

POLICY UPDATE

JANUARY 2020

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Brazil PROCONVE L-7 and L-8 emission standards for light- duty vehicles

OVERVIEW OF THE STANDARDS

Brazil's National Council for the Environment, Conselho Nacional do Meio Ambiente (CONAMA), approved the Programa de Controle de Poluição do Ar por Veículos Automotores (PROCONVE) L-7 and L-8 emission standards for new light-duty vehicles (LDVs) on December 20, 2018.¹ The standards apply to new light passenger and commercial vehicles with a maximum weight of not more than 3,856 kilograms (kg) and a maximum running weight of not more than 2,720 kg.² The PROCONVE L-7 standards will go into effect on January 1, 2022 for all new vehicles and the L-8 standards will be introduced starting on January 1, 2025. The stringency of the L-8 standards is scheduled to increase with time, and they will be fully phased in for light passenger vehicles (PVs) by January 1, 2029 and for light commercial vehicles (LCVs) by January 1, 2031.

The L-7 standards follow a similar regulatory approach as previous phases of the PROCONVE program for LDVs. Separate tailpipe emission limits are set for passenger and commercial vehicles, and in the case of certain pollutants, separate limits are set for vehicles equipped with spark-ignition (SI) engines, which are typically gasoline or flex-fuel vehicles, and for vehicles with diesel engines. All vehicle models of a given category must meet the corresponding emission limits.

Noteworthy aspects of the new L-7 standards include:

- » New classifications for LDVs
- » Introduction of a combined non-methane organic gas (NMOG) plus nitrogen oxides (NO_x) emission limit, including provisions for taking the ozone-forming potential of NMOG emissions into account during vehicle certification testing
- » Establishment of a particulate matter (PM) emission limit for vehicles equipped with direct injection SI engines

¹ CONAMA Resolution 492/2018, Diário Oficial da União, No. 246, 24 December 2018, http://www.in.gov.br/materia/-/asset_publisher/Kujrw0TZC2Mb/content/id/56643907.

² The running weight, or curb weight, is equivalent to the maximum weight minus the weight of passengers and cargo.

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- » Reduction of the evaporative emission limit from 1.5 grams (g) per test to 0.5 g per test for vehicles fueled with gasoline or ethanol, and a transition to a 48-hour diurnal test procedure
- » Introduction of a 50 milligrams (mg) per liter (L) refueling emission limit for vehicles fueled with gasoline or ethanol, to be phased in between 2023 and 2025
- » Extension of the vehicle useful life period from 80,000 kilometers (km) or 5 years to 160,000 km or 10 years
- » Introduction of real-driving emissions testing and reporting requirements

With the implementation of the L-8 standards starting in 2025, Brazil will transition to a corporate averaging approach where vehicle manufacturers will be required to meet fleet-average emission limits set for their entire vehicle fleet. These corporate average emission limits are set separately for light passenger and commercial vehicles and will increase in stringency as the L-8 standards are phased in between 2025 and 2029 for PVs and between 2025 and 2031 for LCVs. Evaporative emission and durability requirements introduced in the L-7 standards are maintained in the L-8 standards. A type-approval real-driving emission limit equal to two times the laboratory limit will be introduced with the L-8 standards in 2025. This limit will be reduced to one and a half times the laboratory limit 2 years later, in 2027. The real-driving limits apply to emissions of carbon monoxide (CO) and the sum of non-methane hydrocarbons (NMHC) and NO_x. The L-8 standards also call for the creation of an emissions credit system; such systems offer manufacturers additional compliance flexibility beyond that afforded by the corporate averaging regulatory approach.

By establishing the L-7 and L-8 standards, Brazil has taken positive steps toward reducing the environmental impacts of LDVs. The level at which tailpipe emission limits are set for PVs compares favorably with international best practices. Further, provisions are strengthened or introduced in the standards to address important shortcomings in previous phases of the PROCONVE program. These include the adoption of more stringent evaporative emission requirements and in particular the introduction of a refueling emission limit, which should lead to the widespread use of on-board refueling vapor recovery (ORVR) systems. These systems are one of the most effective methods of controlling evaporative emissions from vehicles. The extension of the vehicle useful life period at the L-7 stage and the introduction of a real-driving test with associated NMHC+NO_x and CO limits at the L-8 stage will also promote the application of more robust emission control systems in Brazilian LDVs.

However, it is also clear that the L-7 and L-8 standards fall short of international best practices in a number of important areas. For one, until 2031, LCVs are subject to less stringent standards than PVs. Furthermore, the standards are not fuel neutral—diesel vehicles are allowed to emit higher amounts of NMOG+NO_x and PM than comparable SI vehicles in both the L-7 and L-8 standards. The relative weakness of standards for diesel vehicles will likely significantly delay the use of best available emission control technologies, which are now in widespread use in other regions where more stringent emission standards for these vehicles are in place. Additionally, regulatory exemptions allowing vehicles with certain off-road characteristics to be certified as LCVs are maintained in the L-7 and L-8 standards. This will continue to allow sport utility vehicles and pick-up trucks used primarily for passenger transport applications to emit more pollution than passenger vehicles used for similar applications. The relative share of sales of these vehicles has been increasing in recent years, and this exemption may further incentivize sales. Finally, compliance provisions needed to effectively manage the emissions performance of vehicles throughout their useful lives, like in-use testing requirements, are still missing from the Brazilian PROCONVE program.

POLICY BACKGROUND

The Brazilian motor vehicle air pollution control program, PROCONVE, was established through a resolution issued by CONAMA in 1986.³ To date, six phases of PROCONVE have been implemented for LDVs in Brazil. Table 1 gives an overview of the establishing legislation and implementation dates for each phase. Initial phases of PROCONVE (L-1-L-3) set emission limits at successively more stringent levels to promote the application of best-available engine design strategies and aftertreatment control devices. Subsequent phases of PROCONVE have continued to set more stringent emission limits for LDVs, with a specific focus on addressing urban ozone pollution problems through better control of NO_x and hydrocarbon (HC) emissions. Beginning in 1994, light-duty diesel vehicles were also explicitly included in PROCONVE regulation. The phase of PROCONVE in force today, L-6, was approved in 2009 and fully implemented in 2015.

Table 1. Implementation timeline of PROCONVE standards for LDVs in Brazil

Phase	Regulation	Implementation Dates
Phase 1 (L-1)	CONAMA Resolution N° 18/1986	January 1, 1989
Phase 2 (L-2)	CONAMA Resolution N° 18/1986	January 1, 1992 March 1, 1994 (light-duty diesel vehicles)
Phase 3 (L-3)	CONAMA Resolution N° 15/1995	January 1, 1997
Phase 4 (L-4)	CONAMA Resolution N° 315/2002	January 1, 2005: 40% annual production January 1, 2006: 70% annual production January 1, 2007: 100% annual production
Phase 5 (L-5)	CONAMA Resolution N° 315/2002	January 1, 2009
Phase 6 (L-6)	CONAMA Resolution N° 415/2009	January 1, 2013: diesel vehicles January 1, 2014: new Otto cycle models January 1, 2015: all vehicle models
Phase 7 (L-7)	CONAMA Resolution N° 492/2018	January 1, 2022
Phase 8 (L-8)	CONAMA Resolution N° 492/2018	January 1, 2025 January 1, 2029 (fully phased in for PVs) January 1, 2031 (fully phased in for LCVs)

APPLICABILITY

The PROCONVE L-7 and L-8 emission standards apply to new light passenger and commercial vehicles. The standards revise somewhat the classification of LDVs relative to previous PROCONVE phases, and they are defined as follows:

Light passenger vehicle: Motor vehicle with maximum total weight of up to 3,856 kg and a maximum running weight of up to 2,720 kg that is designed for the carriage of passengers and has no more than eight seats in addition to the driver's seat; also cargo vehicles with a payload of up to 1,000 kg.

Light commercial vehicle: Motor vehicle with maximum total weight of up to 3,856 kg and a maximum running weight of up to 2,720 kg that is also: (1) designed for the transport of a payload greater than 1,000 kg; or (2) designed for passenger transport, with more than eight seats in addition to the driver's seat; or (3) has special characteristics for off-road use.

³ Conselho Nacional do Meio Ambiente. (1986). Resolução CONAMA N° 018/1986, Provides for the creation of the Program for the Control of Air Pollution by Automotive Vehicles - PROCONVE, May 6, 1986, <http://www.mma.gov.br/port/conama/legiabre.cfm?codlegi=41>

EXHAUST EMISSION LIMITS AND REQUIREMENTS

L-7 STANDARDS

PROCONVE L-7 emission standards set separate emission limits for light-duty passenger and commercial vehicles, as is shown in Table 2. Regulated pollutants include NMOG+NO_x, PM, CO, and aldehydes. Emission limits for LCVs are not fuel-neutral; NMOG+NO_x and PM limits for diesel LCVs are, respectively, 2.3 and 3.3 times the limits for LCVs equipped with SI engines. As with previous PROCONVE phases, all vehicle models of a given category must be certified to the corresponding emission limits.

Table 2. PROCONVE L-7 emission limits for light-duty passenger and commercial vehicles

Vehicle category	NMOG + NO _x	PM ^(a)	CO	Aldehydes ^(c)	NH ₃ ^(b)	Evaporative ^(e)	Refueling ^(e)
	mg/km	mg/km	mg/km	mg/km	ppm	g/test	mg/L supplied
Passenger vehicles	80	6	1,000	15	Declare	0.5	50
Light commercial vehicles	140 ^(c)	6 ^(c)					
	320 ^(d)	20 ^(d)					

(a) Applicable to vehicles equipped with diesel engines or direct injection SI engines

(b) Applicable to vehicles equipped with diesel engines with aftertreatment systems using a liquid reducing agent

(c) Applicable to vehicles equipped with SI engines

(d) Applicable to vehicles equipped with diesel engines

(e) Not applicable to vehicles fueled by diesel or compressed natural gas

With the exception of the definition and calculation of NMOG emissions, no major changes to existing exhaust emission certification test procedures are introduced in the L-7 standards. In previous phases of PROCONVE, organic gas emissions were regulated with NMHC and aldehyde limits. The L-7 standards preserve a separate aldehyde limit for vehicles equipped with SI engines and introduce a combined NMOG+NO_x limit to replace separate NMHC and NO_x limits used in previous PROCONVE phases. The NMOG metric provides a more comprehensive accounting of the organic gases emitted by combustion engines by explicitly including species such as alcohols, which are not well characterized by methods used to measure NMHC emissions. For ethanol and flex-fuel vehicles, this means that emissions of unburned ethanol will be counted as NMOG emissions in the L-7 standards. The L-7 regulation adopts NMOG test procedures developed by the State of California. Additional provisions are included for the adjustment of NMOG emissions measured during certification testing for their chemical reactivity, or ozone-forming potential.

The L-7 standards maintain the NBR 6601 driving cycle for vehicle certification testing. This cycle is equivalent to the United States Federal Test Procedure cycle.

Figure 1 compares L-7 NMOG+NO_x limits with L-6 NMHC and NO_x limits by vehicle category and fuel type. For passenger vehicles, the 80 mg/km L-7 NMOG+NO_x limit is equivalent to the L-6 NO_x limit and approximately 40% lower than the sum of the L-6 NMHC and NO_x limits. For larger LCVs, L-7 emission limits for vehicles equipped with diesel engines are reduced by a relatively small amount from L-6 levels. Vehicles in this class equipped with SI engines face a greater tightening of emission limits, in both relative and absolute terms.

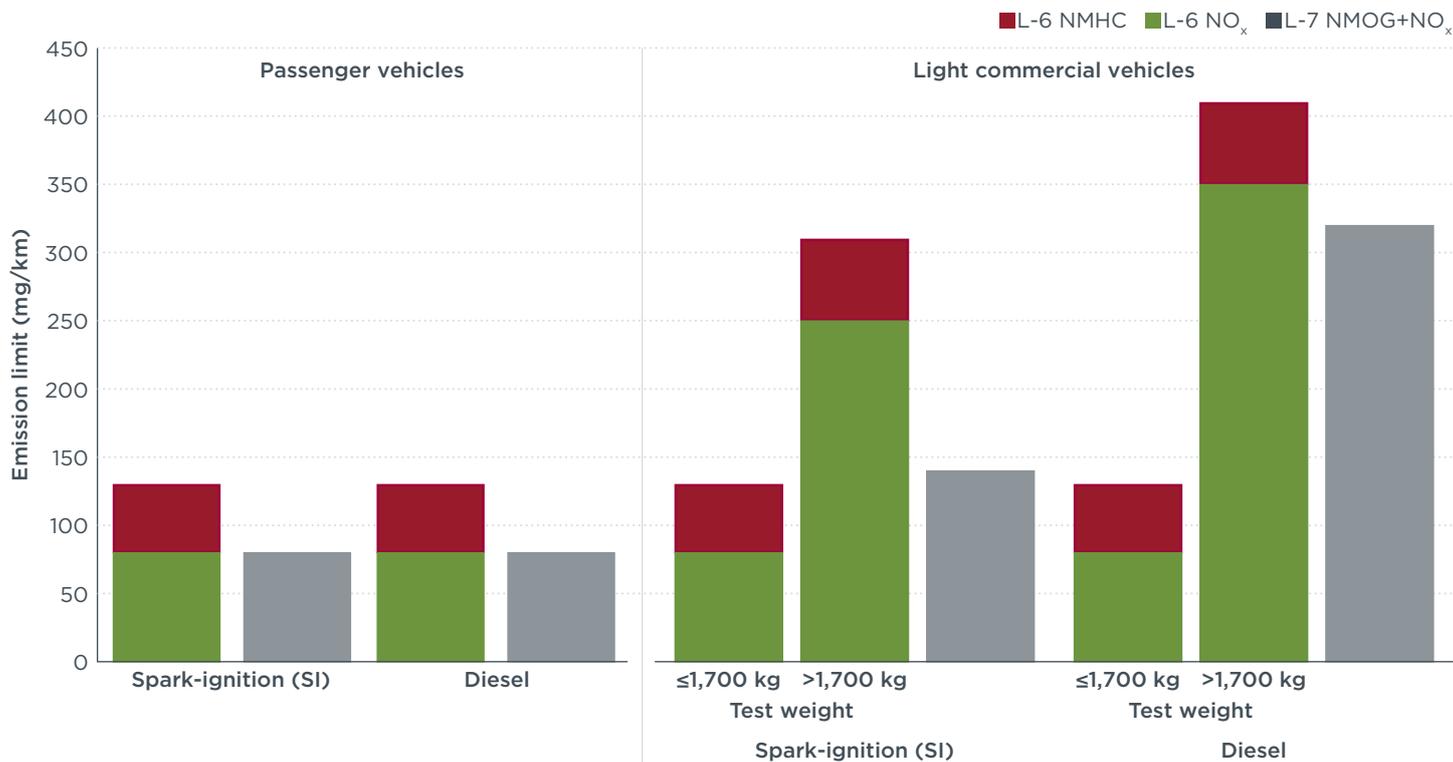


Figure 1. Comparison of PROCONVE L-6 and L-7 NO_x, NMHC, and NMOG+NO_x emission limits for light-duty passenger and commercial vehicles. *Note:* Test weight is defined as the vehicle running weight plus 136 kg. L-6 standards are set separately for LCVs with test weight ≤1,700 kg and for LCVs with test weight >1,700 kg.

The L-7 standards introduce a PM limit of 6 mg/km for LDVs equipped with SI direct injection engines. PM emissions from these vehicles were previously unregulated. As shown in Figure 2, L-7 standards also tighten PM limits for vehicles equipped with diesel engines. The 20 mg/km PM limit set for diesel LCVs in the L-7 standards represents a 33% and 50% reduction relative to L-6 levels for small and large LCVs, respectively.

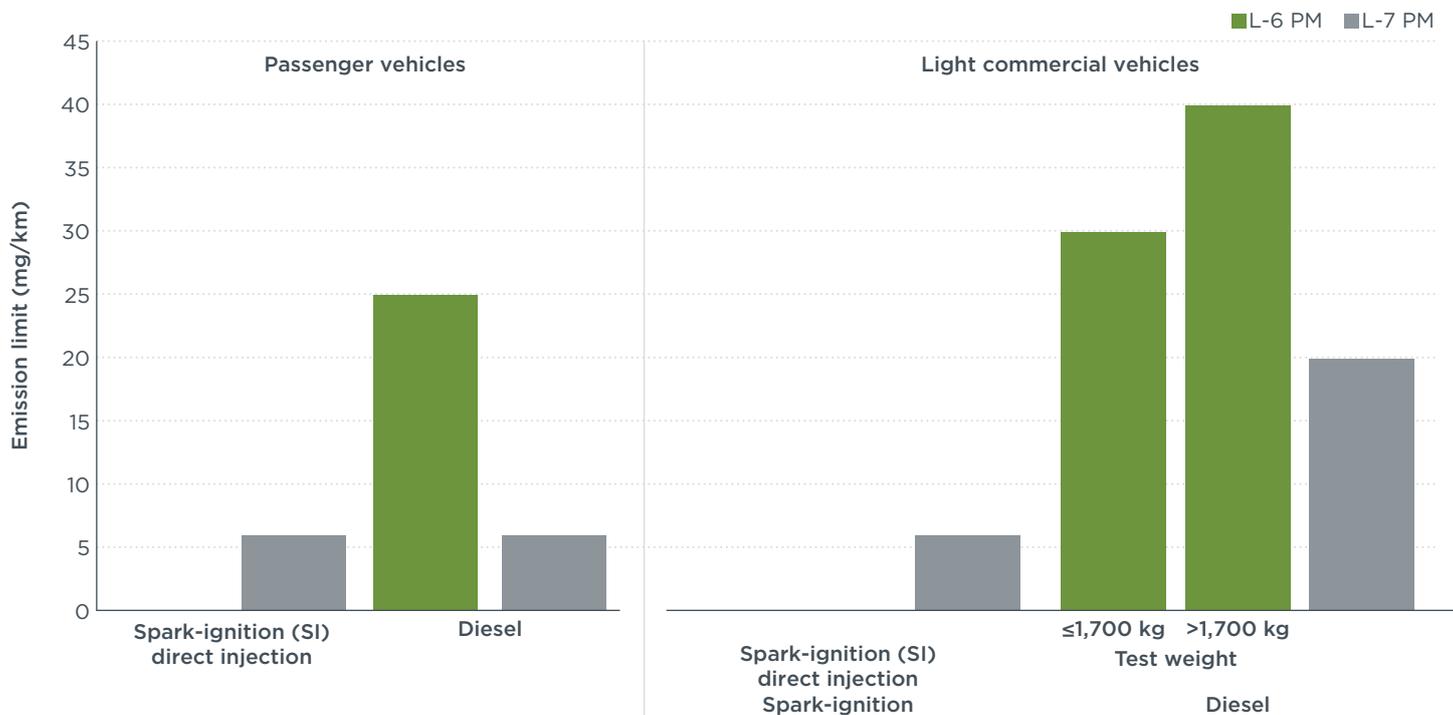


Figure 2. Comparison of PROCONVE L-6 and L-7 PM emission limits for light-duty passenger and commercial vehicles.

L-8 STANDARDS

The PROCONVE L-8 standards introduce a corporate averaging regulatory approach. Vehicle manufacturers will be required to meet fleet-average emission limits set separately for PVs and LCVs. In the L-8 framework, individual vehicle models must be certified to one of the pre-defined emission levels shown in Table 3. The emission levels for individual vehicle models are then averaged and weighted by annual sales to calculate fleet average emissions. The L-8 standards are not fuel neutral; diesel LCVs are allowed to certify to higher emission levels than other vehicle types. Additionally, the L-8 standards introduce an ammonia (NH₃) limit of 10 parts per million (ppm) for vehicles equipped with diesel engines with aftertreatment systems that use a liquid reducing agent.

Table 3. Emission levels for PROCONVE L-8 LDVs

			Level	NMOG+NO _x mg/km	PM ^(a) mg/km	CO mg/km	Aldehydes ^(c) mg/km	NH ₃ ^(b) ppm	Evaporative ^(c) g/test	Refueling mg/L fuel supplied
Diesel LCVs			320	320	20	1000	—	10	0.5	50
			280	280	20	1000	—			
			250	250	20	1000	—			
			220	220	10	1000	—			
			200	200	10	1000	—			
			170	170	9	1000	—			
	Spark-ignition LCVs (test mass > 1700 kg)	PVs and LCVs (test mass ≤ 1700 kg)	140	140	6	1000	15			
			110	110	6	1000	15			
			80	80	6	1000	15			
			70	70	4	600	10			
			60	60	4	600	10			
			50	50	4	600	10			
			40	40	4	500	10			
			30	30	3	500	8			
			20	20	2	400	8			
			0	null	null	null	null			

(a) Applicable to vehicles equipped with diesel engines or direct injection SI engines

(b) Applicable to vehicles equipped with diesel engines with aftertreatment systems using a liquid reducing agent

(c) Applicable to vehicles equipped with Otto cycle engines

Corporate average emission limits for the L-8 standards are shown in Table 4. The limits correspond to emission levels included in Table 3, which define corporate average emission limits for each regulated pollutant. For example, in 2025, the corporate average emission level for passenger vehicles is set at 50, which corresponds to fleet-average emission limits of 50 mg/km for NMOG+NO_x, 4 mg/km for PM, 600 mg/km for CO, and 10 mg/km for aldehydes.

Table 4. Corporate average emission levels for PROCONVE L-8 standards

Implementation date	PV corporate average emission level	LCV corporate average emission level
January 1, 2025	50	140
January 1, 2027	40	110
January 1, 2029	30	50
January 1, 2031	30	30

The emission limits are tightened over time and are scheduled to be fully implemented by 2029 for PVs and by 2031 for LCVs. Figure 3 shows the implementation timeline for the L-8 corporate average CO, PM, and NMOG+NO_x limits. LCVs are subject to less stringent limits than PVs through 2030.

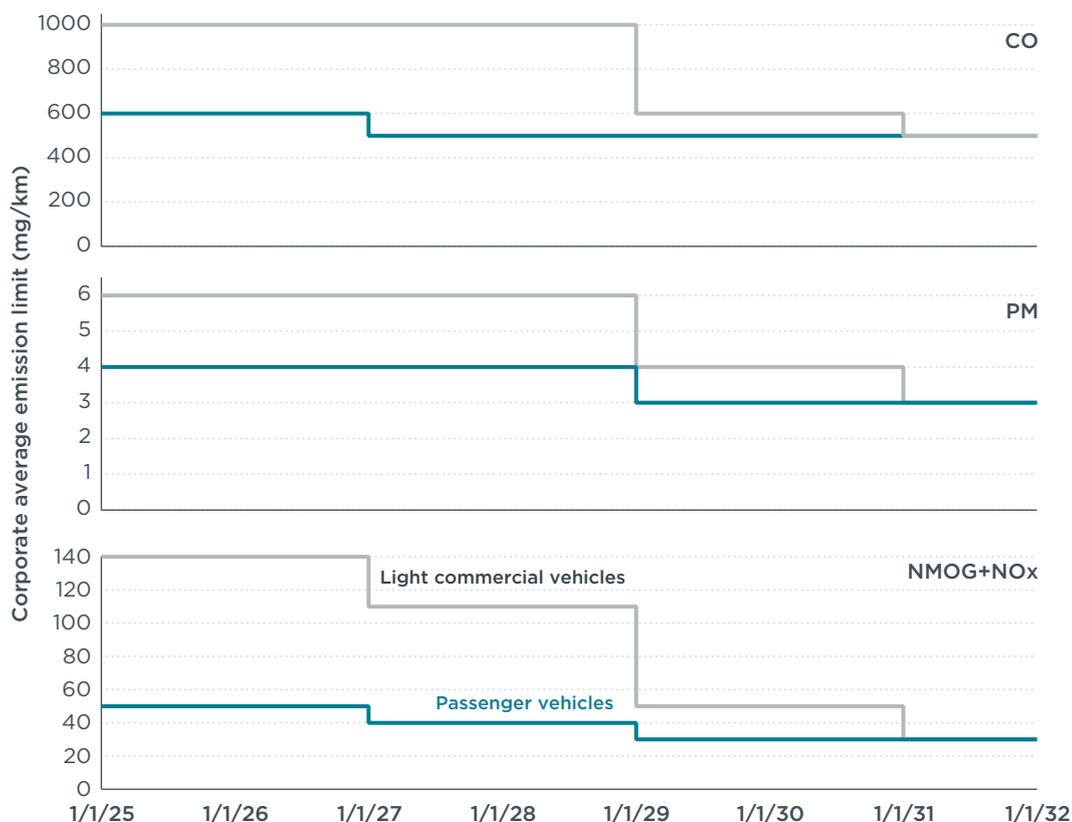


Figure 3. Implementation timeline for PROCONVE L-8 corporate average emission limits for light-duty passenger and commercial vehicles.

The L-8 standards also call for establishing an emissions credit system. Such systems provide additional compliance flexibility for manufacturers. The Brazilian Institute for the Environment and Renewable Resources (Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis, IBAMA) is tasked with developing a procedure for regulating the generation, balance, and use of emissions credits and publishing this information, at the latest, 2 years prior to the implementation of the L-8 standards.

EVAPORATIVE AND REFUELING EMISSION REQUIREMENTS

Evaporative emission requirements for LDVs will be strengthened considerably with the implementation of PROCONVE L-7 standards. The L-7 standards reduce the diurnal evaporative test emission limit from 1.5 g per test to 0.5 g per test. This more stringent limit is accompanied by the introduction of more challenging evaporative emission test procedures. The 1-hour simulated diurnal test currently in use will be replaced by a 48-hour test modeled after the 48-hour test used in the U.S. LDV emission control program. These changes should promote the application of more robust evaporative emission control systems in Brazilian LDVs.

In addition to the changes to the diurnal evaporative emission test limit and test procedures, the L-7 standards also introduce a refueling emission limit of 50 mg/L of fuel dispensed, applicable to vehicles equipped with SI engines and fueled with

ethanol or gasoline. This limit is similar to refueling limits included in the United States' Tier 2 and Tier 3 standards, as well as the recently adopted China 6 standards for LDVs.⁴ The refueling limit will be phased in beginning in 2023, following the implementation timeline shown in Table 5. The introduction of a refueling emission limit should lead to the widespread use of ORVR systems, one of the most effective devices for controlling evaporative emissions.

Table 5. Phase-in timeline for 50 mg/L refueling emission limit

Year	Compliance target
2023	20% total sales per manufacturer
2024	60% total sales per manufacturer
2025 and onward	All vehicle models subject to refueling limit

DURABILITY REQUIREMENTS

The L-7 standards extend the vehicle useful life period from 80,000 km or 5 years to 160,000 km or 10 years. Vehicle manufacturers are responsible for demonstrating that exhaust emissions remain below regulatory limits over this period. This is done by applying deterioration factors to certification test results, to account for degradation in the emissions performance of a vehicle over the course of its useful life. Deterioration factors are determined experimentally through vehicle mileage accumulation testing. Alternatively, for vehicles whose engine groupings have expected annual sales fewer than 15,000 units, manufacturers can apply the deterioration factors stipulated in the regulation (Table 6).

Table 6. PROCONVE L-7 and L-8 deterioration factors

Engine type	Multiplicative factor for exhaust emissions				
	NMHC	CO	NO _x	Aldehydes	PM
Diesel	1.2	1.2	1.2	1.0	1.2
Otto	1.4	1.4	1.2	1.2	1.0

REAL-DRIVING TESTING

Real-driving test requirements are introduced in the L-7 standards. These requirements add an on-road test to supplement laboratory testing during the vehicle homologation process. Manufacturers will be required to measure fuel economy and emissions of CO, NO_x, total hydrocarbons (THC), methane (CH₄), NMHC, and carbon dioxide (CO₂) in real driving conditions. The tests are to be performed on the same vehicles used for laboratory homologation testing and will follow procedures defined in the first two packages of the European real-driving emissions (RDE) legislation until a separate technical normative instruction is published by IBAMA.⁵ To meet L-7 standards, manufacturers are only required to test vehicle emissions in real-driving conditions and report results. The L-8 standards introduce real-driving limits for emissions of CO and NMHC+NO_x. These limits are set at two times the laboratory emission limit in 2025 and 2026 and are reduced to one and a half times the laboratory limit from 2027 onward.

⁴ Hui He, Liuhanzi Yang, *China's Stage 6 emission standard for new light-duty vehicles (final rule)*, (ICCT: Washington, DC, 2017), <https://www.theicct.org/publications/chinas-stage-6-emission-standard-new-light-duty-vehicles-final-rule>.

⁵ Peter Mock, *Real-Driving Emissions test procedure for exhaust gas pollutant emissions of cars and light commercial vehicles in Europe*, (ICCT: Washington DC, 2017), <https://www.theicct.org/publications/real-driving-emissions-test-procedure-exhaust-gas-pollutant-emissions-cars-and-light>.

OTHER REGULATORY PROVISIONS

The CONAMA resolution establishing the L-7 and L-8 emission standards states that IBAMA will publish an updated technical standard for on-board diagnostics (OBD) system requirements for LDVs within 18 months of the publication of the resolution. This technical standard, OBD Br3, will apply to vehicles equipped with diesel or SI engines and will take as reference the United States OBD specifications.⁶

Test fuels used for homologation testing must follow specifications set by the National Agency of Petroleum, Natural Gas, and Biofuels (Agência Nacional do Petróleo, Gás Natural e Biocombustíveis). Of note is the fact that the current Brazilian specification for the maximum sulfur content of certification and commercial gasoline fuels, 50 ppm, is considerably greater than the 10 ppm limit set in other regions that have introduced stringent emission standards for LDVs like the United States, European Union, and China.

Data transparency provisions are included in the resolution. They require IBAMA to make data and information from the vehicle homologation process available to the public in an electronic format. Similar provisions were included in the PROCONVE L-6 standards, but IBAMA has not yet shared publicly the type-approval emissions data as required by the regulation.

The latest CONAMA resolution also requires IBAMA to establish a system for conformity of production (COP) assessment prior to the implementation of the L-7 standards in 2022. COP testing consists of checking production-line quality and testing production-line vehicles or engines using the same procedures as are used for pre-production compliance. Despite the introduction of COP testing, the Brazilian compliance program for LDVs falls short of matching international best practices established in other major vehicle markets. In places such as the United States, the European Union, and China, additional program components like in-use testing requirements help to track and maintain the emissions performance of vehicles throughout their useful lives.

INTERNATIONAL CONTEXT

PROCONVE NMHC/NMOG+NO_x emission limits for passenger vehicles are illustrated alongside comparable limits in U.S., EU, and Chinese regulatory programs for LDVs in Figure 4. The United States uses the same certification test cycle as Brazil, and as such, provides the most direct comparison. The L-7 NMOG+NO_x limit is 20% lower than the U.S. Tier 2 limit, while the L-8 limit, when the standards are fully implemented in 2029, is 61% greater than the final U.S. Tier 3 limit. L-7 and L-8 limits are also more restrictive than limits included in the Euro 6 and China 6a and 6b regulations, though different test cycles are used in these regions. In general, the L-7 and L-8 NMOG+NO_x emission limits compare favorably to international best practices.

⁶ Title 40 Part §86.1806, United States Code of Federal Regulations.

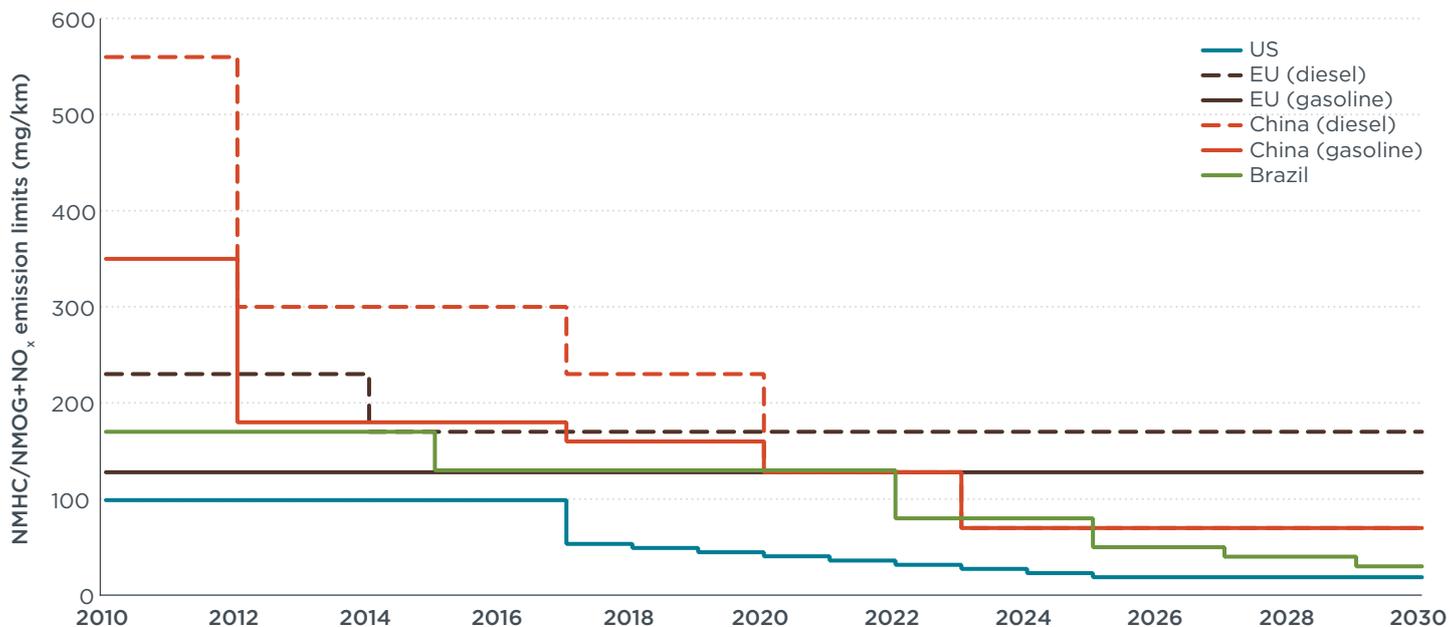


Figure 4. A comparison of NMOG/NMHC+NO_x emission requirements for PVs in Brazil, China, the European Union, and the United States, 2010-2030.

The more stringent evaporative emission limit, the challenging test procedures, and the new refueling emission limit introduced in the PROCONVE L-7 standards all follow similar provisions included in the China 6 emission standards, which will take effect beginning in 2020. In both countries, control of evaporative emissions is expected to be significantly improved and brought closer to the level achieved in the United States.

The L-7 and L-8 standards fall well short of international best practices with respect to in-use testing requirements. Post-production monitoring activities are a critical element in comprehensive vehicle emissions regulatory programs and have been implemented to varying degrees in many regions. Testing of in-use vehicles throughout their normal useful lifetime helps to ensure that vehicle emissions comply with pollutant limits and to identify systematic problems such as failures of emission-control system components. To date, Brazil has not required any post-production testing or monitoring of vehicles. This remains unchanged in the L-7 and L-8 standards.

Moreover, the relatively weak emission limits for LCVs and regulatory exemptions for vehicles with off-road characteristics in the L-7 and L-8 standards introduce the risk of incentivizing the sale of more-polluting vehicles. Figure 5 compares NMOG+NO_x and PM standards for LCVs in the United States and Brazil. Standards adopted in the Brazilian rulemaking are less stringent than U.S. Tier 3 standards, in particular for diesel LCVs in the L-7 phase. The L-7 PM limit of 20 mg/km can be met without a diesel particulate filter and, similarly, the 320 mg/km NMOG+NO_x limit can be met without aftertreatment. Given provisions for diesel LCVs to certify to higher emission levels than other LD vehicle types in the L-8 standard, as well compliance flexibilities introduced in this phase, best available emission control technologies are not likely to be employed in Brazilian diesel LCVs until the implementation of L-8 standards in 2025, if not later. Furthermore, both L-7 and L-8 standards maintain regulatory exemptions which allow vehicles with certain off-road characteristics to be certified as LCV. This exemption will continue to allow sport utility vehicles and pick-up trucks used primarily for passenger transport applications to emit more pollution than PVs used for similar applications.

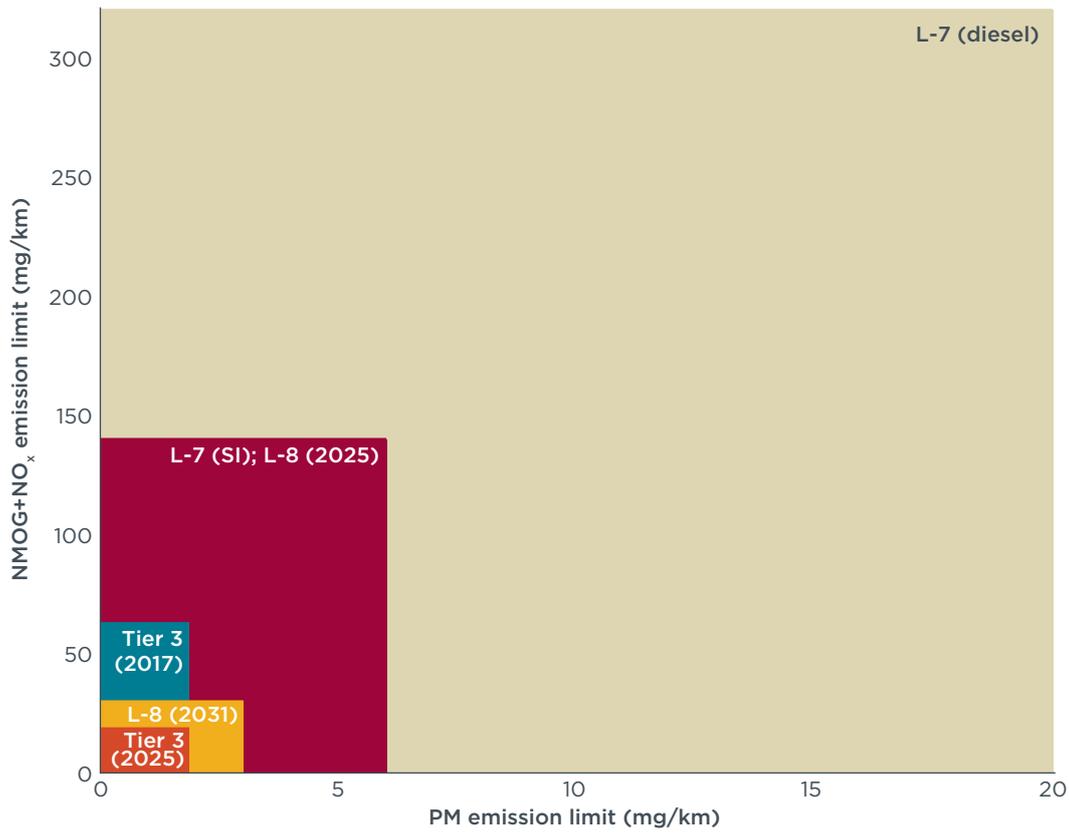


Figure 5. Comparison of NMOG+NO_x and PM emission requirements for LCVs in Brazil and the United States.