

BHARAT STAGE IV EMISSION STANDARDS FOR TWO-WHEELERS IN INDIA

ICCT POLICY UPDATES

SUMMARIZE

REGULATORY

AND OTHER

DEVELOPMENTS

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On July 4, 2014, India finalized the fourth stage of emission standards for motorized two-wheeled vehicles. The Bharat Stage (BS) IV standards will go into effect for type approval of new motorcycle models in April 2016, and for all motorcycle models in April 2017. The new standards tighten the HC+NO_x emission limits compared with the existing BS III standards by 23%–60%, depending on motorcycle category. The other significant change to the regulation is the adoption of the Worldwide Harmonized Motorcycle Test Cycle (WMTC) as the mandatory test cycle. With this change, India has harmonized the testing cycle as well as the definition of motorcycle categories as per United Nations Economic Commission for Europe (UNECE) Global Technical Regulation 2 (GTR-2). In addition, the new regulation establishes the first evaporative emission standards for two-wheelers in India. Lastly, BS IV establishes that crankcase emissions from BS IV motorcycles are prohibited from release into the atmosphere.

The text of the BS IV two-wheeler regulation can be found in the *Gazette of India* [here](#).¹

TWO-WHEELER BHARAT STAGE IV EMISSION STANDARDS

The Bharat Stage IV standards cover motorized two-wheeled vehicles with engine displacement volume above 50 cubic centimeters (cc) and a maximum design speed above 50 km/h ($V_d > 50$ cc, $V_{Max} > 50$ km/h). Table 1 shows the Current BS III two-wheeler limits and the newly approved BS IV limits.

The most significant change in the regulation is the adoption of a new testing protocol. Emission testing for Bharat IV will be carried out under the Worldwide Harmonized Motorcycle Test Cycle (WMTC) following the United Nations Economic Commission for Europe (UNECE) Global Technical Regulation 2 (GTR-2). The WMTC differs considerably from the current BS III emission test cycle, the Indian Driving Cycle (IDC). The WMTC better reflects real driving conditions, with higher maximum speed and steeper acceleration ramps than the IDC.

Another significant change is that BS IV defines independent NO_x standards, in addition to the combined HC+NO_x limits. This requirement will force manufacturers to adopt

¹ egazette.nic.in/WriteReadData/2014/160193.pdf

technology that specifically targets NO_x, including electronic fuel injection, better designed three-way catalyst systems, and, very likely, oxygen sensors.

Table 1 also shows European two-wheel standards (Euro 3 and Euro 4), for purposes of comparison. Under the European regulation emissions are also measured with the WMTC, but with some changes in the weighting factors. It seems that the proposed Bharat IV standards for classes 1, 2-1 and 2-2, the most popular two-wheelers in India, fall somewhere in between Euro 3 and Euro 4 for HC+NO_x, but are ten years behind Euro 3 in terms of NO_x limits.

Table 1 Emission standards for two-wheelers, India and Europe

Emission Standard for 2-W	Motorcycle Class	Emission Limits (g/km) ^[1]			
		CO	NO _x	HC+NO _x	
				If Evap. Test ≤ 2.0 g/test	If Evap. Test ≤ 6.0 g/test
Bharat III (2010) IDC	All 2-W	1.0	-	1.0	1.0
Bharat IV (2016 TA; 2017 AV)	Class 1 and Subclass 2-1	1.403	0.39	0.79	0.59
	Subclass 2-2	1.970	0.34	0.67	0.47
	Subclass 3-1 and 3-2	1.970	0.20	0.40	0.20
European Standards - WMTC testing					
Euro 3 (2006)	V _{max} <130km/h	2.62	0.17	0.92	0.92
	V _{max} ≥130km/h	2.62	0.22	0.55	0.55
Euro 4 (2016 TA; 2017 AV)	V _{max} <130km/h	1.14	0.07	0.45	0.45
	V _{max} ≥130km/h	1.14	0.09	0.26	0.26

[1] Test procedure and driving cycles according to WMTC GTR-2 regulations, incorporating amendment 2, with preconditioning soaking and colds starts. Emission sampling starts at t=0 seconds.

The BS IV standards give manufacturers some flexibility by allowing certification under two different sets of evaporative and tailpipe emission limits. The alternative evaporative emission standards allowed in Bharat IV are 2 or 6 grams of hydrocarbons (HC) emitted during the sealed housing for evaporative determination (SHED) test.² Manufacturers can elect to deploy vehicle designs able to meet the lower evaporative emission standard (e.g., sealed fuel systems) and rely less on tailpipe HC emission controls, or opt for the higher evaporative emission standard and employ engine and aftertreatment systems to achieve lower tailpipe HC emissions, depending on which is the more cost-effective solution for them. Currently only China, Taiwan Province of China, Thailand, and the United States have adopted evaporative emission standards for motorcycles, typically at 2 g/test. Europe will implement this requirement by 2016–2017.

2 For the SHED test the vehicle is placed in a sealed, temperature-controlled chamber and evaporative hydrocarbon emissions are measured while the temperature within the chamber is varied to reflect variation in ambient temperatures over the course of a day

The tailpipe emission limits summarized in Table 1 incorporate durability requirements. Durability requirements help ensure that emission limits will be met over a vehicle's lifetime. In contrast to the EU, where durability is defined for 50,000 km, the Indian regulation sets the durability requirement for only 30,000 km. Some regulatory programs require that the vehicle manufacturer perform durability demonstration testing for emission control system through accelerated aging cycles to verify that the system will operate effectively throughout the expected service life. Other regulations, including the new Bharat Stage IV, aim to set a stringent enough emission standard that it allows for anticipated deterioration of the emission control systems. In other words, in order to meet the NO_x emission limit of 0.2 g/km at 30,000 km, the manufacturer would ensure that the new motorcycle emits less than 0.2/1.2 or 0.16g/km.

Table 2 shows BS IV vehicle classifications and weighting factors for calculating emission values under the GTR-2 protocols. The new rule closely follows the GTR-2 vehicle classification, defining five different motorcycle classes and subclasses according to engine displacement (V_d) and maximum design speed (V_{max}).

Table 2 Bharat IV two-wheeler vehicle classifications, applicable test cycles, and weighting factors

Motorcycle class	Definition	Test Cycles	Weighting Factors for final emission results
Class 1	$50 \text{ cc} < V_d < 150 \text{ cc}$ and $V_{max} \leq 50 \text{ km/h}$ or $V_d < 150 \text{ cc}$ and $50 \text{ km/h} < V_{max} < 100 \text{ km/h}$	Part 1 Reduced Speed cold, followed by Part 1 Reduced Speed hot	$0.5 * \text{Part}_{1_RS\text{cold}} + 0.5 * \text{Part}_{1_RS\text{hot}}$
Sub class 2-1	$V_d < 150 \text{ cc}$ and $100 \text{ km/h} \leq V_{max} < 115 \text{ km/h}$ or $V_d \geq 150 \text{ cc}$ and $V_{max} < 115 \text{ km/h}$	Part 1 Reduced Speed cold, followed by Part 1 Reduced Speed hot	$0.5 * \text{Part}_{1_RS\text{cold}} + 0.5 * \text{Part}_{1_RS\text{hot}}$
Sub class 2-2	$115 \text{ km/h} \leq V_{max} < 130 \text{ km/h}$	Part 1 cold, followed by Part 2 hot	$0.3 * \text{Part}_{1\text{cold}} + 0.7 * \text{Part}_{2\text{hot}}$
Sub class 3-1	$130 \text{ km/h} < V_{max} < 140 \text{ km/h}$	Part 1 cold, followed by Part 2 hot, followed by Part 3 Reduced Speed	$0.25 * \text{Part}_{1\text{cold}} + 0.5 * \text{Part}_{2\text{hot}} + 0.25 * \text{Part}_{3_RS}$
Sub class 3-2	$V_{max} \geq 140 \text{ km/h}$	Part 1 cold, followed by Part 2 hot, followed by Part 3	$0.25 * \text{Part}_{1\text{cold}} + 0.5 * \text{Part}_{2\text{hot}} + 0.25 * \text{Part}_{3}$

V_d : Engine displacement volume, V_{max} : Maximum design speed; RS: Reduced Speed

Details on the speed traces that define each of the WMTC test cycle parts (Part 1, Part 2 and Part 3) can be found on the UN ECE GTR 2 website [here](#).³

³ www.unece.org/fileadmin/DAM/trans/main/wp29/wp29wgs/wp29gen/wp29registry/ECE-TRANS-180a2a1c1e.pdf

A chapter in the BS IV document is devoted to motorcycles with engine displacements smaller than 50 cc and top speeds below 50 km/h ($V_d < 50$ cc and $V_{max} < 50$ km/h). Two-wheelers with such characteristics are typically pedal-powered mopeds, which have been reduced to a very small market in India. Table 3 presents the emission standards for mopeds, under IDC testing, with durability factor of 1.2 included in the emission limit.

Table 3 Bharat IV emission standards for two-wheelers with $V_d \leq 50$ cc and $V_{max} \leq 50$ km/h

Motorcycle Class	Emission Limits (g/km)	
	CO	HC+NO _x
$V_d \leq 50$ cc and $V_{max} \leq 50$ km/h	0.75	0.75