

BRAZIL PROCONVE P-8 EMISSION STANDARDS

ICCT POLICY UPDATES

SUMMARIZE

REGULATORY

AND OTHER

DEVELOPMENTS

RELATED TO CLEAN

TRANSPORTATION

WORLDWIDE.

Brazil's National Council for the Environment (CONAMA) established the PROCONVE P-8 emission standards for new on-road heavy-duty vehicles (HDVs) effective November 16, 2018.¹ The standards apply to all new passenger and freight vehicles equipped with compression-ignition or spark-ignition engines and weighing at least 3,856 kg. The P-8 standards will go into effect for new type approvals on January 1, 2022, and for all new sales and registrations on January 1, 2023. The standards allow for voluntary certification in advance of these dates.

The P-8 standards specify maximum limits for exhaust gas emissions, particulates, and noise,² as well as requirements for durability, on-board diagnostic (OBD) systems, and in-use testing, among other provisions. P-8 is equivalent to Euro VI standards and will bring Brazilian HDV regulations into alignment with those of the European Union. The adoption of P-8 in Brazil follows similar developments in other major vehicle markets, notably India,³ China,⁴ and Mexico.⁵ After these standards take effect between 2020 and 2023, an estimated 70% of new HDVs with diesel engines worldwide will meet Euro VI-equivalent standards, compared with 40% in 2018.

Brazil's current P-7 standards are equivalent to Euro V and have been in effect since 2012. The introduction of P-8 standards will significantly strengthen Brazil's regulatory program. Of particular note is the tightening of particulate matter (PM) mass emission limits and the introduction of a particle number (PN) limit for HDVs with compression-ignition, or diesel, engines. As observed with the introduction of equivalent provisions in Europe, these limits are expected to lead to the universal application of diesel particulate filters (DPF) that reduce PM emissions

1 CONAMA Resolution 490/2018, Diário Oficial da União, No. 223, 21 November 2018, <http://pesquisa.in.gov.br/imprensa/jsp/visualiza/index.jsp?data=21/11/2018&jornal=515&pagina=153>

2 This policy update focuses on the provisions relevant to exhaust gas and particulate emissions.

3 Tim Dallmann and Anup Bandivadekar, *India Bharat Stage VI Emission Standards*, (ICCT: Washington, DC, 2016), <https://www.theicct.org/publications/india-bharat-stage-vi-emission-standards>.

4 Liuhanzi Yang and Hui He, *China's Stage VI Emissions Standard for Heavy-Duty Vehicles (Final Rule)*, (ICCT: Washington, DC, 2018), <https://www.theicct.org/publications/china%E2%80%99s-stage-vi-emissions-standard-heavy-duty-vehicles-final-rule>.

5 Kate Blumberg, *Mexico Heavy-Duty Vehicle Emission Standards*, (ICCT: Washington, DC, 2018), <https://www.theicct.org/publications/mexico-heavy-duty-vehicle-emission-standards>.

by 90% compared with the current P-7 standards and by 99% compared with uncontrolled levels.⁶

Other key provisions of the P-8 standards include a switch to more-representative test cycles for type approval, the addition of in-service conformity (ISC) requirements, and inclusion of cold-start emissions requirements for on-road emissions tests.⁷ The European Stationary Cycle and European Transient Cycle used for P-7 type approval are replaced with the World Harmonized Steady-State Cycle (WHSC) and World Harmonized Transient Cycle (WHTC). P-8 adds an off-cycle emissions test using the World-harmonized Not-To-Exceed (WNTE) methodology. Together, these changes to the type-approval procedures will ensure that pollutant emissions are effectively reduced over a broad range of engine and ambient operating conditions. P-8 also establishes requirements for manufacturers and importers to conduct and report on ISC testing of vehicles after they have met minimum service requirements. These tests will be conducted using portable emissions measurement systems (PEMS) and ensure that vehicles maintain their emissions performance well into their useful life and under real-world driving conditions.

Additional noteworthy aspects include the tightening of requirements for OBD systems. As detailed in a previous briefing paper,⁸ the P-7 standard did not contain the same OBD provisions as the equivalent Euro V standard. P-7 lacked urea concentration OBD monitoring requirements, making it possible for users to fill the tank with water or agro-industrial urea and avoid activating the OBD, warnings, and inducement systems. P-8 introduces a broader set of OBD requirements for emission-control monitoring. Moreover, it makes OBD data streams standard across manufacturers, so any HDV from any brand can be checked with the same OBD reader. This opens the possibility for cost-effective HDV inspection and maintenance programs.

The introduction of P-8 standards in Brazil will have far-reaching benefits for controlling harmful emissions from HDVs and reducing the associated impacts on air quality and public health. Compared with the P-7 baseline, the introduction of P-8 would yield an estimated US\$11 in health benefits for every dollar invested in improved vehicle emission-control technologies.⁹

POLICY BACKGROUND

Brazil has controlled HDV emissions through the Programa de Controle da Poluição do Ar por Veículos Automotores (PROCONVE) since 1990, following the European precedent for emission limits and certification test procedures. Brazilian implementation has been an average of five years behind Europe with the most-recent implementation in 2012 being PROCONVE P-7, which is equivalent to Euro V standards (see Table 1).

6 Joshua Miller and Cristiano Façanha, *Cost-Benefit Analysis of Brazil's Heavy-Duty Emission Standards (P-8)*, (ICCT: Washington, DC, 2016), http://www.theicct.org/sites/default/files/publications/P-8%20White%20Paper_final.pdf.

7 In Europe, inclusion of cold-start emissions data as part of the ISC would be implemented in September 2020 for new type approvals and in September 2021 for all new vehicles. It is unclear when would this be included in the current P-8 regulation in Brazil.

8 Cristiano Façanha, *Deficiencies in the Brazilian PROCONVE P-7 and the case for P-8 standards*, (ICCT: Washington, DC, 2016), https://www.theicct.org/sites/default/files/publications/Brazil%20P-7%20Briefing%20Paper%20Final_revised.pdf.

9 Joshua Miller and Cristiano Façanha, *Cost-Benefit Analysis of Brazil's Heavy-Duty Emission Standards (P-8)*, (ICCT: Washington, DC, 2016), http://www.theicct.org/sites/default/files/publications/P-8%20White%20Paper_final.pdf.

Table 1. Implementation timeline of PROCONVE standards for heavy-duty vehicles in Brazil

Standard	Resolution	Euro Equivalent	Implementation date
PROCONVE P-1	CONAMA 18/1986	-	1987 (Urban buses) 1989 (100%)
PROCONVE P-2	CONAMA 08/1993	Euro 0	1994 (80%) 1996 (100%)
PROCONVE P-3		Euro I	1994 (Urban buses) 1996 (80%) 2000 (100%)
PROCONVE P-4		Euro II	1998 (Urban buses) 2000 (80%) 2002 (100%)
PROCONVE P-5	CONAMA 315/2002	Euro III	2004 (Urban buses) 2005 (Micro buses) 2005 (40%) 2006 (100%)
PROCONVE P-6	CONAMA 315/2002	Euro IV	Never implemented because the ULSD would not be available; P-5 was continued through 2011
PROCONVE P-7	CONAMA 403/2008	Euro V	2012
PROCONVE P-8	CONAMA 490/2018	Euro VI	2022 (type approvals) 2023 (all sales and registrations)

OVERVIEW OF THE STANDARDS

The introduction of Euro VI-equivalent P-8 standards will significantly strengthen Brazil's regulatory program, including more-stringent emission limits, a switch to more-representative test cycles, requiring advanced OBD and fail-safes to ensure proper use and functioning of selective catalytic reduction (SCR) systems, and establishing in-use conformity requirements. These provisions are discussed in the following sections.

APPLICABILITY

The P-8 standards will apply to all new on-road passenger and freight vehicles equipped with compression-ignition or spark-ignition engines and weighing at least 3,856 kg. These vehicle categories currently account for an outsized contribution to on-road vehicle emissions in Brazil. For example, in the State of São Paulo, heavy-duty trucks and buses account for less than 4% of the on-road vehicle fleet but more than 80% of PM and NO_x emissions.¹⁰ These emissions will be progressively reduced with the implementation of P-8 standards.

Subject to approval by the Brazilian Institute of the Environment and Renewable Resources (IBAMA), light commercial vehicles weighing between 3,500 and 3,856 kg whose engine drivetrains are approved for HDVs may be certified to P-8 in lieu of the applicable light-duty standard. The P-8 standards will go into effect for new type approvals on January 1, 2022, and for all new sales and registrations on January 1, 2023. The standards apply to domestically produced and imported vehicles. IBAMA retains the authority to make a determination based on evidence

¹⁰ CETESB, "Vehicle Emissions Inventory for the State of Sao Paulo 2016," (September 2017), http://cetesb.sp.gov.br/veicular/wp-content/uploads/sites/6/2017/11/EMISS%C3%95ES-VEICULARES_09_nov.pdf.

to partially or totally exempt certain engines and vehicles that are not used for road transport.

EMISSION LIMITS

Table 2 shows the maximum emission limits of the P-8 standards.¹¹ These limits are equivalent to Euro VI for all fuel types, pollutants, and test cycles.¹² Emission limits over the WHSC apply only to compression-ignition engines. Total hydrocarbons (THC) emission limits apply to compression-ignition engines, whereas non-methane hydrocarbons (NMHC) and methane (CH₄) limits apply to spark-ignition engines. Ammonia (NH₃) limits apply to vehicles equipped with after-treatment systems with reducing agents (SCR) and vehicles fueled with compressed natural gas (CNG). IBAMA retains the authority to alter the metric of NH₃ from parts per million (ppm) to g/kWh. For turbocharged engines, the exhaust gas emission limits apply to the sum of tailpipe emissions plus any crankcase emissions as measured over the WHSC, WHTC, or WNTE.

Table 2. Maximum emission limits for on-road heavy-duty vehicles of PROCONVE P-8

Cycle	CO (mg/kWh)	THC ¹ (mg/kWh)	NMHC ² (mg/kWh)	CH ₄ ² (mg/kWh)	NO _x ³ (mg/kWh)	NH ₃ ³ (ppm)	PM (mg/kWh)	PN (#/kWh)
WHSC ¹	1,500	130	-	-	400	10	10	8.0 x 10 ¹¹
WHTC ¹	4,000	160	-	-	460	10	10	6.0 x 10 ¹¹
WHTC ²	4,000	-	160	500	460	10	10	-
OCE (WNTE)	2,000	220	-	-	600	-	16	-
ISC	6,000	240	240	750	690	-	-	-

(1) Applicable only to compression-ignition (diesel) engines

(2) Applicable only to spark-ignition (gasoline and CNG) engines

(3) Applicable to vehicles equipped with after-treatment systems with reducing agents (SCR) or vehicles fueled with CNG

DURABILITY REQUIREMENTS

The durability requirements of P-8 are equivalent to those of Euro VI. Vehicle manufacturers or importers must demonstrate compliance with emission limits up to a minimum vehicle mileage or duration of operation, whichever comes first. These requirements are differentiated by vehicle usage, whether passenger or freight, and gross vehicle weight (in tonnes; t):

- » 160,000 km or five years for passenger vehicles weighing less than 5 t.
- » 300,000 km or six years for freight vehicles weighing between 3.856 t and 16 t, and for passenger vehicles weighing between 5 t and 7.5 t.
- » 700,000 km or seven years for freight vehicles weighing more than 16 t and for passenger vehicles weighing more than 7.5 t.

Emissions for durability testing must be within the maximum emission limits multiplied by a deterioration factor. These factors are shown in Table 3. A factor of one indicates that the limit for durability testing is identical to the limits given in the previous table.

11 For comparison with emission limits of previous standards, see <https://www.transportpolicy.net/standard/brazil-heavy-duty-emissions>

12 UN Regulation No. 49.06, Official Journal of the European Union, 42013X0624(01), 24 June 2013, <https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=CELEX%3A42013X0624%2801%29>

Table 3. Multiplication deterioration factors for on-road heavy-duty vehicles of PROCONVE P-8

Cycle	CO	THC ¹	NMHC ²	CH ₄ ²	NO _x	NH ₃	PM	PN
WHSC / WHTC	1.3	1.3	1.4	1.4	1.15	1.0	1.05	1.0

(1) Applicable only to compression-ignition (diesel) engines

(2) Applicable only to spark-ignition (gasoline and CNG) engines

With approval from IBAMA, manufacturers or importers may simulate mileage on an engine dynamometer or test track. If this option is taken, it must be performed with commercial fuels. Subsequent emission testing to verify durability must be conducted using the reference fuel.

TEST CYCLES AND REFERENCE FUEL

Until equivalent national procedures are published by IBAMA or defined by reference to a Brazilian technical standard, the P-8 test procedures include the WHTC, WHSC, and WNTC in accordance with the United Nations Economic Commission for Europe (UNECE) Regulation R49.06 (Euro VI). No changes are made in P-8 concerning the reference fuels used for testing until ANP publishes new specifications considering biodiesel blends.

IN-SERVICE CONFORMITY TESTING

In addition, P-8 requires an on-road PEMS test to be performed for at least one vehicle in each engine family to demonstrate compliance with emission limits. These requirements are in accordance with Euro VI as defined in UNECE Regulation R49.06, Annex 10, Appendix 1. As in Euro VI, the on-road test must also record and report on carbon dioxide emissions and fuel consumption.

The provisions for ISC are likewise defined in UNECE Regulation R49.06, Annex 10, Appendix 1. Beginning with the introduction of P-8, each manufacturer or importer must submit to IBAMA its plan for carrying out ISC for at least one vehicle and at least one additional urban bus. Two years after the introduction of P-8, each manufacturer or importer will have to submit to IBAMA its plan for carrying out ISC for the remaining engine families. Applicable vehicles selected for ISC must meet the minimum mileage or duration-of-operation requirements established for durability testing.

In the case that a vehicle model is found to be non-compliant during ISC testing, the manufacturer or importer must submit a plan to IBAMA to recall and repair the affected vehicles. The repair plan must be approved by IBAMA before its execution. While mandatory, execution of the repair plan will not necessarily exempt the manufacturer or importer from other penalties.

ON-BOARD DIAGNOSTICS

Until equivalent national procedures are published by IBAMA or defined by reference to a Brazilian technical standard, the OBD requirements for compliance with P-8 are those in Annexes 9A, 9B, 9C, 11, and 14 of UNECE Regulation R49.06 and Annex XIII of EC 582/2011. If the expected technical standards issued by authorities in Brazil retain the main elements set by the OBD part of UNECE R49.06, the vehicles would receive important emission-

control improvements because the Euro VI OBD introduced many more-detailed requirements, including:¹³

- » OBD data streams to be harmonized.
- » More-stringent OBD threshold values and type approval based on the WHTC.
- » Adoption of in-use performance ratios (IUPRs). IUPRs give an idea of how often the conditions subject to monitoring occurred and how frequently the monitoring was conducted. The regulation establishes a minimum of IUPR = 0.1, or 1 in 10 times.
- » Additional monitoring requirements for DPF systems and regeneration events, exhaust gas recirculation (EGR) flow, EGR cooling system, boost by turbo and superchargers, and fuel-injection systems.
- » Better use of non-erasable memory to avoid deleting active malfunction codes by disconnecting the battery, resulting in better in-use emissions control.

This set of improvements opens the possibility of implementing an inspection and maintenance program in Brazil that uses OBD as one key component of in-use operation performance verification. This approach is being studied in China and California for such programs.

OTHER COMPLIANCE PROVISIONS

The P-8 standards apply the same definition of auxiliary emission strategies established in Euro VI. Any parameters that modify the emission-control strategy must be reviewed and approved by IBAMA before certification. Those parameters must subsequently be made available for tracking during operation of the vehicle in any condition.

INTERNATIONAL CONTEXT

The adoption of P-8 in Brazil follows similar developments in other major vehicle markets, notably India,¹⁴ China,¹⁵ and Mexico.¹⁶ After each of these standards takes effect between 2020 and 2023, an estimated 70% of new HDVs with diesel engines worldwide will meet Euro VI-equivalent standards, compared with 40% of new HDVs in 2018 (Figure 1). With the adoption of P-8 in Brazil, 14 of the G20 economies have adopted Euro VI-equivalent standards. Australia, Argentina, and Russia are at Euro V; and Indonesia, South Africa, and Saudi Arabia are at earlier stages.

13 Francisco Posada and Anup Bandivadekar, *Global overview of on-board diagnostic (OBD) systems for heavy-duty vehicles*, (ICCT: Washington, DC, 2015), <https://www.theicct.org/publications/global-overview-board-diagnostic-obd-systems-heavy-duty-vehicles>

14 Tim Dallmann and Anup Bandivadekar, *India Bharat Stage VI Emission Standards*, (ICCT: Washington, DC, April 2016), <https://www.theicct.org/publications/india-bharat-stage-vi-emission-standards>.

15 Liuhanzi Yang and Hui He, *China's Stage VI Emissions Standard for Heavy-Duty Vehicles (Final Rule)*, (ICCT: Washington, DC, July 2018), <https://www.theicct.org/publications/china%E2%80%99s-stage-vi-emissions-standard-heavy-duty-vehicles-final-rule>.

16 Kate Blumberg, *Mexico Heavy-Duty Vehicle Emission Standards*, (ICCT: Washington, DC, February 2018), <https://www.theicct.org/publications/mexico-heavy-duty-vehicle-emission-standards>.

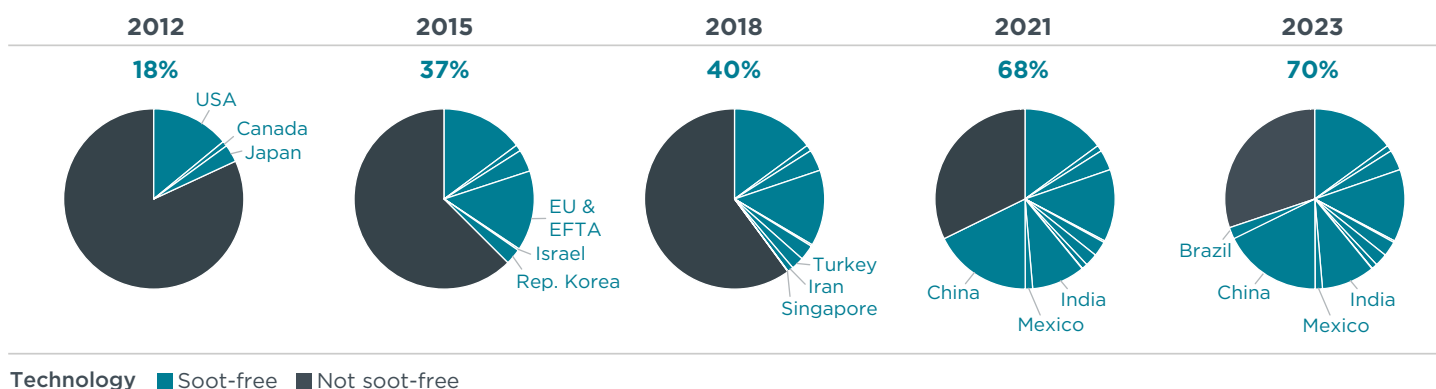


Figure 1. Share of global new heavy-duty diesel vehicle sales meeting soot-free emissions performance standards. Adapted from “Global progress toward soot-free diesel vehicles in 2018.”¹⁷ Soot-free performance is defined as Euro VI or better for tailpipe particulate emissions. For diesel vehicles, this can be achieved with a properly-functioning DPF.

REGULATORY IMPACTS

The introduction of P-8 standards in Brazil will have far-reaching benefits for controlling harmful emissions from HDVs and reducing the associated impacts on air quality and public health. In a 2016 analysis of the costs and benefits of P-8 standards in Brazil, we found that introduction of P-8 would yield US\$11 in health benefits for every dollar invested in improved vehicle emission control technologies.¹⁸ Over a 30-year period following the introduction of P-8, cumulative HDV emissions could be reduced by 130,000 tons of PM_{2.5}, 110,000 tons of black carbon, 12 million tons of NO_x, 2.7 million tons of carbon monoxide, and 24,000 tons of HC.

The final implementation date for P-8 comes several years later than our original expectation of 2018. Looking forward, several actions could be taken to accelerate the benefits of the P-8 standards. Importantly, the standards allow for voluntary certification before 2022. In fact, some Euro VI-compliant buses are already produced in Brazil and exported to Chile for the Transantiago bus system.¹⁹ Effective immediately, cities in Brazil could integrate P-8/Euro VI technologies into their procurement tenders to accelerate reductions in PM, black carbon, and NO_x emissions from urban bus fleets. Second, as soon as P-8-compliant trucks are commercially available, Brazil could undertake a national fleet renewal program to incentivize scrappage of older trucks and stimulate sales of P-8 trucks. Such a program should be designed carefully to maximize emission reductions in a cost-effective manner.²⁰

17 Joshua Miller and Lingzhi Jin, *Global Progress toward Soot-Free Diesel Vehicles in 2018*, (ICCT: Washington, DC, July 2, 2018), <https://www.theicct.org/publications/global-progress-toward-soot-free-diesel-vehicles-2018>.

18 Joshua Miller and Cristiano Façanha, *Cost-Benefit Analysis of Brazil's Heavy-Duty Emission Standards (P-8)*, (ICCT: Washington, DC, 2016), http://www.theicct.org/sites/default/files/publications/P-8%20White%20Paper_final.pdf.

19 “Mercedes-Benz and Marcopolo sell 342 buses to Chile,” *Automotive Business*, January 11, 2019, <http://www.automotivebusiness.com.br/noticia/28563/mercedes-benz-e-marcopolo-vendem-342-onibus-ao-chile>.

20 Joshua Miller, “Brazil’s Vehicle Fleet Renewal Program Should Aim to Benefit from Others’ Successes, and Their Mistakes,” International Council on Clean Transportation, November 10, 2016. <http://www.theicct.org/blogs/staff/brazil-vehicle-fleet-renewal-program>.

The adopted P-8 standards allow for the possibility of future changes that could affect the emissions performance of P-8 vehicles. As evidenced in Europe, the Euro VI standards owe their success in reducing real-world emissions to several key provisions, including the switch to more-representative test cycles and the addition of requirements for ISC testing, OBD systems, cold-start testing, and on-road emissions testing.²¹ When Brazil adopted the P-7 standards, it relaxed some of the Euro V provisions for OBD systems. Those changes enabled a significant fraction of truck operators to install defeat devices to avoid using adequate diesel exhaust fluid (a mixture 32.5% urea and 67.5% water known as ARLA-32 in Brazil), leading to much higher NO_x emissions.²² Brazil's own experience with P-7 demonstrates the potential for reduced effectiveness of emissions standards if changes are made to the underlying provisions. Thus, if Brazil opts to develop its own rules for any of the provisions of P-8, the onus is on the regulator to justify any deviations from Euro VI and safeguard the effectiveness of the standards.

21 Rachel Muncrief, *NO_x Emissions from Heavy-Duty and Light-Duty Diesel Vehicles in the EU: Comparison of Real-World Performance and Current Type-Approval Requirements*, (ICCT: Washington, DC, 2017), <https://www.theicct.org/publications/nox-emissions-heavy-duty-and-light-duty-diesel-vehicles-eu-comparison-real-world>.

22 Cristiano Façanha, *Deficiencies in the Brazilian PROCONVE P-7 and the case for P-8 standards*, (ICCT: Washington, DC, 2016), https://www.theicct.org/sites/default/files/publications/Brazil%20P-7%20Briefing%20Paper%20Final_revised.pdf.