **2. Program Background Description**

In 2004, the EPA adopted a voluntary ABT program for NOx plus Non-methane Hydrocarbons (NOx plus NMHC) and PM pollutants applicable to heavy duty engines. This program was finalized in the rule entitled "Control of Emissions of Air Pollution from 2004 and Later Model Year Heavy-Duty Highway Engines and Vehicles; Revisions of Light-Duty On-Board Diagnostics Requirements". This rule provided some flexibility to manufacturers in how they comply with the criteria pollutant standards. The primary flexibility was an engine ABT program in which NOx plus NMHC credits could be generated for certain groups of engines that were certified to values less than those of the applicable criteria pollutant

standard. These credits could then be used to offset other groups of engines that were certified to values greater than those of the applicable standard. The ABT program allowed for emission credits to be averaged, banked, or traded within each of the “averaging sets”, which are based on the primary intended service class, allowing manufacturers the opportunity to comply on average with the emission standards.

Similarly, in the 2007 with the rule entitled “New Motor Vehicles: Heavy-Duty Engine and Vehicle Standards and Highway Diesel Fuel Sulfur Control Requirements”, the EPA adopted a voluntary ABT program for NOx and PM pollutants applicable to heavy duty engines. Although very similar to the program released with the rulemaking in 2004, manufacturers were then able to convert their NOx plus non-methane hydrocarbons (NMHC) to NOx-only credits using a discount factor of 0.8, which is proportional to the relative fraction of NOx to NOx+NMHC in typical diesel exhaust.

### **3. Heavy-Duty Engines**

The emissions from the engines that power heavy-duty vehicles are measured over Federal certification test cycles, subject to the standard setting part and all other referenced parts of the Code of Federal Regulations (CFR). NOx and PM are directly measured for certification purposes. The measured NOx and PM test results are then converted into appropriate family compliance levels (FCL) by applying adjustments for both deterioration and the infrequent regeneration of aftertreatment systems. These FCL values are then compared to a set of engine standards to determine compliance. In addition to meeting standards for NOx and PM, engines must also meet standards for two additional criteria pollutants produced during engine combustion: NMHC and carbon monoxide (CO). The measured emissions levels of NMHC and CO are also compared to a set of standards developed by EPA to determine compliance. The manufacturer must test these engines on an engine dynamometer and measure criteria emissions (NOx, PM, NMHC, and CO) over three specific operating cycles: the transient Federal Test Procedure (FTP), the steady-state Ramped Modal Cycle (RMC) and beginning in MY2027 the Low-Load Cycle (LLC).

NOx credits may be generated by an engine test result and resulting certification value that is less than that of the applicable standard. NOx deficits may be generated by an engine test result and resulting certification value that is greater than that of the applicable standard. NOx credits may be used to offset NOx deficits generated in the same averaging set. There are four averaging sets for heavy-duty engines<sup>1</sup>, which are:

1. Light Heavy-Duty (LHD) Compression Ignition (CI) (intended for use in Class 2b-5 vocational vehicles)
2. Medium Heavy-Duty (MHD) CI (intended for use in Class 6-7 vocational vehicles or Class 7 tractors)
3. Heavy Heavy-Duty (HHD) CI (intended for use in Class 8 vocational vehicles or tractors)
4. All Heavy-Duty Spark Ignition (SI)<sup>2</sup>

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<sup>1</sup> Urban Buses, per 40 CFR 86.004-15, are treated as members of the primary intended service class where they otherwise would fall.

<sup>2</sup> The engine produced in the Heavy-Duty SI averaging set are not included in this report.

This report only details criteria emissions credits from the three CI averaging sets above.

There are four possible early credit generation methods (Methods 1-4 discussed below) that are optional and begin phase-in, beginning with MY2022. , These “early” credit generation methods will not be available after MY 2026. These “early” NOx credit generation methods were provided as a means for manufacturers to establish a credit balance that assists in the transition to the final NOx standard in MY2027 of 35 mg/hp-hr (a significant reduction from the previous 200 mg/hp-hr standard).

NOx credit balances are presented in Table 1 below for the initial program, which include credit balances from MY2021 and earlier. Please note that a blank cell means that either the manufacturer did not certify any products in that averaging set or that they did not participate in the ABT program. These credits are based on the following useful life values:

1. HHD = 435,000 miles
2. MHD = 185,000 miles
3. LHD = 110,000 miles

Credits from MY2021 and earlier had an unlimited credit life and were restricted to the same averaging set in which they were generated. Where applicable, NOx plus NMHC credits were converted to NOx only credits using the appropriate discount factor. These credits will all expire after MY2026. Table 2 is also included showing the status for PM credits, which will also expire after MY2026.

**Table 1**  
**Model Year 2021 and Earlier NOx Credit Balances Expiring After MY2026 Compliance**

<b>Manufacturer</b>	<b>LHD</b>	<b>MHD</b>	<b>HHD</b>
Cummins		10,230.3	2,128.8
Detroit Diesel			
Ford Motor	283.7		
General Motors	4,360.4		
Isuzu	22.1	627.7	
Navistar	1,119.9	766.3	59.5
Volvo Trucks			6,449.0
Westport Fuel Systems		577.0	1,161.0

**Table 2**  
**Model Year 2021 and Earlier PM Credit Balances Expiring After MY2026 Compliance**

<b>Manufacturer</b>	<b>LHD</b>	<b>MHD</b>	<b>HHD</b>	<b>Urban Bus</b>
Cummins		669.7	1,548.1	20.0
Detroit Diesel				
Ford Motor	47.3			
General Motors				
Isuzu	35.2	11.7		
Navistar				
Volvo Trucks			1,982.1	
Westport Fuel Systems				

Credits earned in the final phase of the new criteria pollutant program, beginning in MY2027, may be used by all engines. The engines must be certified to a family emission limit (FEL) less than the NOx standard of 35 mg/hp-hr in order to generate credits, or an FEL greater than the NOx standard if the certified family is to use credits to comply. These credits will be based on the following useful life values:

1. HHD = 650,000 miles
2. MHD = 350,000 miles
3. LHD = 270,000 miles

Credits generated during this program, will no longer have an unlimited life, but will expire 5 years after the model year in which they are generated. The credits will be restricted for use in the same averaging set in which they were generated. Since this program will only allow for NOx credit generation; measured emissions of PM, NMHC, and CO must each meet the applicable standards. Families participating in the final credit program must meet all other MY2027 and later requirements including longer warranty requirements, new LLC compliance, and a completely revised in-use standards program. Applicable FEL values for the LLC and in-use testing compliance will be determined by scaling the declared FEL value over the FTP cycle as described in 40 CFR 1036.104(c).

#### **4. Early NOx Credit Generation Programs**

As mentioned above, the new rule provides four distinct methods to generate early NOx credits in model years (MY2022-26) leading up to the final program (MY2027 and beyond). Early NOx credits generated using Method 1, also known as “2026 Service Class Pull-Ahead” method, will only be allowed during MY2026 for HHD averaging set engines. These engines must certify the entire diesel-fueled HHD averaging set to an FEL of 50 mg/hp-hr or less in order to generate credits relative to a 200 mg/hp-hr standard. Credits may not be generated in the MHD or LHD CI averaging sets using this method. Additionally, credits may not be generated by engines fueled with natural gas using this method. The credits will be based on the following useful life values:

1. HHD = 650,000 miles
2. MHD = 350,000 miles
3. LHD = 270,000 miles

The credits generated using this method may also be transferred to an MHD averaging set at a 10% discount rate. Such credits will have an extended credit life through MY2034 and may only be used in HHD and MHD averaging sets. The engines must also meet MY2027 and later standards for PM, NMHC, and CO, as well as all other provisions such as but not limited to the warranty requirements, LLC compliance, and new in-use standards.

Early NO<sub>x</sub> credits generated using Method 2, also known as “Full Credits”, will be allowed during MY2024 through 2026 and may be used by all engines. These credits may be generated by any engine family certified to an FEL less than the 200 mg/hp-hr standard. The credits will be based on the following useful life values:

1. HHD = 650,000 miles
2. MHD = 350,000 miles
3. LHD = 270,000 miles

Credits generated using this method will have an extended credit life through MY2032, regardless of the year in which the credit is generated and are restricted to the averaging set where generated. The engines must also meet MY2027 and later standards for PM, NMHC, and CO as well as other provisions such as but not limited to the warranty requirements, LLC compliance, and new in-use standards.

Early NO<sub>x</sub> credits generated using Method 3, also known as “Partial Credits”, are only allowed during MY2024 through 2026 and may be generated in each of the three averaging sets. These credits may be generated for any engine family certified to an FEL below 200 mg/hp-hr standard. The credits will be based on the following useful life values:

1. HHD = 435,000 miles
2. MHD = 185,000 miles
3. LHD = 110,000 miles

Credits generated using this credit method have an extended credit life through MY2032 regardless of year in which the credit is generated. These credits are also restricted to the averaging set in which they are generated. The engine family must continue to meet the MY2021 and earlier standards for PM, NMHC, and CO as well as the requirements for warranty. The engine family must meet the provisions of MY2027 and later for LLC compliance and new in-use standards only.

Early NO<sub>x</sub> credits generated using Method 4, also known as “Discounted Credits”, are only available during MY2022 through MY2026 and open to all engines. These credits can be generated by any family certified to an FEL below the 200 mg/hp-hr standard. Credits generated using this method will be discounted by 40% for use in future model years until expiration. The credits will be based on the following useful life values:

1. HHD = 435,000 miles
2. MHD = 185,000 miles
3. LHD = 110,000 miles

Credits generated using this credit method have an extended credit life through MY2029 regardless of the year in which the credit was generated. These credits are restricted to the averaging set in which they are generated. The engine family must continue to meet the 2021 and earlier standards for PM, NMHC, and CO as well as all other earlier requirements.

Table 3 below presents the available credit balances using one of these four methods for early credit generation. The data presented in this table is through MY2022 compliance, so any values would represent the use of the “Discounted Credits” method, which was the only method available in MY2022. Detroit Diesel is the only manufacturer that optionally chose to use this method in MY2022. The credit balance included in Table 3 for Detroit Diesel reflects the 40% discount, and this balance is fully available for MY2027 and later compliance.

**Table 3**  
**Model Year 2022 NOx Credit Balances Available for MY2027+**  
**Compliance**

<b>Manufacturer</b>	<b>LHD</b>	<b>MHD</b>	<b>HHD</b>
Cummins			
Detroit Diesel			3,103.01
Ford Motor			
General Motors			
Isuzu			
Navistar			
Volvo Trucks			
Westport Fuel Systems			

## **5. Conclusions**

As previously indicated, each of the manufacturers participating in the ABT program has generated a positive banked credit balance showing compliance through MY2022 in each of the three NOx averaging sets and four PM averaging sets. As previously stated, participation in the ABT program is optional and not utilized by all manufacturers. If a manufacturer chooses not to participate in ABT, compliance is determined based on the applicable standards, meaning that each of the manufacturer’s engine products must meet the applicable criteria pollutant standards.

The success of the heavy-duty engine criteria pollutant program as documented in this report has been demonstrated by the manufacturers’ production of systems and processes that demonstrate compliance, improve their products to meet more stringent criteria pollutant standards and document through submission of reports that that their products comply with both the standards and the aggregated averaging set requirements. All manufacturers are compliant, and several have created significant credit banks.