POLICY UPDATE

DECEMBER 2017

FUEL CONSUMPTION STANDARDS FOR HEAVY-DUTY VEHICLES IN INDIA

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

On August 16, 2017, the government of India, in consultation with the Bureau of Energy Efficiency (BEE), published final fuel-efficiency standards for commercial heavy-duty vehicles (HDVs). The regulatory process formally started on July 1, 2014, when the Ministry of Petroleum and Natural Gas (MoPNG) convened a steering committee to guide the development of fuel-consumption norms for heavy-duty vehicles in India. The regulations were developed through a combined effort of the Ministry of Road Transport and Highways (MoRTH), the Petroleum Conservation and Research Association (PCRA, which is part of MoPNG), BEE, and various other stakeholders.

The regulation is the government's response to India's rapidly growing commercial vehicle sector. Driven by economic growth, India's diesel consumption has doubled in the past decade, increasing from 36.6 million metric tonnes (MMT) in 2002 to 72.9 MMT in 2015 (MoPNG, 2016). In India, HDVs account for a greater share of transportation petroleum end-use than in wealthier countries where passenger cars tend to dominate.

The regulations are aimed at reducing fuel consumption and greenhouse gas (GHG) emissions from diesel-powered trucks and buses with a gross vehicle weight (GVW) of 12 tonnes or greater. Indian HDVs greater than 12 tonnes represent about 60% of total fuel use and GHG emissions from the entire HDV fleet—that is, all HDVs greater than 3.5 tonnes. With trucks and buses less than 12 tonnes accounting for approximately 40% of fuel use and emissions, we encourage regulators in India to pursue fuel efficiency norms for these smaller commercial vehicles as soon as possible.

REGULATORY REQUIREMENTS

The new standards include two phases of regulatory compliance. Phase 1 goes into effect April 1, 2018, while Phase 2 is effective beginning April 1, 2021. The regulatory classes affected by this rule are as follows (Vahan Sewa, 2017):

- Category M3: motor vehicles for the carriage of passengers, comprising nine or more seats in addition to the driver's seat with GVW exceeding 5 tonnes
- Category N3: motor vehicles for the carriage of goods with GVW exceeding 12 tonnes

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Although the M3 regulatory subclass includes vehicles 5 tonnes and above, the rule applies only to vehicles greater than 12 tonnes GVW. Tables 1 and 2 summarize the limit value equations for all of the subcategories within the M3 and N3 vehicle classifications.

The standards are represented in an equation based on GVW and axle configuration, providing normalized values of fuel consumption in liters per hundred kilometers (l/100 km). The regulations are a minimum performance requirement, similar to the existing Bharat Stage (BS) emission norms. To demonstrate compliance, each vehicle model and configuration is required to meet the fuel consumption levels shown in Tables 1 and 2. This stands in contrast to the fuel consumption and greenhouse gas standards in the United States and Canada, which are based on sales-weighted averaging.

For evaluating the performance of the vehicles, manufacturers are required to use a constant speed fuel consumption (CSFC) driving cycle. This means that the fuel consumption is measured over a set speed without any transient behavior. In this particular regulation, the CSFC test is run at two separate speeds—one at 40 km/h, and the other at 60 km/h. The CSFC testing has been used in India as part of the vehicle certification process for several years (Sharpe & Delgado, 2015). The CSFC cycle is different from the regulatory cycles adopted in HDV standards for other countries. The four countries that currently have HDV fuel-efficiency standards in place —Japan, the United States, Canada, and China—all evaluate vehicles over cycles that include some portion of urban, stop-and-go driving. The vehicle weights for the CSFC cycle are defined by Indian Standard 9211 (Org.1979, Rev. 2003), and the test protocols are defined in Indian Standard 11921:1993. The test is conducted at the gross vehicle weight of the testing vehicle.

The efficiency standards are required for both vehicle manufacturers and importers. The conformity-of-production test will be undertaken by MoRTH once every two years. The CSFC testing and reporting also needs to be done at least once before April 1, 2020. There is no such requirement before Phase 1 goes into effect April 1, 2018, because the standards reflect averages found in HDV baseline testing between 2014 and 2015.

Table 1. Stringency equations for Phase 1 (effective April 1, 2018)

Vehicle Category	Gross vehicle weight (tonnes)	Axle configuration	Equation	Fuel consumption (l/100km)	
				Value at lower weight limit	Value at upper weight limit
40 kilometers per hour					
N3 Rigid Vehicles	12.0-16.2	4x2	Y = 0.362X + 10.327	14.7	16.2
	16.2-25.0	6x2	Y = 0.603X + 6.415	16.2	21.5
	16.2-25.0	6x4	Y = 0.723X + 4.482	16.2	22.6
	25.0-31.0	8x2	Y = 0.527X + 8.333	21.5	24.7
	25.0-31.0	8x4	Y = 0.928X - 0.658	22.5	28.1
	31.0-37.0	10x2	Y = 0.960X - 5.100	24.7	30.4
N3 Tractor Trailers	35.2-40.2	4x2	Y = 0.986X - 7.727	27.0	31.9
	40.2-49.0	6x2	Y = 0.628X + 6.648	31.9	37.4
	40.2-49.0	6x4	Y = 1.255X - 18.523	31.9	43.0
M3 Vehicles	12.0 and above	4x2 and 6x2	Y = 0.509X + 11.062	17.2	
60 kilometers per hour					
N3 Rigid Vehicles	12.0-16.2	4x2	Y = 0.788X + 9.003	18.5	21.8
	16.2-25.0	6x2	Y = 0.755X + 9.546	21.8	28.4
	16.2-25.0	6x4	Y = 1.151X + 3.122	21.8	31.9
	25.0-31.0	8x2	Y = 0.650X + 12.160	28.4	32.3
	25.0-31.0	8x4	Y = 0.968X + 7.692	31.9	37.7
	31.0-37.0	10x2	Y = 0.650X + 12.160	32.3	36.2
N3 Tractor Trailers	35.2-40.2	4x2	Y = 0.208X + 32.198	39.5	40.6
	40.2-49.0	6x2	Y = 0.628X + 15.298	40.5	46.1
	40.2-49.0	6x4	Y = 1.342X - 13.390	40.6	52.4
M3 Vehicles	12.0 and above	4x2 and 6x2	Y = 0.199X + 19.342	21.7	

Table 2. Stringency equations for Phase 2 (effective April 1, 2021)

Vehicle Category	Gross vehicle weight (tonnes)	Axle configuration	Equation	Fuel consumption (l/100km)	
				Value at lower weight limit	Value at upper weight limit
40 kilometers per hour					
N3 Rigid Vehicles	12.0-16.2	4x2	Y = 0.329X + 9.607	13.6	14.9
	16.2-25.0	6x2	Y = 0.523X + 6.462	14.9	19.5
	16.2-25.0	6x4	Y = 0.673X + 4.032	14.9	20.9
	25.0-31.0	8x2	Y = 0.430X + 8.780	19.5	22.1
	25.0-31.0	8x4	Y = 0.732X + 2.558	15.7	20.1
	31.0-37.0	10x2	Y = 0.963X - 7.753	22.1	27.9
N3 Tractor Trailers	35.2-40.2	4x2	Y = 0.826X - 3.165	25.9	30.0
	40.2-49.0	6x2	Y = 0.630X + 4.732	20.6	26.1
	40.2-49.0	6x4	Y = 1.008X - 10.480	30.0	38.9
M3 Vehicles	12.0 and above	4x2 and 6x2	Y = 0.659X + 6.582	14.5	
60 kilometers per hour					
N3 Rigid Vehicles	12.0-16.2	4x2	Y = 0.600X + 9.890	17.1	19.6
	16.2-25.0	6x2	Y = 0.515X + 11.271	19.6	24.6
	16.2-25.0	6x4	Y = 0.932X + 4.515	19.6	27.8
	25.0-31.0	8x2	Y = 0.382X + 14.598	24.2	26.4
	25.0-31.0	8x4	Y = 1.318X - 5.148	27.8	35.7
	31.0-37.0	10x2	Y = 1.043X - 5.913	26.4	32.7
N3 Tractor Trailers	35.2-40.2	4x2	Y = 0.260X + 27.888	37.0	38.3
	40.2-49.0	6x2	Y = 0.2364X + 28.838	38.3	40.4
	40.2-49.0	6x4	Y = 0.563X + 15.728	38.4	43.3
M3 Vehicles	12.0 and above	4x2 and 6x2	Y = 0.340X + 14.300	18.4	

The values shown in Tables 1 and 2 apply to all vehicles that are subject to the BS-IV norms. The ruling declares that for all vehicles complying with BS-VI norms, a correction factor will be introduced as an addendum to the current regulations.

The required fuel-consumption levels for Phase 1 and Phase 2 for rigid trucks at 40 km/h are shown in Figure 1. The figure represents the fuel-consumption values for the lower weight limit of a particular segment. The average fuel consumption decreases 7-10% between Phase 1 and Phase 2 for N3 rigid trucks on the 40 km/h cycle. Figures for all other duty cycles can be found in Appendix A. In all of these figures that summarize the maximum fuel consumption limits, we assume the minimum weight for a given weight range. For example, for the 25 to 30 tonne weight category of rigid trucks, we assign the vehicle a weight of 25 tonnes to determine the limit values shown in Figure 1.

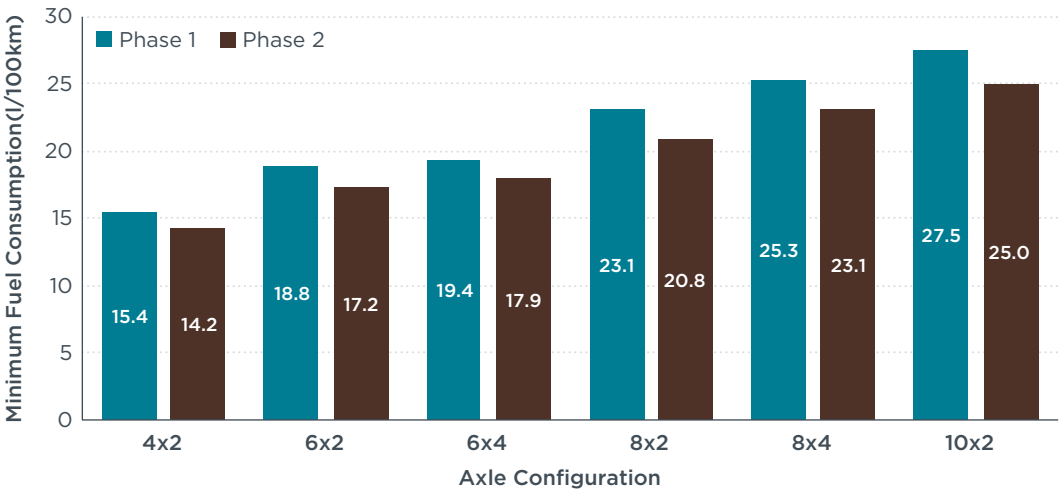

Figure 1. Phase 1 and Phase 2 fuel consumption limit values at 40 km/h for N3 rigid trucks by axle configuration

BASELINE DETERMINATION

The final rules are based on actual testing data collected by various HDV testing agencies in India between 2014 and 2015. As per internal government records, the Phase 1 stringency for each vehicle subcategory represents the average fuel consumption from CSFC testing. Thus, starting April 1, 2018, for every segment of the market, the maximum allowable fuel consumption is equal to the average fuel consumption from the baseline testing campaign. The Phase 2 stringency represents the 20th percentile of the baseline testing data, meaning that 20% of the baseline vehicles had fuel consumption levels lower than the limit curve.

FUEL CONSUMPTION STRINGENCY: PHASE 1 TO PHASE 2

Assuming equal weighting for the two test cycles, an estimated fuel-consumption reduction from Phase 1 to Phase 2 can be calculated as shown in Table 3. The average stringency is calculated using sales weighting, which comes from data that was acquired from Segment Y Automotive Intelligence for the year 2013-2014.

Table 3: Required reduction in fuel consumption from Phase 1 to Phase 2 and market shares by vehicle category in fiscal year 2013-14

	GVW Bin (tonnes)	Axle Configuration	Required fuel-consumption reduction between Phases 1 and 2	Market Share
Rigid truck	12.0-16.2	4x2	8.2%	23.3%
	16.2-25.0	6x2	10.7%	13.9%
	16.2-25.0	6x4	9.6%	16.8%
	25.0-31.0	8x2	13.3%	12.9%
	25.0-31.0	8x4	8.9%	6.5%
	31.0-37.0	10x2	11.5%	0.5%
Tractor-trailer	35.2-40.2	4x2	5.4%	8.9%
	40.2-49.0	6x2	7.2%	0.0%
	40.2-49.0	6x4	10.0%	2.6%
Bus	12.0 and above	All Configuration	15.5%	14.5%
Sales-weighted average stringency			**10.4%**	

The Phase 1 to Phase 2 stringency analysis shows that transit buses face the largest reduction in fuel consumption from 2018 to 2021 at 15.5%. The fleet-wide fuel-consumption reduction from Phase 1 to Phase 2 is estimated at 10.4%. This is calculated on a vehicle-population weighted average and therefore is not necessarily representative of the overall fuel savings that will be achieved as a result of the regulation. This is due to the difference in fuel consumption that the different vehicle configuration may have. For example, changing the stringency of for a tractor-trailer by 1% will not have the same result as changing the value for a rigid truck.

Because the regulation applies only to trucks and buses greater than 12 tonnes GVW, a significant percentage of the HDV market in India is not subject to these standards. Sales data from Segment Y provides evidence that nearly half of the HDV market is less than 12 tonnes and thus is not covered by this regulatory program. Figure 2 represents the cumulative market share of HDVs in India.

As shown in Figure 2, 66% of buses and 37% of trucks are not covered by these norms. Moreover, a sizeable portion of rigid trucks are rated at 11.9 tonnes, and it is conceivable that an increasing share of trucks that would otherwise weigh slightly more than the 12-tonne threshold would be designed to weigh in just less than 12 tonnes to avoid the regulatory requirements. Therefore, it is imperative that the standards be extended to cover all HDVs greater than 3.5 tonnes to minimize the potential for unintended market distortions and opportunities for gaming the system.

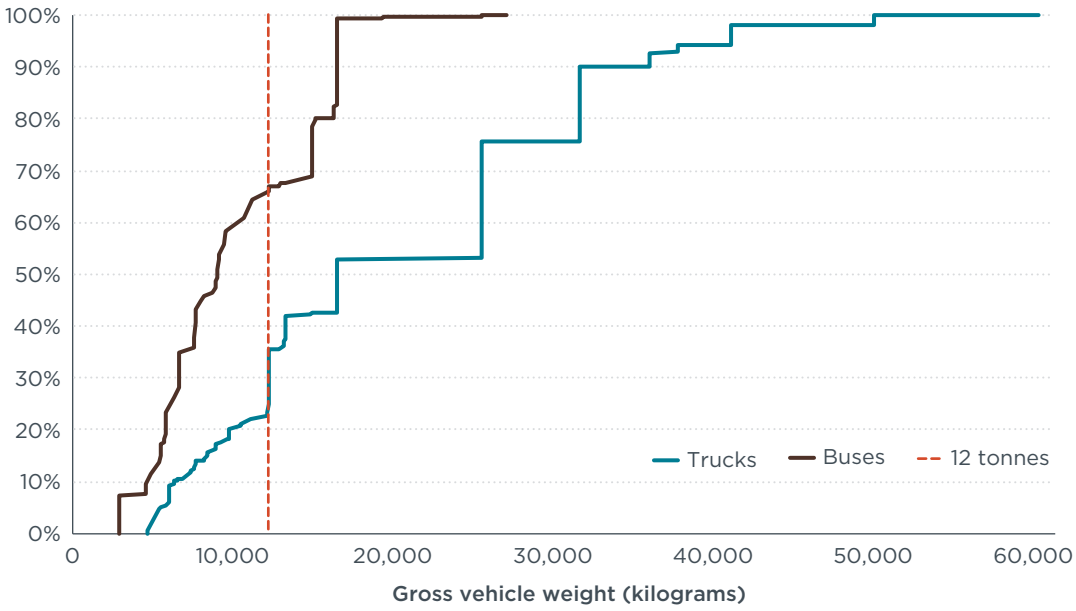

Figure 2. Cumulative market share by vehicle gross vehicle weight in fiscal year 2013-14

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APPENDIX: FUEL CONSUMPTION LIMIT VALUES

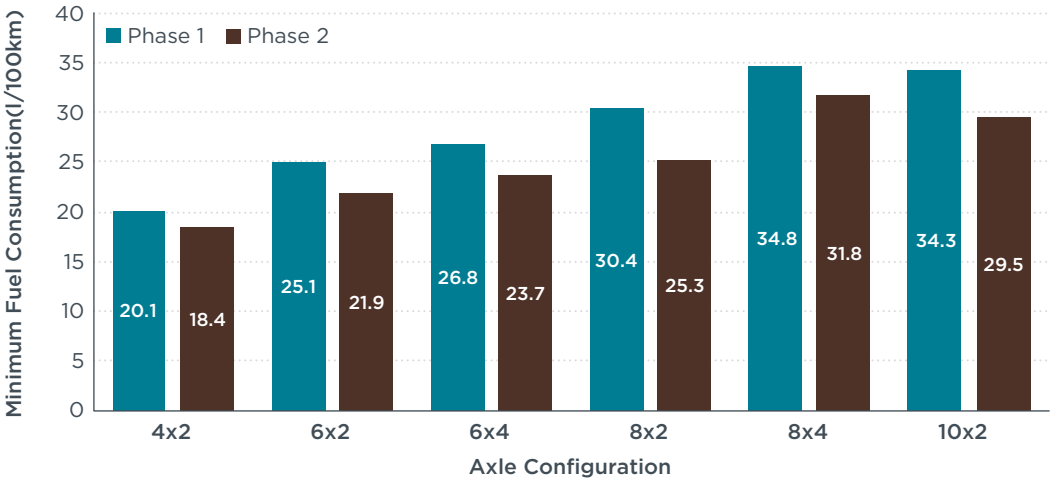

Figure A1. Phase 1 and Phase 2 fuel consumption limit values at 60 km/h for N3 rigid trucks by axle configuration

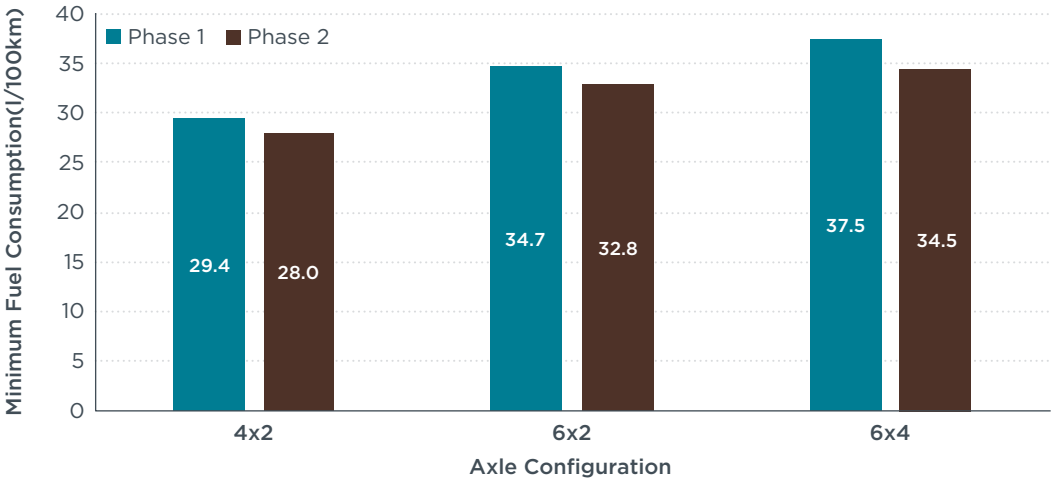

Figure A2. Phase 1 and Phase 2 fuel consumption limit values at 40 km/h for N3 tractor-trailers by axle configuration

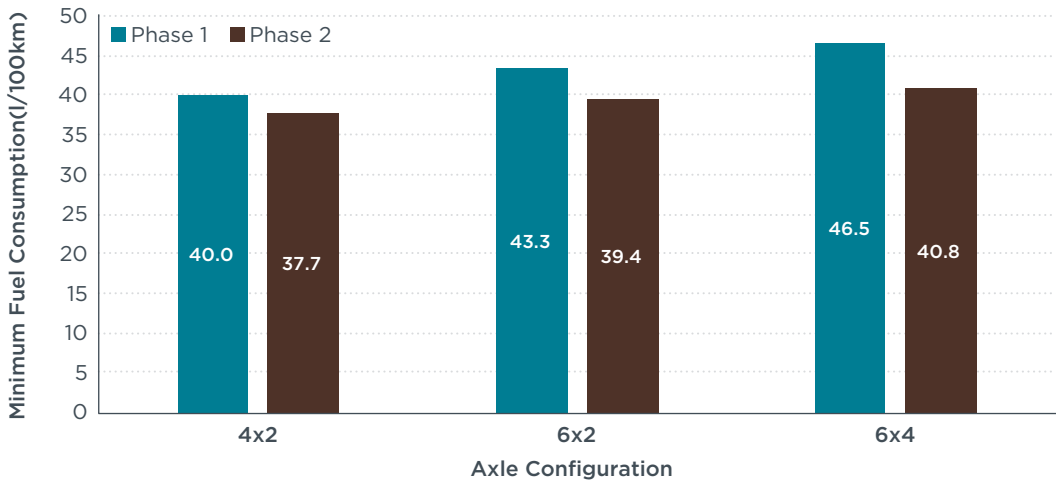

Figure A3. Phase 1 and Phase 2 fuel consumption limit values at 60 km/h for N3 tractor-trailers by axle configuration

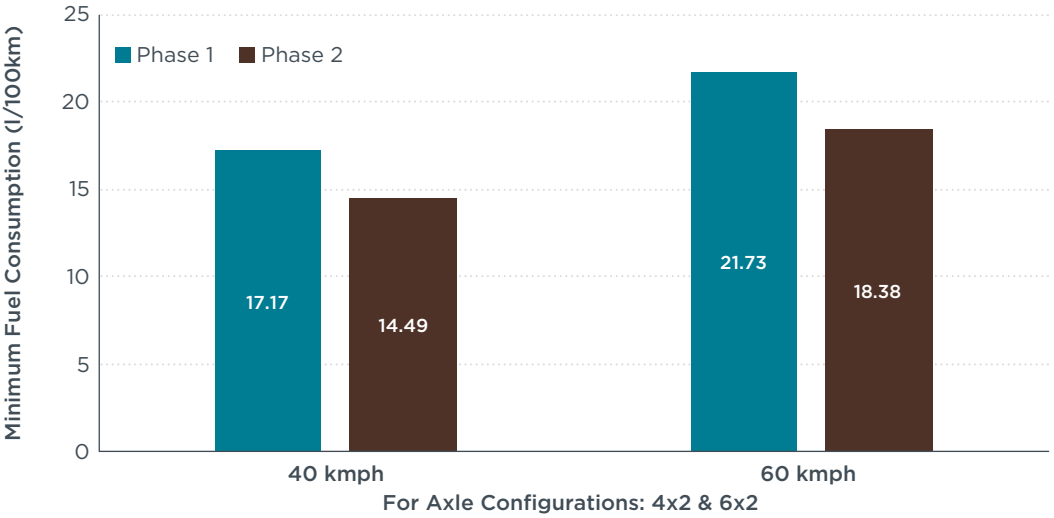

Figure A4. Phase 1 and Phase 2 fuel consumption limit values for M3 buses