POLICY UPDATE

DECEMBER 2014

MEXICO HEAVY-DUTY VEHICLE EMISSIONS STANDARDS

ICCT **POLICY UPDATES** SUMMARIZE REGULATORY AND OTHER DEVELOPMENTS RELATED TO CLEAN TRANSPORTATION WORLDWIDE.

On December 1, 2014, COMARNAT, the national regulatory committee of the Secretariat of Environment and Natural Resources (SEMARNAT), approved a proposed update by SEMARNAT to existing emissions standards regulating particulate matter (PM), nitrogen oxides (NO_x), hydrocarbons (HC) and carbon monoxide (CO) from heavy-duty diesel engines and vehicles, including trucks, buses and large pickups and vans. The proposed modification of NOM-044-SEMARNAT-2006[1], *PROY-NOM-044-SEMARNAT-2014 which establishes maximum permissible emissions limits of total hydrocarbons, non-methane hydrocarbons, carbon monoxide, nitrogen oxides, and particles from the tailpipe of new motors that use diesel fuel and that are used in new vehicles with a gross vehicle weight greater than 3,857 kilograms, as well as new complete vehicles with gross vehicle weight greater than 3,857 kilograms that are equipped with these motors*, was published in the official federal diary of Mexico, on 17 December 2014. Publication opens a 60-day public comment period, after which another vote will be required in COMARNAT to finalize the standard.

The new standards would require new heavy-duty diesel vehicles sold after January 1, 2018, to meet emissions standards equivalent to those in the United States and European Union—EPA 2010 or Euro VI standards, respectively. The proposal to fully align with the prevailing US and European standards in 2018 will require new vehicles to be equipped with diesel particulate filters (DPFs), advanced NO_x aftertreatment, full on-board diagnostic (OBD) systems, and failsafes which ensure correct operation of emissions control systems.

BACKGROUND

Cleaner fuels are an important factor in reducing emissions from vehicles, and the proposed filter-based standards require ultralow-sulfur diesel with sulfur content no more than 15 parts per million (ppm). SEMARNAT is the sole agency responsible for emissions standards for new vehicles and has shared responsibility with the Ministry of Energy (SENER) for fuel quality standards. Fuel quality standards finalized in 2006

1 *PROY-NOM-044-SEMARNAT-2014, Que establece los límites máximos permisibles de emisión de hidrocarburos totales, hidrocarburos no metano, monóxido de carbono, óxidos de nitrógeno, y partículas provenientes del escape de motores nuevos que usan diesel como combustible y que se utilizarán para la propulsión de vehículos automotores nuevos con peso bruto vehicular mayor de 3,857 kilogramos, así como para unidades nuevas con peso bruto vehicular mayor a 3,857 kilogramos equipadas con este tipo de motores.* DOF: XX/12/2014: http://dof.gob.mx/XXX

(NOM-086-SEMARNAT-SENER-SCFI-2005) required diesel fuel throughout the country to meet ultralow-sulfur standards by September 2009. While the border region and major metropolitan areas of Mexico City, Guadalajara and Monterrey are all supplied with 15 ppm sulfur diesel, the rest of the country continues to be supplied with diesel containing up to 500 ppm sulfur, in violation of NOM-086. The recent energy sector reform in Mexico will open the market to external fuel providers starting in 2016 and allow imports of fuels in 2017. Regulatory authority for fuel specifications has also been transferred to the Energy Regulatory Commission (CRE). These reforms have provided the necessary assurance that fuel quality will not be a barrier to implementation of the proposed standards.

Emissions standards for heavy-duty diesel vehicles were first established in 1993, aligning Mexico with the U.S. standards in force at the time. The 2006 update for these emissions standards, NOM-044-SEMARNAT-2006, introduced the option for compliance with either U.S. or European Union standards and set requirements through June of 2011. Because there was still no clarity regarding the timeline for compliance with NOM-086, these standards were extended through June 2014. In June 2014, with work underway on the current proposal, an additional extension was granted until publication of the replacement for the existing standard.

Figure 1 shows the progression of historical and proposed standards for Mexico, along with the timeline for U.S. and European standards.

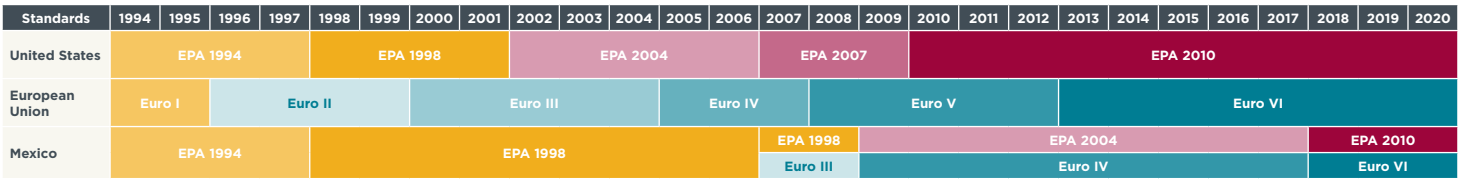

Figure 1. Heavy-duty diesel emissions standards in the U.S., European Union, and Mexico

THE CURRENT SITUATION

The current standard, NOM-044-SEMARNAT-2006, was published by SEMARNAT in 2006 and is enforced by Profepa, the autonomous arm of SEMARNAT that determines compliance with standards. NOM-044 sets standards for PM, NO_x, CO, HC and opacity from engines used in heavy-duty vehicles with a gross vehicle weight of more than 3,857 kg or from new complete vehicles of the same weight class. The limit values set by these standards are equivalent to Euro IV or EPA 2004 standards. These two compliance options differ significantly in several ways, including emissions levels, technologies and in-use performance, compliance costs, and fuel quality requirements.

Key differences between the two compliance options include:

- *PM emissions:* Euro IV standards require significantly lower PM emissions than EPA 2004 standards. Since neither standard requires use of a particulate filter or regulates total particle number, emissions of ultrafine particles are similar under the two standards.
- *NO_x emissions and controls:* While Euro IV certification limits for nitrogen oxides (NO_x) are slightly higher than those of EPA 2004, the more stringent PM limits under Euro IV result in the use of more costly and complex technologies to control NO_x emissions. Euro IV standards require the use of selective catalytic reduction (SCR) to control NO_x, which allows for PM reductions through changes in engine tuning. Unfortunately, the SCR systems used for Euro IV vehicles have not been effective in controlling real-world NO_x emissions, especially in urban areas. As a result, NO_x controls are both more costly and less effective under Euro IV than under EPA 2004.
- *Compliance costs:* Due to the added cost of SCR systems, Euro IV vehicles have a higher upfront cost than EPA 2004 vehicles. While the changes in engine tuning also reduce the fuel consumption of Euro IV vehicles compared to EPA 2004 vehicles, SCR systems require use of a diesel exhaust fluid (DEF), the cost of which slightly offsets the fuel savings.
- *Fuel quality requirements:* Euro IV vehicles are certified for use with 50 ppm sulfur fuel, much lower than the 500 ppm sulfur fuel available throughout Mexico. Only urban buses that have access to lower sulfur fuel are more likely to be Euro-certified vehicles.

As a result of all these factors, EPA 2004 has been the dominant compliance option, capturing approximately 90 percent of the new heavy-duty vehicle market in Mexico.

KEY ELEMENTS OF THE PROPOSED REGULATION

The proposed regulation will still apply to diesel engines or full vehicles with a gross vehicle weight above 3,857 kg. Table 1 shows the timing and certification requirements of the proposed standard. Standard A, in force from the adoption of the proposal through 2017, is essentially the same as the current NOM-044 standard; starting in 2018, Standard B requires proof of certification to either Euro VI/6 or EPA 2010 standards. The current NOM-044 standard allows results from a testing laboratory to be submitted as proof of conformity with the standards. Because Profepa does not have the staffing resources or technical capacity to complete the type of auditing and enforcement done by EPA and by the type approval authorities of EU member-states, the option to certify in Mexico through submission of laboratory test results has been eliminated in the current proposal. In the proposed standard, proof of EPA certification or Euro type approval will have to be provided for all engines or new vehicles sold in Mexico.

Table 1. Framework of the proposed standards

Timeframe	NOM-044 Standard	Certification requirement
2015-2017	1A	EPA 2004
	2A	Euro IV
Beginning Jan. 1, 2018	1B	EPA 2010
	3B	
	2B	Euro VI
	4B	Euro 6

As shown in Figure 2, unlike the Euro IV and EPA 2004 standards, Euro VI and EPA 2010 are functionally equivalent, with very similar limit values for NO_x and PM emissions. Comparing Standards A and B, certification limits are 50%-93% lower for PM and 85%–93% lower for NO_x. Real world emissions reductions are expected to be even more substantial, with modeled emissions factors suggesting 90%–98% reductions for PM and 93%–95% reductions for NO_x. Both compliance options require strong and complete OBD systems, which will be fully phased in under both Euro and EPA standards by 2018. Additionally, each option requires warnings and driver inducements to ensure proper use of DEF in SCR systems.

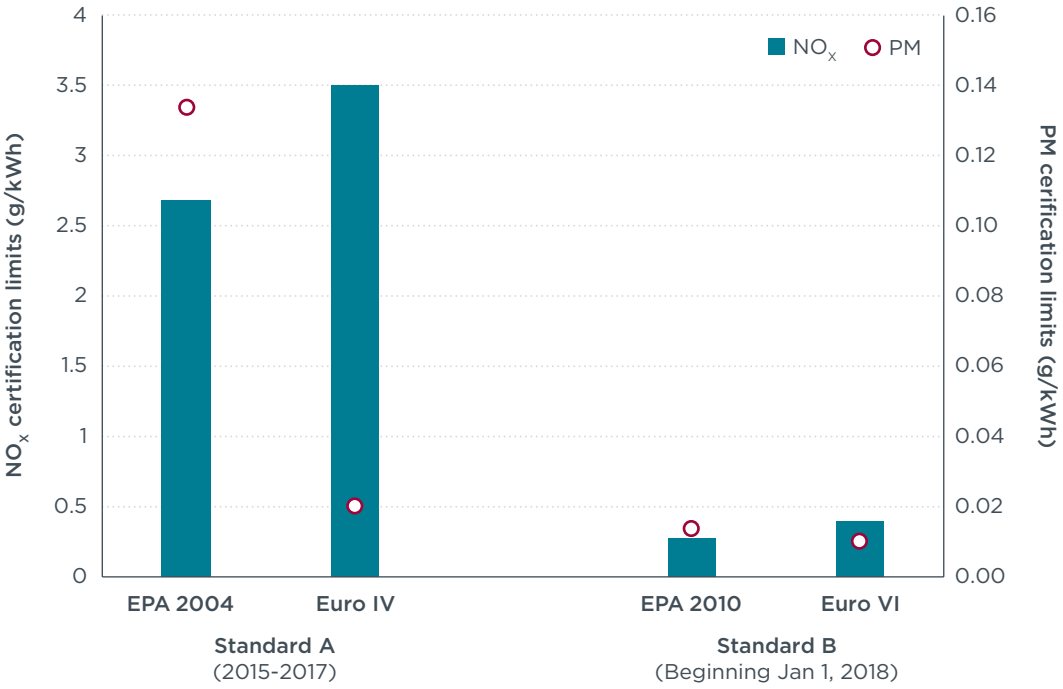

Figure 2. Heavy-duty diesel emissions certification limits in the U.S., European Union, and Mexico

LIMIT VALUES

Limit values for heavy-duty engines are shown in Table 2. Limits are set in grams per brake horsepower-hour (g/bhp-hr) for EPA 2004 and EPA 2010 standards, and are in grams per kilowatt-hour (g/kWh) for Euro IV and Euro VI standards.[2] The limits for opacity included in the current NOM-044 standard were eliminated in the proposal as they are no longer relevant to filter-based technologies. Particle number and ammonia (NH_3) limits are set as part of the Euro VI standards but have not been defined as limit values under EPA standards.

Table 2. Certification limit values for heavy-duty engines

Certification requirement	Standard	Test Method	CO	NO_x	NMHC	HCNM + NO_x	PM	Particle Number (#/kWh)	NH_3
			g/bhp-hr						
EPA 2004	1A	SET & FTP	15.5	—	—	2.4	0.10	—	—
					0.5	2.5		—	—
EPA 2010	1B	SET & FTP	15.5	0.20	0.14	—	0.01	—	—

Certification requirement	Standard	Test Method	CO	NO_x	NMHC	HC	PM	Particle Number (#/kWh)	NH_3
			g/kWh						
Euro IV	2A	ESC	1.5	3.5	—	0.46	0.02	—	—
		ETC	4.0	3.5	0.55	—	0.03	—	—
Euro VI	2B	WHSC	1.5	0.4	—	0.13	0.01	8.0×10^{11}	10
		WHTC	4.0	0.46	—	0.16	0.01	6.0×10^{11}	10

The proposal defines the useful life as the reference values (measured in vehicle-km and years) that are used in durability tests for new engine or vehicle certification. Useful life does not refer to in-use vehicle emissions, nor is it equivalent to the manufacturer warranty. Table 3 provides useful life requirements under the proposed standard. Requirements have not changed under EPA regulations, but Euro VI standards have increased the distance requirements so that they now more closely match EPA standards.

Table 3. Useful life requirements

Certification requirement	Standard	Gross Vehicle Weight (kg)	Useful Life	
			Distance (km)	Time (years)
EPA 2004 & EPA 2010	1A & 1B	3,857 – 8,845	177,023	10
		8,846 – 14,970	297,721	
		14,971 and larger	700,046	
Euro IV	2A	3,857 – 15,999	200,000	6
		16,000 and larger	500,000	7
Euro VI	2B	3,857 – 15,999	300,000	6
		16,000 and larger	700,000	7

2 Figure 1 compares the standards on an equivalent g/kWh, although differences in test cycles introduce error into the comparison.

The proposed standard includes optional alternative certification limits for medium-duty complete vehicles starting in 2018. The 2015-2017 standards do not include options for complete vehicle certification because these options are only available in the EPA 2010 and Euro VI standards. Table 4 includes the optional pathways for certification of complete vehicles.

Table 4. Certification limit values and useful life requirements for medium-duty vehicles

Certification option	Standard	Gross vehicle weight (kg)	Test cycle	CO	NO_x	NMHC	PM	Particle Number (#/km)	Useful Life	
				g/km					km	years
EPA 2010	3B	3,857 – 4,539	FTP 75	—	0.124	0.121	0.012	—	177,023	10
		4,540 – 6,350		—	0.249	0.143	0.012	—		
Certification option	**Standard**	**Reference mass (kg)**	**Test cycle**	**CO**	**NO_x**	**HC+NO_x**	**PM**	**Particle Number (#/km)**	**Useful Life**	
				g/km					km	years
Euro 6	4B	≤2,840	NCEP	0.74	0.125	0.215	0.005	6.0×10^{11}	160,000	5

The 3B pathway was introduced because EPA 2010 standards provide an option to certify vehicles with a gross vehicle weight rating (GVWR) of less than 6,350 kg as complete vehicles on a chassis dynamometer, using the same FTP 75 drive test cycle that is used for light-duty emissions standards. The g/km limit values included in the proposal are taken directly from EPA 2010 heavy-duty emissions standards.

The 4B pathway was introduced due to a change in metrics for weight ratings in Euro VI standards for heavy-duty vehicles and Euro 5 and 6 standards for light-duty vehicles. The previous European standards had defined heavy-duty vehicles as having a technically permissible maximum laden mass[3] greater than 3.5 tons, whereas the new standards define heavy-duty vehicles according to their reference, or unloaded, mass. This change means that some vehicles sold will have a GVWR higher than 3,857 kg but a reference mass below the 2,610 kg cut-off under European standards. These vehicles would then be subject to light-duty Euro 6 standards (Regulation 692/2008), rather than heavy-duty Euro VI standards (Regulation 595/2009). In order to ensure that any vehicle certified to Euro 6 standards could be sold in Mexico, the proposed standard makes complete vehicle certification an option for all vehicles with a reference mass less than or equal to 2,840 kg, the maximum allowable under light-duty Euro 6 standards.[4]

ON-BOARD DIAGNOSTICS AND COMPLIANCE INDUCEMENTS

The proposed standards require the installation and operation of full OBD systems on all new vehicles. The type of OBD system must be recorded in the certification documentation. Appendix B of the proposal provides a detailed explanation of the

3 Maximum laden mass is defined in a very similar manner as GVWR, as the total curb weight of the vehicle plus its maximum recommended load of passengers and cargo.

4 Euro 6 and VI standards for light- and heavy-duty vehicles both define the cut-off as reference mass of 2,610 kg. Each standard, however, includes some margin of flexibility up to 2,840 kg if requested by manufacturers. In order to ensure that any vehicle approved for sale in the EU market can also be certified for sale in Mexico, the maximum allowable reference mass was incorporated into this proposal.

general system requirements and attendant documentation. As both EPA and Euro standards require the full phase-in of OBD systems before 2018, the proposal relies on certification documentation as the primary proof of compliance with OBD requirements.

Similarly, the proposal requires that new vehicles and engines that use a reagent for NO_X-reducing SCR systems are also equipped with operating alerts and driver inducements to ensure the correct functioning of these systems. These failsafes include lights, auditory alarms and requirements to safely limit vehicle operation in the case of improper use, such as poor quality DEF or insufficient DEF supply. Appendix C provides a detailed explanation of the system requirements and attendant documentation. The EPA and Euro regulations have similar system requirements, and certification remains the primary proof of compliance.

PROVISIONAL LIMITATIONS

The proposal includes five *transitorios,* or provisional limitations to the standard. The first two and the final provisions are common limitations, specifying that the standard comes into force 60 days after publication, that it replaces the existing NOM-044 standard, and that currently valid certificates issued under the existing standard will be valid until the application of the B standards established under the new proposal.

Two additional provisions are more unique to this proposal. The third provision states that in January 2017, SEMARNAT will evaluate the national availability of ultralow-sulfur diesel in order to determine if the conditions exist for compliance with the B standards. In the case that availability is insufficient, the Secretary will delay the entry into force of the B standards by 12 months. Given that ultralow-sulfur diesel is still not available nationwide and fuel quality compliance has a poor track record, this provision is intended to protect manufacturers from costs that could be incurred by a delay in application of the fuel standard.

The fourth provision allows manufacturers to sell existing inventories of vehicles that were produced during the application of standard A for up to six months after the implementation of standard B. The intent is to provide a reasonable period of transition while protecting against stockpiling of old inventory.

EXPECTED EFFECTS OF THE REGULATION

These world-class standards will bring significant air quality, health, and climate benefits, along with multiple co-benefits for industry and consumers. The cost-benefit analysis of the proposed standards, done in part using the ICCT Roadmap Model Health Module, estimated that in the year 2037 the new standards will result in:

- Prevention of 6,800 premature deaths from exposure to $PM_{2.5}$ emissions in urban areas
- Reduction of 24,000 tons of $PM_{2.5}$, 17,000 tons of black carbon, and 410,000 tons of NO_X
- Health benefits valued at US$22 billion to $30 billion, compared with combined incremental operating and technology costs of $1.8 billion

The cumulative benefits over the years 2018 to 2037 include:

- Climate benefits from reduced black carbon emissions equivalent to avoiding the release of 54 million tons of CO_2 (using a 20-year global warming potential)
- Net economic benefits of up to $123 billion

Moreover, these figures do not take into account the savings in fuel consumption expected from new and more efficient engines. The proposed standards will also confer significant additional but as yet unquantified health benefits, including reductions in asthma, bronchitis, stroke, heart attack and other heart and lung disorders.

INTERNATIONAL CONTEXT

The proposed revisions to NOM-044 place Mexico at the forefront of clean vehicle policy in Latin America and amid other major vehicle markets worldwide. Starting in 2018, the standards will virtually eliminate fine particle and black carbon emissions from new diesel trucks and buses. Mexico stands to become the first middle-income country in the world to adopt and implement world-class, filter-based standards for heavy-duty vehicles. As shown in Figure 3, only the U.S., Canada, Japan, European Union, and South Korea have adopted such standards.

Within Latin America, many countries have made or are planning to make dramatic improvements in diesel quality. Mexico's proposal demonstrates the viability of skipping interim emissions standards and moving directly to best-practice standards as soon as a reliable timeline for ultralow-sulfur fuel is established. Filter-based standards are necessary to get the full benefits of clean fuel investments that have been made throughout the region:

- Chile has met nationwide ultralow-sulfur diesel standards since 2013.
- Brazil—the largest vehicle manufacturer in the region—and Argentina have both made ultralow-sulfur diesel available at fuel stations throughout the country.
- Uruguay's only refinery now produces 10 ppm sulfur diesel.
- Venezuela and Ecuador are jointly investing in new refinery facilities to produce ultralow-sulfur diesel.
- Costa Rica, Colombia and Peru already have or will soon require 50 ppm sulfur fuel nationwide; much of the diesel fuel imported to Costa Rica and Colombia already contains only 15 ppm sulfur.

Timeline for adopted nationwide heavy-duty emissions standards (all sales & registrations)

Group	Region	2014	2015	2016	2017	2018	2019	2020
Other selected markets	US & Canada	EPA 2010						
	EU	Euro VI						
	Japan	PNLTES						
	South Korea	Euro V	Euro VI					
	Australia	Euro V/EPA 2007/JE05						
	Russia	Euro IV		Euro V				
	China	China IV						
	India	Bharat III						
Latin America	Mexico	EPA 2004/Euro IV				EPA 2010/Euro VI		
	Brazil	P-7						
	Argentina	Euro IV		Euro V				
	Chile	Euro IV		Euro V				
	Colombia	Euro II	Euro IV					
	Peru	Euro III						
	Uruguay	Euro III						
	Ecuador	EPA 94/Euro II						
	Costa Rica	Euro I						
	Venezuela	EPA 88/Euro I						

Euro-equivalent

Pre-Euro II	II	III	IV	V	VI

Figure 3. Timeline for adopted nationwide heavy-duty emissions standards (all sales and registrations)