INDIAN EMISSIONS REGULATIONS

Limits, Regulations, Measurement of Exhaust Emissions and Calculation of Fuel Consumption

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The Automotive Research Association of India

With Best Compliments from :
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Director - ARAI

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The content of this booklet represents the status of information at the time of print.

It does not replace the need to always refer official regulation and it is subject to change.

November 2018

The Emission Standards for Bharat Stage-VI (BS VI)

for 2 wheeler vehicle models manufactured on 1st April 2020 as per GSR 889(E) dt.16th Sept 2016

Limit Values for 2 wheelers fitted with PI & CI engines: BSVI

	Vehicle Class	BS VI Emission Norms							
		CO mg/km	HC mg/km	NOx mg/km	NMHC mg/km	PM mg/km	EVAP mg/test	OBD	Durability mileage (km) Type V
PI Vehicles	1 & 2-1	1000	100	60	68	4.5*	1500	STAGE I & STAGE II***	20000
	2-2	1000	100	60	68	4.5*			
	3-1 & 3-2	1000	100	60	68	4.5*			35000
CI Vehicles	All	500	100	90	68	4.5*	-		35000
	DF (for all classes)	1.3	1.3 (SI) 1.1 (CI)	1.3 (SI) 1.1 (CI)	1.3 (SI) 1.1 (CI)	1.0 (CI)	300**	-	-

* Applicable to gasoline direct injection (DI) engines only.

**Fixed DF of 300 mg/test shall be added to SHED test results. Alternative to fixed DF, manufacture may opt for ageing of evaporative emission control devices as per procedure specified in AIS 137 and as amended time to time.

*** OBD STAGE II will be applicable from 1st April 2023

PI= Positive Ignition CI= Compression Ignition

Mass Emission Standards (Bharat Stage VI) for 2 wheelers with Spark Ignition engines
(Vehicles with cc ≤ 50 and Vmax ≤ 50 km/hr)

Pollutant	TA=COP norms mg/km	Deterioration Factor (D.F.)	Test Cycle (Cold Start at T=0 sec)
CO	500	1.2	IDC as per AIS137
HC	350	1.2	
NOx	150	1.2	

Applicability of Test Requirements for Type-Approval: BS VI

	Vehicle with SI engines including hybrids									Vehicles with CI engines including hybrids		
	Mono-fuel					Bi-fuel(3)			Flex-fuel	Flex-fuel	Mono-fuel	Dual Fuel
	Gasoline (E5)	LPG	CNG / Bio methane/ Bio-Gas/ LNG	H_2	HCNG (Hydrogen + CNG)	Gasoline (E5) LPG	Gasoline (E5) CNG/ Bio methane	Gasoline (E5) H_2	Gasoline (E5) Ethanol (E85)/ E100	Diesel (B7) Up to 100% (1)Biodiesel	Diesel (B7)	Diesel + CNG
Gaseous pollutant Type I test	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (Both fuels)	Yes (both fuels)	Yes (Both fuels)	Yes	Yes
(2) Type I test Particulate mass	Yes	No	No	No	No	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes	Yes	Yes
Idle emission (Type II)	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (gasoline only)	Yes (both fuels)	No	No	No
Crankcase emission (Type III test)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Evaporative emission (Type IV test)	Yes	No	No	No	No	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	No	No	No

continued...

Durability (Type V test)	Yes	Yes	Yes	Yes	Yes	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (B 7 Only)	Yes	Yes
[4]CO_2 & Fuel consumption	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes
On board diagnosis OBD	Yes	Yes	Yes	Yes	Yes	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (B 7 Only)	Yes	Yes
Smoke Opacity	No	No	No	No	No	No	No	No	No	Yes (B 7 Only)	Yes	No

[1] Vehicles fuelled with bio diesel blends up to 7% shall be tested with reference diesel (B7) and vehicles fuelled with Bio diesel blends above 7% will be tested with respective blends.

[2] In case of PI engines, applicable only to vehicles with direct Injection engines.

[3] Vehicle models and variants having option for Bi-fuel operation and fitted with limp-home gasoline tank of capacity not exceeding two litres on two wheelers shall be exempted from test in gasoline mode.

[4] CO_2 emission and fuel consumption shall be measured as per procedure laid down in AIS 137 and as amended time to time.

* When bi-fuel vehicle is combined with a flex fuel vehicle, both test requirements are applicable. Vehicle tested with E100 need not to be tested with E85.

Classification of Vehicles and Weighting Factor

	Definition of class	WMTC Cycles	Weighting Factors
Class 1	Vehicles that fulfill the following specifications belong to class 1 : 50 cm^3 < engine capacity < 150 cm^3 and Vmax ≤ 50 km/h or engine capacity < 150 cm^3 and 50 km/h <Vmax< 100 km/h	Part 1 Reduced Speed Cold followed by	W1:50%
		Part 1 Reduced Speed Hot	W2:50%
Sub Class 2-1	Vehicles that fulfill the following specifications belong to sub class 2-1: Engine capacity < 150 cm^3 and 100 km/h ≤Vmax< 115 km/h or Engine capacity ≥150 cm^3 and Vmax< 115 km/h	Part 1 Reduced Speed Cold followed by	W1:50%
		Part 2 Reduced Speed Hot	W2:50%
Sub Class 2.2	Vehicles that fulfill the following specifications belong to sub class 2 - 2 : 115 km/h ≤ Vmax< 130 km/h	Part 1 Cold followed by	W1:50%
		Part 2 Hot	W2:50%
Sub Class 3-1	Vehicles that fulfill the following specifications belong to sub class 3 - 1 : 130 km/h ≤ Vmax< 140 km/h	Part 1 Cold followed by	W1: 25 %
		Part 2 Hot followed by	W2: 50%
		Part 3 Reduced Speed	W3: 25%
Sub Class 3-2	Vehicles that fulfill the following specifications belong to sub class 3 - 2 : Vmax ≥ 140 km/h	Part 1 Cold followed by	W1: 25 %
		Part 2 Hot followed by	W2: 50%
		Part 3	W3: 25%

The On-Board Diagnostic (OBD) systems for emission control

OBD Functions and Associate

Monitoring Items	OBD Stage I (BS VI) 1st April, 2020	OBD Stage II (BS VI) 1st April, 2023
Circuit continuity for all emission related power train component (if equipped)	✓	✓
Distance travelled since MIL (Malfunction indicator lamp) ON	✓	✓
Electrical disconnection of Electronic evaporative purge control device (if equipped and if active)	✓	✓
Catalytic converter monitoring	X	✓
EGR system monitoring	✓	✓
Misfire detection	X	✓
Oxygen sensor deterioration	X	✓

On-board (OBD) diagnostics emission thresholds for BSVI Applicable from 1st April, 2023

Vehicle Class	OBD Stage II/Gasoline			
	CO mg/km	NMHC mg/km	NOx mg/km	PM mg/km
1 & 2 - 1	1900	250	300	50(1)
2 - 2	1900	250	300	50(1)
3 - 1 & 3 - 2	1900	250	300	50(1)
Vehicle Class	OBD Stage II /Diesel			
	CO mg/km	NMHC mg/km	NOx mg/km	PM mg/km
All	1900	320	540	50

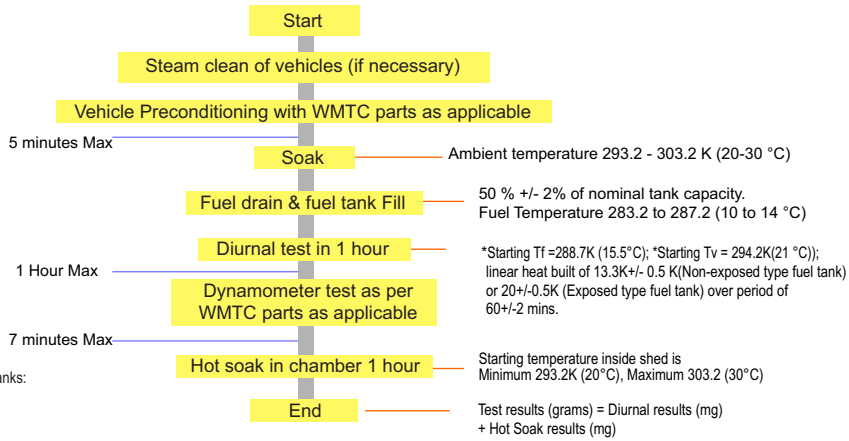
(1) In case of P.I engines, applicable to vehicles with direct injection engines.

2W Type IV Test: Evaporative Emission Determination SHED Test (BS - VI)

Soak Duration Table

Engine Capacity	Minimun (hours)	Maximum (hours)
≤ 169cm³	6	36
170 cm³ < engine capacity ≤ 279 cm³	8	36
>279 cm³	12	36

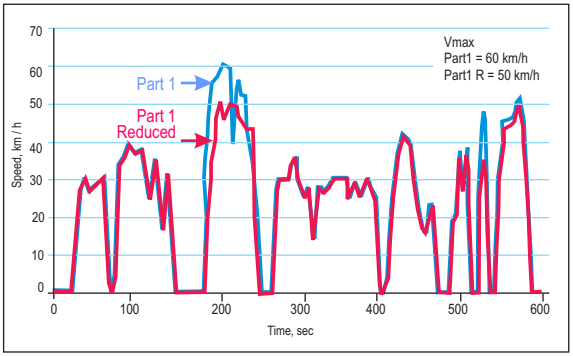
* For exposed type and non-exposed type fuel storage tanks:
Tf = required temperature of fuel (K)
Tv = required temperature of vapour (K)



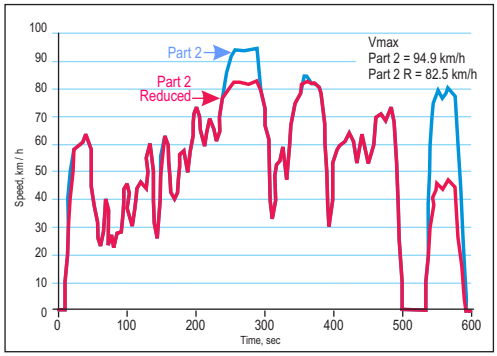
(Hot soak loss test -1 hr + Diurnal loss test -1 hr) Limit: 1500 mg/test

WMTC Test Cycles

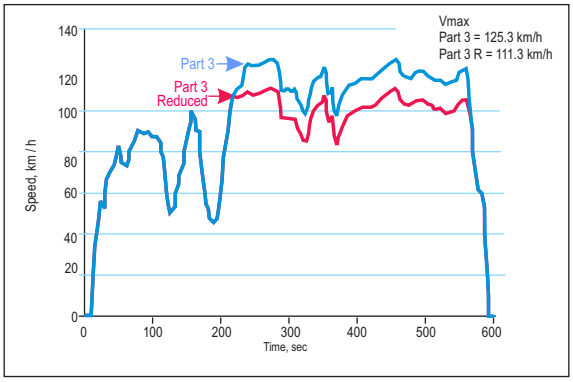
WMTC Part 1 & Part 1 Reduced Speed Cycles



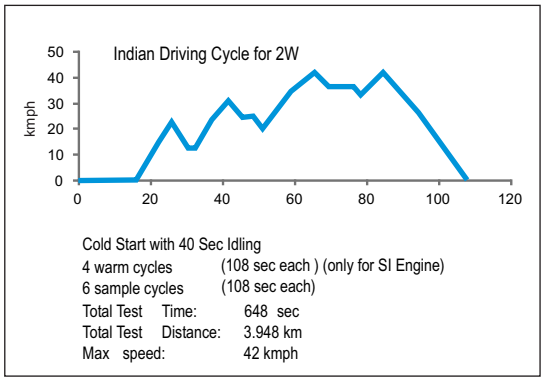
WMTC Part 2 & Part 2 Reduced Speed Cycles



WMTC Part 3 & Part 3 Reduced Speed Cycles



Driving Cycle Type I Test : 6 Cycles (IDC) Sampling



Cold Start with 40 Sec Idling

4 warm cycles	(108 sec each) (only for SI Engine)
6 sample cycles	(108 sec each)
Total Test Time:	648 sec
Total Test Distance:	3.948 km
Max speed:	42 kmph

Notes:

- Type I Test :- Spark Ignition (WMTC), Compression Ignition (IDC)
  Type II Test :- Idle & High Idle CO & HC
  Type III Test :- Crankcase ventilation from gasoline vehicle is not permitted.
- Determination of evaporative emission (Gasoline Vehicles) (Hot soak loss test -1 hr + Diurnal loss test -1 hr) Limit: 1.5 g/test
- $IUPR_n$ for BS VI Vehicles manufactured on or after 1st April 2023 shall be greater than or equal to 0.1 for all monitors M
  $IUPR_M$ = Numerator/Denominator (Indicates how often specific monitor is operating relative to vehicle operation)
  Numerator = Numerator measures number of times a monitoring function has run and a malfunction could have been detected
  Denominator = Denominator measures the number of driving events taking in to account special condition
- Conformity of production (COP) : at least 50 % of vehicle models produced from particular plant shall be selected randomly from dealer's location or warehouse.
- The Vehicle presented for Type Approval shall have been run at least 1000 km before the test

Engine Net Power Measurement Tolerance

For SI Engines

Test Type	Engine Type	Acceptable Tolerance Max. Power & Max. Torque (%)	Other measurement points on the curve (%)	Tolerance for engine speed (%)
Type Approval	≤11kW(≤1kW)*	±5 (±10)*	—	±1.5(±3)*
	> 11kW (>1kW)*	±2 (±5)*	—	±1.5(±3)*

For CI Engines

Test Type	Engine Type	Rated net power (%)	Other measurement points on the curve (%)	Tolerance for engine speed (%)
Type Approval	All	±2	±4	±2

Note: The engine power shall be measured on engine dynamometer and measured power shall conform to the power specified and tested as per procedure prescribed in AIS 137 and as amended time to time.
* for Moped Vehicles

Mass Emission Standards (BS IV) for 2 Wheelers Gasoline Vehicles

Applicability of Tests:
Type I Test:
Mass emission: Spark Ignition (WMTC)
Compression Ignition(IDC)
Type II Test:
Spark Ignition – Idle & high idle CO & HC
Compression Ignition: Free acceleration smoke
Type III Test:
Crankcase emission to atmosphere from gasoline vehicle is not permitted
Breather pipe to be connected to intake system

Type IV Test:
Determination of evaporative emission (Petrol Vehicles)
(Hot soak loss test – 1 hr. + Diurnal loss test – 1 hr.) Limit: 2 g/test or 6g/test
Type V Test:
Durability of anti-pollution devices

Mass emission standards (BS IV) for 2 wheelers with SI engines (Vehicle with cc>50 and Vmax > 50 kmph)

Class	TA = COP norms (g/km)			
	CO	NOx	HC + NOx	
			If the evaporative emission complies with 2 g/test	If the evaporative emission complies with 6 g/test
Class 1 and Sub-Class 2-1	1.403	0.39	0.79	0.59
Sub Class 2-2	1.970	0.34	0.67	0.47
Sub Class 3-1 and Sub Class 3-2	1.970	0.20	0.40	0.20

Note: Requirements of durability have been built in to mass emission standards specified above.
Mass emission standards (BS IV) shall come in to force for two wheeler manufactured on and after 1st April 2016 for new type of vehicle models and from 1st April, 2017 for existing type of vehicle models based on WMTC

Mass emission standards (BS IV) for 2 wheelers with SI engines
(Vehicle with cc <=50 and Vmax <= 50 kmph)

	TA = COP norms (g/km)	Deterioration factor (D.F)
CO	0.75	1.2
HC + NOx	0.75	1.2

2 wheeled vehicles fitted with diesel engines-
The mass emission standards shall be same as those applicable for diesel 3 wheelers.

Classification of Vehicles and Weighting Factors

for final emission result of 2 wheeler gasoline vehicle GSR 431 (E) dated 4 July 2014

Classification of Vehicles

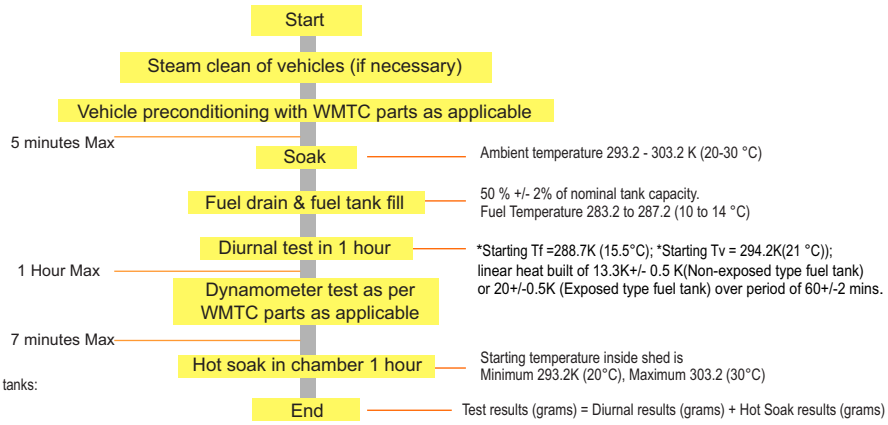
	Definition of Class	Cycles	Weighting Factor
Class 1	Vehicles that fulfill the following specifications belongs to class 1: 50 cc < Engine capacity < 150 cc and Vmax ≤ 50km/h or Engine capacity <150 cc and 50 km/h < Vmax < 100 km/h	Part 1 Reduced Speed cold	W1 : 50%
		Part 1 Reduced Speed Hot	W2: 50 %
Sub-Class 2.1	Vehicles that fulfill the following specification belong to class 2.1: Engine capacity <150 cc and 100 km/h ≤ Vmax ≤115 km/h or Engine capacity ≥ 150 cc and Vmax <115 km/h	Part 1 Reduced Speed cold	W1 : 50%
		Part 1 Reduced Speed Hot	W2 : 50%
Sub-Class 2.2	Vehicles that fulfill the following specification belong to class 2.2: 115 km/h ≤ Vmax<130km/h	Part 1 Cold	W1 : 30%
		Part 2 Hot	W2 : 70%
Sub-Class 3.1	Vehicles that fulfill the following specification belong to class 3.1: 130km/h≤Vmax<140 km/h	Part 1 Cold	W1: 25 %
		Part 2 Hot	W2: 50 %
		Part 3 Reduced Speed	W3: 25 %
Sub-Class 3.2	Vehicles that fulfill the following specification belong to class 3.2: Vmax ≥140 km/h	Part 1 Cold followed by	W1: 25 %
		Part 2 Hot followed by	W2: 50 %
		Part 3	W3: 25 %

2W Type IV Test: Evaporative Emission Determination SHED Test (BS - IV)

Soak Duration Table

Engine Capacity	Minimun (hours)	Maximum (hours)
≤ 169cm³	6	36
170 cm³ < engine capacity ≤ 279 cm³	8	36
>279 cm³	12	36

* For exposed type and non-exposed type fuel storage tanks:
Tf = required temperature of fuel (K)
Tv = required temperature of vapour (K)



(Hot soak loss test – 1 hr. + Diurnal loss test – 1 hr.) Limit: 2 g/test or 6g/test

Scope : 2W (Gasoline)

Type I Test :
Exhaust emissions (IDC)

Type II Test :
Spark Ignition - Idle CO - HC

Type III Test :
The durability of Anti Pollution Device is determined either by an actual durability run over 30 000 km or by application of a fixed deterioration factor

Emission Limits *

Class	Pollutants	Limits** (g/km)
Class 1 & Sub Class 2.1	CO	1.87
	HC+NOx	1.08
Sub Class 2.2	CO	2.62
	HC+NOx	0.92
Sub Class 3.1	CO	2.62
	HC+NOx	0.55
Sub Class 3.2	CO	2.62
	HC+NOx	0.55

* Notification under issue by MORTH
** Limits with DF

WMTC Test Limits and Test Cycles For 2 Wheeler Gasoline Vehicles

Alternate Mass Emission Standards (BS III) for two wheeler gasoline vehicles, with engine capacity exceeding >50 cc and maximum design speed >50kmph based on WMTC GSR 515(E) dated 29 June 2012

Classification of Vehicles

	Definition of Class	Cycles	Weighting Factor
Class 1	Engine capacity above 50cc but less than 150cc and vehicle maximum speed equal to or less than 50 km/h OR Engine capacity less than 150cc and vehicle maximum speed more than 50km/h but less than 100 km/h.	Part 1 Reduced Speed cold	W1 : 50%
		Part 1 Reduced Speed Hot	W2: 50 %
Sub Class 2.1	Engine capacity less than 150 cc and vehicle maximum speed 100 km/h to less than115 km/h OR engine capacity 150 cc & above and vehicle maximum speed less than 115 km/h	Part 1 Reduced Speed cold	W1 : 50%
		Part 1 Reduced Speed Hot	W2 : 50%
Sub Class 2.2	Any engine capacity, vehicle maximum speed 115 km/h to less than 130 km/h	Part 1 Cold	W1 : 30%
		Part 2 Hot	W2 : 70%
Sub Class 3.1	Any engine capacity, vehicle maximum speed 130 km/h to less than 140 km/h	Part 1 Cold	W1: 25 %
		Part 2 Hot	W2: 50 %
		Part 3 Reduced Speed	W3: 25 %
Sub Class 3.2	Any engine capacity, vehicle maximum speed 140 km/h and above	Part 1 Cold	W1: 25 %
		Part 2 Hot	W2: 50 %
		Part 3	W3: 25 %

Emission Standards for 2 Wheeler Vehicles

Deterioration Factors (BS III)

Engine category	CO	HC+NOx	PM
2W (Gasoline engines)	1.20	1.20	-

BS - III Type I Limits

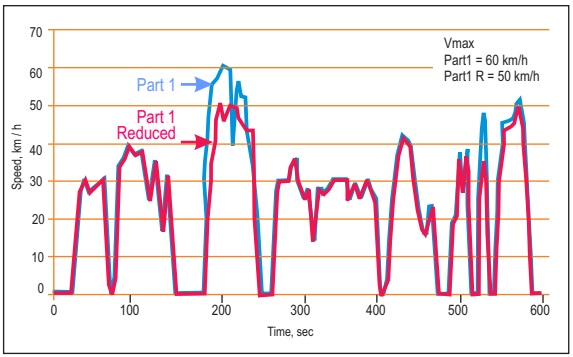
	Effective Date	Category	CO g/km	HC + NOx g/km	PM g/km
Gasoline	1.10.2010	2W	1.00	1.00	-

Emission Standard History for 2 Wheeler Vehicles

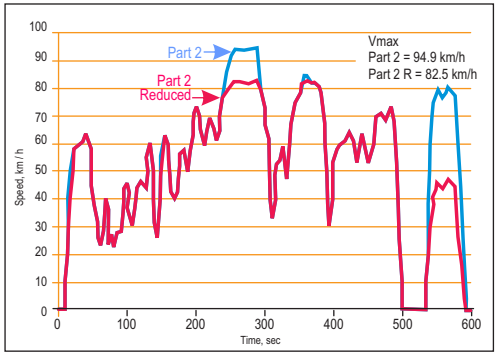
2 Wheelers	CO (g/km)	HC (g/km)	HC+NOx (g/km)
1991 Norms	12- 30	8 - 12	-
1996 Norms	4.50	-	3.60
BS - I Norms (2000)	2.00	-	2.00
BS - II Norms (2005)	1.50	-	1.50

WMTC Test Cycles

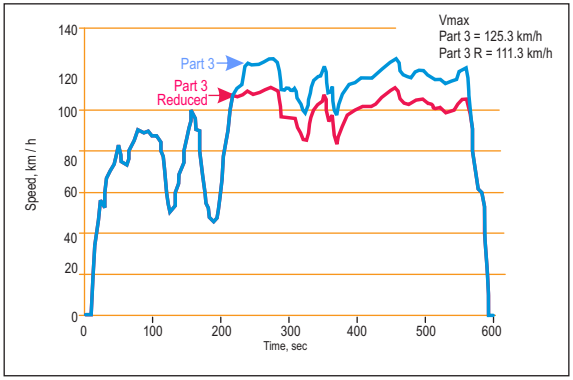
WMTC Part 1 & Part 1 Reduced Speed Cycles



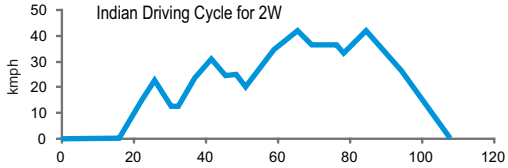
WMTC Part 2 & Part 2 Reduced Speed Cycles



WMTC Part 3 & Part 3 Reduced Speed Cycles



Driving Cycle Type I Test : 6 Cycles (IDC) Sampling



Cold Start with 40 Sec Idling
4 warm cycles (108 sec each) (only for SI Engine)
6 sample cycles (108 sec each)
Total Test Time: 648 sec
Total Test Distance: 3.948 km
Max speed: 42 kmph

The Emission Standards Bharat Stage VI (BS VI)

(3 wheelers vehicle models manufactured on or after 1st April 2020 as per GSR 889(E) dt. 16th Sept 2016.)

3 Wheelers Vehicles fitted with PI Engines

	CO mg/km	HC+NOx mg/km	NOx mg/km	EVAP mg/test	OBD	Durability mileage (km) Type V	Test Cycle (Cold Start at T=0 sec)
Limit	440	435	130	1500	Stage I& Stage II*	35000	IDC AIS137
D.F.	1.20	1.2	1.2	_	_	_	_

* OBD Stage II will be applicable from 1st April 2023

3 Wheelers Vehicle with CI engines

	CO mg/km	HC+NOx mg/km	NOx mg/km	PM	OBD	Durability mileage (km) Type V	Test Cycle (Cold Start at T=0 sec)
Limit	220	200	160	25	Stage I& Stage II*	35000	IDC AIS137
D.F.	1.10	1.0	1.00	1.20	_	_	

* OBD Stage II will be applicable from 1st April 2023

	Vehicle with PI engines including hybrids								Vehicles with CI engines including hybrids		
	Mono-fuel					Bi-fuel(3)		Flex-fuel	Flex-fuel	Mono-fuel	Dual Fuel
	Gasoline (E5)	LPG	CNG/Bio methane/ Bio-Gas/LNG	H_2	HCNG (Hydrogen + CNG)	Gasoline (E5) LPG	Gasoline (E5) CNG/Bio methane	Gasoline (E5) Ethanol (E85)	Diesel (B7) Biodiesel up to100% (1)	Diesel (B7)	Diesel + CNG
Gaseous pollutant (Type I test)	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes
(2) Type I test Particulate mass	Yes	No	No	No	No	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (both fuels)	Yes	Yes
Idle emission (Type II test)	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	No	No	No
Crankcase emission (Type III test)	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No	No	No
Evaporative emission (Type IV test)	Yes	No	No	No	No	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	No	No	No
Durability (Type V test)	Yes	Yes	Yes	Yes	Yes	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (B7 only)	Yes	Yes
(4) CO_2 & Fuel consumption	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes
OBD	Yes	Yes	Yes	Yes	Yes	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (B7 only)	Yes	Yes
Smoke Opacity	No	No	No	No	No	No	No	No	Yes (B7 only)	Yes	Yes

(1) Vehicles fuelled with bio diesel blends up to 7% shall be tested with reference diesel (B7) and vehicles fuelled with Bio diesel blends above 7% will be tested with respective blends.

(2) In case of PI engines, applicable only to vehicles with direct Injection engines.

(3) Vehicle models and variants having option for Bi-fuel operation and fitted with limp-home gasoline tank of capacity not exceeding 3 litres on 3 wheelers shall be exempted from test in gasoline mode.

(4) CO_2 emission and fuel consumption shall be measured as per procedure laid down in AIS 137 and as amended time to time.

* When bi-fuel vehicle is combined with a flex fuel vehicle,both test requirements are applicable. Vehicle tested with E100 need not to be tested with E85.

The On-Board Diagnostic (OBD) systems for emission control shall be as specified in the following Table:

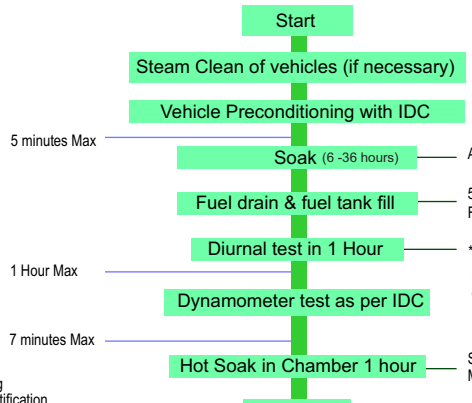
OBD Functions and Associate

Monitoring Items	OBD Stage I (BS VI) 1st April, 2020	OBD Stage II (BS VI) 1st April, 2023
Circuit continuity for all emission related power train component (if equipped)	✓	✓
Distance travelled since MIL (Malfunction Indicator Lamp) ON	✓	✓
Electrical disconnection of Electronic evaporative purge control device (if equipped and if active)	✓	✓
Catalytic converter monitoring	X	✓
EGR system monitoring	X	✓
Misfire detection	X	✓
Oxygen sensor deterioration	X	✓

On-board (OBD) diagnostics emission thresholds for BSVI Applicable from 1st April, 2023

Vehicle	OBD Stage II Gasoline	
	CO mg/km	NOx mg/km
Gasoline	880	425
	OBD Stage II Diesel Vehicles	
Diesel	CO mg/km	NOx mg/km
	440	300

3W Type IV Test: Evaporative Emission Determination Shed Test (BS-VI)



(Hot Soak Loss test -1 hr +Diurnal loss test – 1hr) Limit: 1500 mg/test

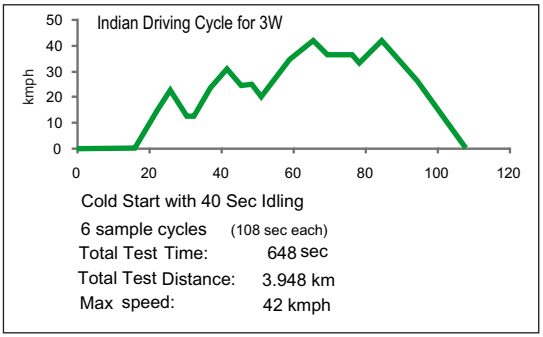
Note : Tailpipe emission may be measured during dynamometer test, but these are not used for certification

* For exposed type and non-exposed type fuel storage tanks:

Tf = required temperature of fuel (K)

Tv = required temperature of vapour (K)

Driving Cycle Type I Test : 6 Cycles (IDC) Sampling



Notes :

- **Type I Test :** Mass emission Test Cycle : (IDC)
- **Type II Test :** Spark Ignition – idling CO & HC, Compression Ignition – Free Acceleration smoke
- **Type III Test :** Crankcase emission from gasoline vehicle is not permitted
- **Type IV Test:** Determination of evaporative emission (gasoline vehicles)

(Hot Soak Loss Test -1 hr +Diurnal loss Test – 1hr) Limit: 1.5 g/test

The Vehicle presented for type Approval shall have been run for 1000 km before test

Engine Net Power Measurement Tolerance

For SI Engines

Test Type	Engine Type	Acceptable Tolerance Max. Power & Max. Torque (%)	Other measurement points on the curve (%)	Tolerance for engine speed (%)
Type Approval	≤ 11kW	±5	—	±1.5
	> 11kW	±2	—	±1.5

For CI Engines

Test Type	Engine Type	Rated net power (%)	Other measurement points on the curve (%)	Tolerance for engine speed (%)
Type Approval	All	±2	±4	±2

Note: The engine power shall be measured on engine dynamometer and the measured power shall confirm to the power specified and tested as per procedure prescribed in AIS 137 and as amended time to time

Mass Emission Test Standard (BS IV) for 3 Wheelers

as per GSR 487 (E) dated 12 June 2015

Applicability of Tests :

Type I Test :
Mass emission (IDC)

Type II Test :
Spark Ignition – Idling CO & HC
Compression Ignition – Free acceleration smoke

Type III Test :
Crankcase emission from gasoline vehicle is not permitted
Breather pipe to be connected to intake system

Type IV Test :
Determination of evaporative emission (Petrol Vehicles)
(Hot soak loss test – 1 hr. + Diurnal loss test – 1 hr.) **Limit: 2 g/test or 6g/test**

Type V Test :
Durability of anti-Pollution devices

Mass emission standards (BS IV) shall come in to force for Three wheeler manufactured on and after 1st April 2016 for new type of vehicle models and from 1st April, 2017 for existing type of vehicle models

Three wheelers fitted with gasoline engines:

	CO	HC + NOx	
		If the evaporative emission complies with 2.0 g/test	If the evaporative emission complies with 6.0 g/test
TA = COP norms (g/km)	0.940	0.940	0.740
D.F (Deterioration factor)	1.2	1.2	1.2

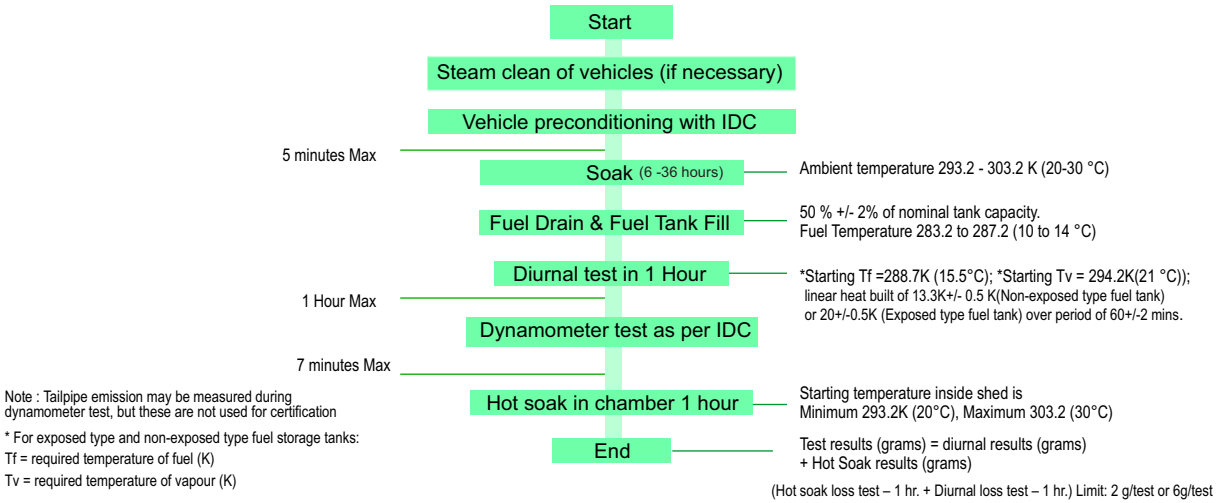
Three wheelers fitted with Compressed Natural Gas (CNG) or Liquefied Petroleum Gas (LPG) engines:

	CO	HC + NOx
TA = COP norms (g/km)	0.940	0.940
Deterioration factor (D.F)	1.2	1.2

Three wheelers fitted with Compression Ignition engines:

	CO	HC + NOx	PM
TA = COP norms (g/km)	0.380	0.380	0.0425
Deterioration factor (D.F)	1.1	1.0	1.2

3W Type IV Test : Evaporative Emission Determination Shed Test (BS-IV)



Note : Tailpipe emission may be measured during dynamometer test, but these are not used for certification

* For exposed type and non-exposed type fuel storage tanks:
Tf = required temperature of fuel (K)
Tv = required temperature of vapour (K)

(Hot soak loss test – 1 hr. + Diurnal loss test – 1 hr.) Limit: 2 g/test or 6g/test

Scope : 3W (Gasoline & Diesel)

Type I Test :
Exhaust emissions (IDC)

Type II Test :
Spark Ignition - Idle CO - HC
Compression Ignition (3W only) - Free acceleration Smoke

Type III Test :
The durability of Anti Pollution Device is determined either by an actual durability run over 30 000 km or by application of a fixed deterioration factor

Deterioration Factors

Engine category	CO g/km	HC + NOx g/km	PM g/km
3W (Gasoline/ Gaseous fueled engines)	1.20	1.20	-
3W (Diesel engines)	1.10	1.00	1.20

BS - III Type I Limits

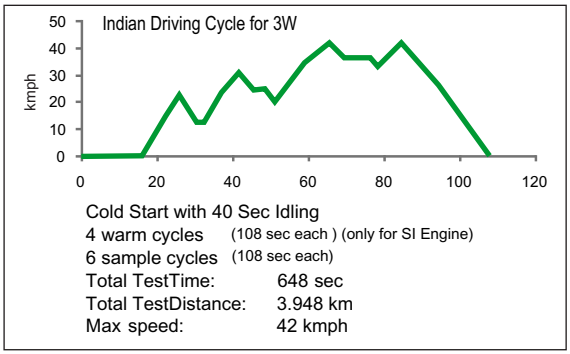
	Effective Date	Category	CO g/km	HC + NOx g/km	PM g/km
Gasoline	1.10.2010	3W	1.25	1.25	-
Diesel		3W	0.50	0.50	0.05

Emission Standard History 3 Wheeler Vehicles

Three - Wheelers (Gasoline)	CO (g/km)	HC (g/km)	HC+NOx (g/km)
1991 Norms	12 - 30	8-12	-
1996 Norms	6.75	-	5.40
BS - I Norms (2000)	4.00	-	2.00
BS - II (2005)	2.25	-	2.00

Three - Wheelers (Diesel)	CO (g/km)	HC (g/km)	HC+NOx (g/km)	PM (g/km)
1991 Norms	12 - 30	8-12	-	-
1996 Norms	6.75	-	5.40	-
BS - I Norms (2000)	2.72	-	0.97	0.14
BS - II (2005)	1.00	-	0.85	0.10

Driving Cycle Type I Test : 6 cycles (IDC) sampling



Cold Start with 40 Sec Idling
4 warm cycles (108 sec each) (only for SI Engine)
6 sample cycles (108 sec each)
Total TestTime: 648 sec
Total TestDistance: 3.948 km
Max speed: 42 kmph

The Emission Standards Bharat Stage IV (BS IV)
(As per G.S.R. 518(E) dated 01st Jun 2018)

Quadricycles (L7) fitted with Gasoline or Compressed Natural Gas (CNG) or Liquefied Petroleum Gas (LPG) engines.

	TA=COP norms			EVAP (g/test)	OBD
	CO(g/km)	HC(g/km)	NOx(g/km)		
Limit	2.0	0.55	0.25	<=2.0	Stage I
D.F.	1.3	1.2	1.2	–	–

Fitted with CI Engine

	TA=COP norms				OBD
	CO	HC	Nox	PM	
	(g/km)				
Limit	1.0	0.10	0.55	0.08	Stage I
D.F.	1.3	1.2	1.2	1.1	–

OBD - Stage I

Monitoring Items	All Positive ignition vehicles	All Compression ignition vehicles
Oxygen (O_2) sensor	✓	-
Secondary Air System, if provided	✓	-
Electronic fuel injection system	-	✓
Coolant temperature	✓	✓
EGR, (Exhaust Gas Recirculation), if provided	✓	✓
Emission Control system / components (Comprehensive Components)	✓	✓
Circuit continuity for all emission related power train components	✓	✓
Distance travelled since MIL (Malfunction Indicator Lamp) ON	✓	✓

Notes:

(i) Type I test: Mass emission Test cycle on Chassis dynamometer : Modified ECE R40

(ii)(a) Reference mass : kerb weight + 150 kg;

(b) Number of test cycles: Six (6), with weightage factors first cycle: 30%; remaining: 70%;

(c) Modified ECE R40 cycle with maximum speed of 43km/hr.

(iii) Type II Test: Spark Ignition –idling CO & HC & high idle CO& λ, Compression Ignition: Free Acceleration Smoke

(iv) Type III Test : Crankcase emission from gasoline vehicle not permitted

(v) Type IV Test: Determination of evaporative emission (gasoline Vehicle) (Hot Soak Loss Test 1 Hr + Diurnal loss test 1 hr): Limit 2.0 g/test

The Emission Standards for Bharat Stage VI (BS-VI)

for category M and N vehicles having Gross Vehicle Weight not exceeding 3500kg, manufactured on or after 1 April 2020 for all models, as per GSR 889 dt. 16 Sept 2016.

		Reference Mass (RM) (kg)	Mass of Carbon Monoxide (CO)		Mass of Total Hydrocarbons (THC)		Mass of Non-Methane Hydrocarbons (NMHC)		Mass of Oxides of Nitrogen (NOx)		Combined Mass of Hydrocarbons and Oxides of Nitrogen (THC + NOx)		Mass of Particulate Matter (PM)		Number of Particles (PN)	
			L1 (mg/km)		L2 (mg/km)		L3 (mg/km)		L4 (mg/km)		L2 + L3 (mg/km)		L5 (mg/km)		L6 (numbers/km)	
Category	Class		PI	CI	PI	CI	PI	CI	PI	CI	PI	CI	PI[1]	CI	PI [1] [2]	CI
M (M1 & M2)	—	All	1000	500	100	—	68	—	60	80	—	170	4.5	4.5	$6.0X\ 10^{11}$	$6.0X\ 10^{11}$
N1	I	RM ≤ 1305	1000	500	100	—	68	—	60	80	—	170	4.5	4.5	$6.0X\ 10^{11}$	$6.0X\ 10^{11}$
	II	1305<RM ≤ 1760	1810	630	130	—	90	—	75	105	—	195	4.5	4.5	$6.0X\ 10^{11}$	$6.0X\ 10^{11}$
	III	1760<RM	2270	740	160	—	108	—	82	125	—	215	4.5	4.5	$6.0X\ 10^{11}$	$6.0X\ 10^{11}$
N2	—	All	2270	740	160	—	108	—	82	125	—	215	4.5	4.5	$6.0X\ 10^{11}$	$6.0X\ 10^{11}$

PI = Positive Ignition, CI = Compression Ignition

(1) For positive ignition, particulate mass and number of particles limit shall apply only to vehicles with direct injection engines.

(2) Until three years after date of implementation for new type approvals and new vehicles, particle number emission limit of 6.0×10^{12} /km shall apply to BS VI gasoline direct injection vehicles upon choice of the manufacturer.

Deterioration Factor shall be as given below: BS VI

Engine Category	Assigned Deterioration Factor						
	CO	THC	NMHC	NOx	HC + NOx	Particulate Matter (PM)	Particle Number (PN)
Positive Ignition	1.5	1.3	1.3	1.6	—	1.0	1.0
Compression Ignition	1.5	—	—	1.1	1.1	1.0	1.0

Note: Alternatively the vehicle manufacturer may opt for vehicle ageing test of 1,60,000 km or bench ageing durability test

OBD Threshold for BS VI Vehicles Manufactured on or after 1st April 2020 :

On-Board Diagnostic (BS VI - OBD-I) Threshold : BS VI

		Reference Mass (RM) (kg)	Mass of Carbon Monoxide (CO) (mg/km)		Mass of Non-Methane Hydrocarbons (NMHC) (mg/km)		Mass of Oxides of Nitrogen (NOx) (mg/km)		Mass of Particulate Matter (PM) (mg/km)	
Category	Class		PI	CI	PI	CI	PI	CI	PI[1]	CI
M (M1 & M2)	-	All	1900	1750	170	290	150	180	25	25
N1	I	RM ≤ 1305	1900	1750	170	290	150	180	25	25
	II	1305<RM ≤1760	3400	2200	225	320	190	220	25	25
	III	1760 < RM	4300	2500	270	350	210	280	30	30
N2	—	All	4300	2500	270	350	210	280	30	30

[1] For positive ignition, particulate mass limits apply only to vehicles with direct injection engines

OBD Threshold for BS VI Vehicles Manufactured on or after 1st April 2023 :

On-Board Diagnostic (BS VI- OBD- II) Threshold : BS VI

		Reference Mass (RM) (kg)	Mass of Carbon Monoxide (CO) (mg/km)		Mass of Non-Methane Hydrocarbons (NMHC) (mg/km)		Mass of Oxides of Nitrogen (NOx) (mg/km)		Mass of Particulate Matter (PM) (mg/km)	
Category	Class		PI	CI	PI	CI	PI	CI	PI[1]	CI
M (M1 & M2)	-	All	1900	1750	170	290	90	140	12	12
N1	I	RM ≤ 1305	1900	1750	170	290	90	140	12	12
	II	1305<RM ≤1760	3400	2200	225	320	110	180	12	12
	III	1760 < RM	4300	2500	270	350	120	220	12	12
N2	—	All	4300	2500	270	350	120	220	12	12

[1] For positive ignition, particulate mass limits apply only to vehicles with direct injection engines

Application of Test Requirements for Type-Approval – BS VI

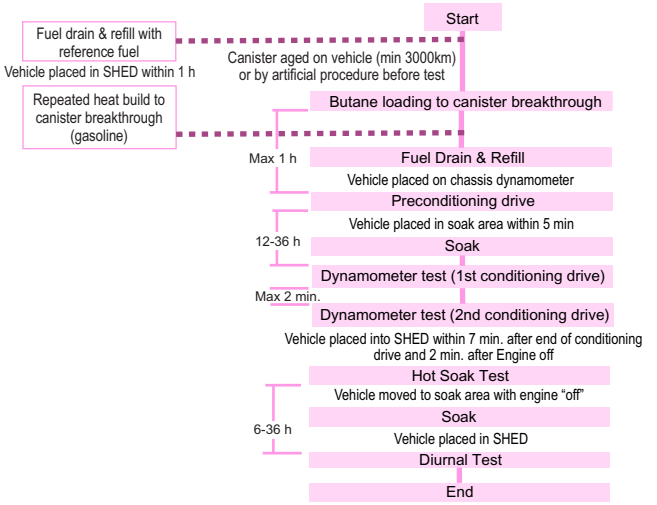
Reference Fuel	Vehicle with PI engines including hybrids									Vehicles with CI engines including hybrids		
	Mono-fuel					Bi-fuel[1]			Flex-fuel[1]	Flex-fuel	Mono-fuel	Dual Fuel
	Gasoline (E5)	LPG	CNG/Bio methane/ Bio-Gas/LNG	Hydrogen (ICE)[3]	H_2CNG (Hydrogen +CNG)	Gasoline (E5) LPG	Gasoline (E5) CNG/Bio methane	Gasoline (E5) Hydrogen (ICE)[3]	Gasoline (E5) Ethanol (E85)/(E100)	Diesel (B7) Biodiesel up to 100% [5]	Diesel (B7)	Diesel + CNG
Gaseous pollutant (Type I test)	Yes	Yes	Yes	Yes[2]	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)[2]	Yes (both fuels)	Yes	Yes	Yes
Particulate Mass and Particulate Number (Type 1 Test)	Yes[4]	–	–	–	–	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (both fuels)	Yes	Yes	Yes
Idle emission (Type II test)	Yes	Yes	Yes	–	Yes	Yes (both fuels)	Yes (both fuels)	Yes (gasoline only)	Yes (both fuels)	–	–	–
Crankcase emission (Type III test)	Yes	Yes	Yes	–	Yes	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	–	–	–

continued....

Evaporative emission (Type IV test)	Yes	–	–	–	–	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	–	–	–
Durability (Type V test)	Yes	Yes	Yes	Yes	Yes	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (gasoline only)	Yes (B7 only)	Yes	Yes
In-Service Conformity	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (gasoline only)	Yes (both fuels)	Yes (B7 only)	Yes	Yes
On-Board Diagnostics and IUPRm	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
[6]CO_2 emission and fuel consumption	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes
Smoke Opacity	–	–	–	–	–	–	–	–	–	Yes	Yes	–
Engine Power	Yes	Yes	Yes	Yes	Yes	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes (both fuels)	Yes	Yes	Yes

(1) When a bi-fuel vehicle has flex fuel option, both test requirements are applicable. Vehicle tested with E100 need not to be tested for E85.
(2) Only NOx emissions shall be determined when the vehicle is running on Hydrogen.
(3) Reference Fuel is 'Hydrogen for Internal Combustion Engine' as Specified in page 83
(4) For Positive ignition, particulate mass and number limits for vehicles with positive ignition engines including hybrids shall apply only to vehicles with direct injection engines.
(5) Vehicle fuelled with Bio diesel blends up to 7% will be tested with reference diesel (B7) & vehicles fuelled with Bio diesel blends above 7% will be tested with respective blends.
(6) CO_2 emission and fuel consumption shall be measured as per procedure laid down in AIS 137 and as amended time to time.

Type VI Test : Evaporative Emission Test



Fuel temperature:283K to 287K (10-14 ˚C))
40% ±2% of nominal tank capacity Ambient temperature :293K to 303K (20-30˚C)

Butane /Nitrogen mixture loading at 40 g butane/hr to breakthrough of canister

Fuel temperature: 291K ± 8K (18 ± 8 ˚C)) 40% ± 2% of nominal tank capacity
Ambient temperature 293K - 303K (20-30˚C)

1 X Part 1 + 2 X Part 2 of Type I test cycle T_{start} = 293 K to 303 K (20-30 ˚C)

Ambient temperature: 293K to 303 K (20-30˚C) Oil and coolant temperatures must reach soak area temperature within ±3 K (±3 ˚C)

Type 1 test cycle T_{start} = 293 K to 303 K (20-30 ˚C)

Type 1: Part 1

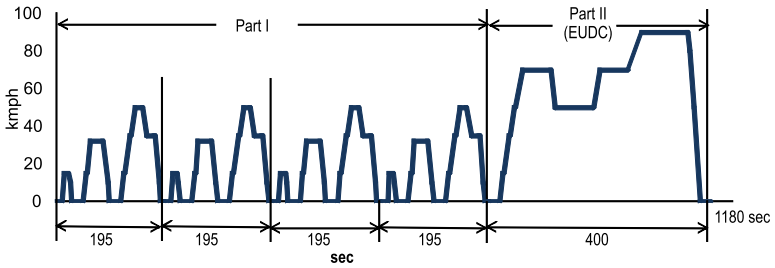
Tmin = 296 K(23˚C) Hot Soak Test
Tmax = 304 K(31˚C) HC measurement
60 min ± 0.5min

T = 293 K ± 2K (20 ± 2 ˚C)) for at least 6 hours

1 Diurnal temperature profile with Tstart= 293 K (20 ˚C)) and Tmax = 308 K (35˚C)) begins within 10 min after closing of the SHED together with initial HC - measurement. Final diurnal test HC measurement after 24hrs ± 6 min

DRIVING CYCLES
Type I Test

1. Modified Indian Driving Cycle (Bharat stage Norms)



Total test time: 1180 sec
Total distance: 10.647 km
Max. speed: 90 km/h
Maximal Acceleration: 0.833 m/s^2
Maximal Deceleration:1.389 m/s^2

Notes :

- **Type I Test :** Mass emission Test Cycle: MIDC
- **Type II Test :** Spark Ignition – idling CO & HC and high idle CO and λ,
  Compression Ignition – Free acceleration smoke
- **Type III Test :** Crankcase emission from vehicle is not permitted
- **Type IV Test :** Determination of evaporative emission (gasoline vehicles)
  (Hot Soak Loss Test -1 hr +Diurnal loss Test – 24hr) Limit :2g / test
- For Diesel vehicles, the emission of visible pollutants (smoke) shall not exceed the limit value of smoke density,when expressed as light absorption coefficient for various nominal flows as given on page No.77 when tested at constant speeds over the full load.
- IUPRm for BS-VI Vehicles manufactured on or after 1st April 2023 shall be greater than or equal to 0.1 .
- During type approval and COP applicable from 1st April, 2020, real world driving cycle emission measurement using PEMS shall be carried out for data collection and from 1st April, 2023 real world driving cycle emission conformity shall be applicable.

Engine Net Power Measurement Tolerance

Engine Type	Engine Type	Rated net power(%)	Other measurement points on the curve (%)	Tolerance for engine speed (%)
Type Approval	All	±2	±4	±2

Note: The engine power shall be measured on engine dynamometer and the measured power shall conform to the powerspecified in AIS 137 as amended from time to time, when tested as per the procedures laid down in AIS 137as amended from time to time

Type I Limits (BS-III & BS-IV)

	Effective Date	Category	Class	RM (kg)	CO (g/km)	HC (g/km)	NO_X (g/km)	HC + NO_X (g/km)	PM (g/km)	Evap. Emission (g/test)
Gasoline	BS- III 1 April 05 -NCR 11 Cities 1 Oct 10- Nationwide	M (GVW ≤ 2500 or up to 6 seater)	----	----	2.30	0.20	0.15	----	----	2.00
		N1 & M (GVW>2500 or above 6 seater)	I	RM ≤ 1305	2.30	0.20	0.15	----	----	
			II	1305<RM ≤1760	4.17	0.25	0.18	----	----	
			III	1760<RM	5.22	0.29	0.21	----	----	
	BS - IV 1 April 10 - NCR 13 Cities	M (GVW ≤ 2500 or upto 6 seater)	----	----	1.00	0.10	0.08	----	----	2.00
		N1 & M (GVW>2500 or above 6 seater)	I	RM ≤ 1305	1.00	0.10	0.08	----	----	
			II	1305<RM ≤1760	1.81	0.13	0.10	----	----	
			III	1760< RM	2.27	0.16	0.11	----	----	

For BS IV

2010.04	NCR,13 cities
2015.07	Above plus 29 cities mainly in the states of Haryana, Uttar Pradesh, Rajasthan and Maharashtra
2015.10	North India plus bordering districts of Rajasthan (9 states)
2016.04	Western India plus parts of south and East India
2017.04	Nationwide

	Effective Date	Category	Class	RM (kg)	CO (g/km)	HC (g/km)	NOx (g/km)	HC + NO x (g/km)	PM (g/km)
Diesel	BS- III 1 April 05 -NCR 11 Cities 1 Oct 10- Nationwide	M (GVW ≤ 2500 or upto 6 seater)	----	----	0.64	----	0.50	0.56	0.05
		N1 & M (GVW>2500 or above 6 seater)	I	RM ≤ 1305	0.64	----	0.50	0.56	0.05
			II	1305<RM≤1760	0.80	----	0.65	0.72	0.07
			III	1760< RM	0.95	----	0.78	0.86	0.10
	BS - IV 1 April 10 -NCR 13 Cities	M (GVW ≤ 2500 or upto 6 seater)	----	----	0.50	----	0.25	0.30	0.025
		N1 & M (GVW>2500 or above 6 seater)	I	RM ≤ 1305	0.50	----	0.25	0.30	0.025
			II	1305<RM≤1760	0.63	----	0.33	0.39	0.04
			III	1760< RM	0.74	----	0.39	0.46	0.06

For BS IV

2010.04	NCR,13 cities
2015.07	Above plus 29 cities mainly in the states of Haryana, Uttar Pradesh, Rajasthan and Maharashtra
2015.10	North India plus bordering districts of Rajasthan(9 states)
2016.04	Western India plus parts of south and East India
2017.04	Nationwide

Additional requirements

On-Board diagnostic (OBD) from BS IV

IOBD - I from 1 April 2010
-Discontinuity test: MIL must be activated if discontinuity of emission-related component occurs.

IOBD - II from 1 April 2013
-MIL must be activated if emission related components cause emission to exceed OBD threshold.

OBD Threshold

Category	Class	RM (kg)	CO (g/km)		HC (g/km)		NOx (g/km)		PM (g/km)
			Petrol	Diesel	Petrol	Diesel	Petrol	Diesel	Diesel
M (GVW ≤ 2500 or upto 6 seater)		All	3.20	3.20	0.40	0.40	0.60	1.20	0.18
N1 & M (GVW>2500 or above 6 seater)	I	RM ≤1305	3.20	3.20	0.40	0.40	0.60	1.20	0.18
	II	1305<RM≤1760	5.80	4.00	0.50	0.50	0.70	1.60	0.23
	III	1760 < RM	7.30	4.80	0.60	0.60	0.80	1.90	0.28

Emission Standards for Passenger Cars & Light Commercial Vehicles (BS IV)

Scope: M and N1 class I, II & III

Type I Test :
Exhaust emissions (MIDC)

Type II Test
Spark Ignition-Idling CO & HC, High Idle CO & λ
Compression Ignition-Free acceleration smoke

Type III Test
Crankcase emission from gasoline vehicle is not permitted

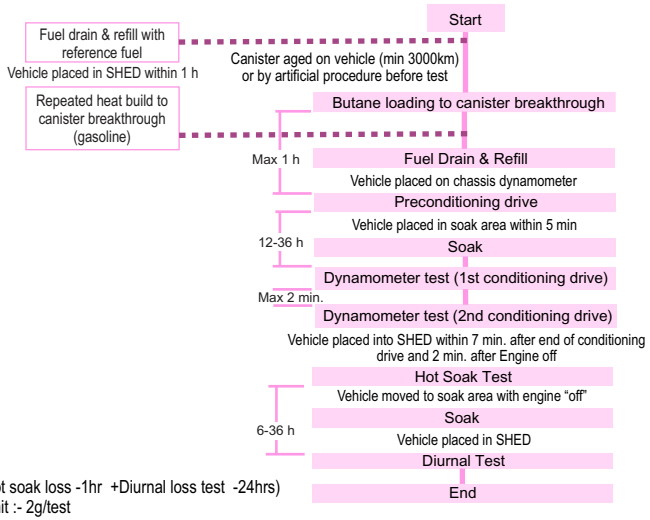
Type IV Test
Evaporative emissions measured in the SHED from gasoline vehicles.
(Hot soak loss -1hr +Diurnal loss test -24hrs) Limit:-2g/test

Type V Test
The durability of Anti Pollution Device is determined either by an actual durability run over 80,000 km or
by application of a fixed deterioration factor

Fixed Deterioration Factors

Engine category	CO	HC	NOx	HC+NOx	PM
Gasoline/Gaseous fuelled engines	1.2	1.2	1.2	NA	NA
Diesel Engines	1.1	NA	1	1	1.2

Type IV Test : Evaporative Test



(Hot soak loss -1hr +Diurnal loss test -24hrs)
Limit :- 2g/test

Fuel temperature:283K to 287K (10-14 °C))
40% ±2% of nominal tank capacity Ambient temperature :293K to 303K (20-30°C)

Butane /Nitrogen mixture loading at 40 g butane/hr to breakthrough of canister

Fuel temperature: 291K ± 8K (18 ± 8 °C)) 40% ± 2% of nominal tank capacity
Ambient temperature 293K - 303K (20-30°C)

1 X Part 1 + 2 X Part 2 of Type I test cycle T_{start} = 293 K to 303 K (20-30 °C)

Ambient temperature: 293K to 303 K (20-30°C) Oil and coolant temperatures must reach soak area temperature within ±3 K (±3 °C)

Type 1 test cycle T_{start} = 293 K to 303 K (20-30 °C)

Type 1: Part 1

Tmin = 296 K(23°C) Hot Soak Test
Tmax = 304 K(31°C) HC measurement
60 min ± 0.5min

T = 293 K ± 2K (20 ± 2 °C)) for at least 6 hours

1 Diurnal temperature profile with Tstart= 293 K (20 °C)) and Tmax = 308 K (35°C)) begins within 10 min after closing of the SHED together with initial HC - measurement. Final diurnal test HC measurement after 24h ± 6 min

Passenger Cars and Light Commercial Vehicles (Gasoline) Emission Standard History

1991 Norms From 1st Apr 1991

Category	CO (g/km)	HC (g/km)
rw ≤ 1020	14.30	2.00
1020 < rw ≤ 1250	16.50	2.10
1250 < rw ≤ 1470	18.80	2.10
1470 < rw ≤ 1700	20.70	2.30
1700 < rw ≤ 1930	22.90	2.50
1930 < rw ≤ 2150	24.90	2.70
rw > 2150	27.10	2.90

1996 Norms From 1st Apr 1996 *

Category	CO (g/km)	HC+NOx (g/km)
cc ≤ 1400	8.68	3.00
1400 < cc ≤ 2000	11.20	3.84
Above 2000	12.40	4.36

1998 Norms From 1st Apr 1998 *

Category	CO (g/km)		HC + NOx (g/km)	
	N-Cat	Cat	N-Cat	Cat
cc ≤ 1400	8.68	4.34	3.00	1.50
1400 < cc ≤ 2000	11.20	5.60	3.84	1.92
Above 2000	12.40	6.20	4.36	2.18

BS I Norms *

	Category	CO (g/km)	HC + NOx (g/km)
1stJune 1999 in National capital region of Delhi and in other case on and after 1st April 2000	All Passenger Cars	2.72	0.97

BS II Norms *

	Category			CO (g/km)	HC+NOx (g/km)
		Class	RM (kg)		
1st Apr 2000 & 2001 for M & N1 respectively in National Capital Region, 1st Jan 2001 in Mumbai, 1st Jul 2001 in Calcutta & in Chennai and in other case on and after 1st April 2005	M (GVW ≤ 2500 or upto 6 seater)	-	-	2.20	0.50
	N1 & M (GVW>2500 or above 6 seater)	I	RM ≤ 1250	2.20	0.50
		II	1250<RM ≤1700	4.00	0.60
		III	1700 < RM	5.00	0.70

* Evaporative Emission Test (1 hr Hot soak + 1 hr Diurnal loss test) Limit :- 2 g/test

N-cat - Vehicle without Catalytic Converter
Cat - Vehicle with Catalytic Converter

Passenger Cars and Light Commercial Vehicles (Diesel) Emission Standard History

1992 Norms From1st Apr 1992

Category RM (kg)	CO (g/km)	HC+NOx (g/km)	PM (g/km)
RM ≤ 1020	14.3	4.7	-
1020 < RM ≤ 1250	16.5	5.1	-
1250 < RM ≤ 1470	18.8	5.4	-
1470 < RM ≤ 1700	20.7	5.8	-
1700 < RM ≤ 1930	23.0	6.2	-
1930 < RM ≤ 2150	24.9	6.5	-
2150 > RM	27.1	6.9	-

BS I Norms

	Category RM (kg)	CO (g/km)	HC+NOx (g/km)	PM (g/km)
1st June 1999 in National capital region of Delhi and in other case on and after 1st April 2000	RM ≤ 1250	2.72	0.97	0.14
	1250<RM ≤ 1700	5.17	1.40	0.19
	1700< RM	6.90	1.70	0.25

1996 Norms From 1st Apr 1996

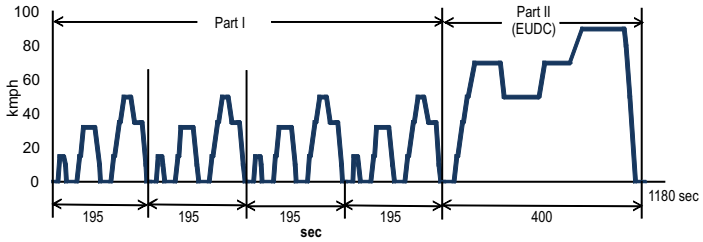
Category RM (kg)	CO (g/km)	HC+NOx (g/km)	PM (g/km)
RM ≤ 1020	5.00	2.00	-
1020 < RM ≤ 1250	5.70	2.20	-
1250 < RM ≤ 1470	6.40	2.50	-
1470 < RM ≤ 1700	7.00	2.70	-
1700 < RM ≤ 1930	7.70	2.90	-
1930 < RM ≤ 2150	8.20	3.50	-
2150 > RM	9.00	4.00	-

BS II Norms

	Category			CO (g/km)	HC+NOx (g/km)	PM (g/km)
		Class	RM (kg)			
1st Apr 2000 & 2001 for M & N1 respectively in National Capital Region, 1st Jan 2001 in Mumbai, 1st Jul 2001 in Calcutta & in Chennai and in other case on and after 1st April 2005	M (GVW ≤ 2500 or upto 6 seater)	-	-	1.00	0.70	0.08
	N1 & M (GVW>2500 or above 6 seater)	I	RM ≤ 1250	1.00	0.70	0.08
		II	1250<RM≤1700	1.25	1.00	0.12
		III	1700< RM	1.50	1.20	0.17

DRIVING CYCLES
Type I Test

1. Modified Indian Driving Cycle - For BSIII and BS IV (Bharat stage Norms)



Total test time: 1180 sec

Total distance: 10.647 km

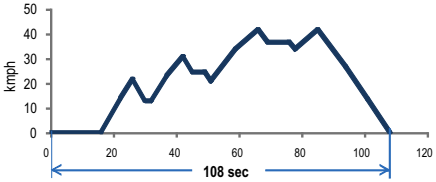
Max. speed: 90 km/h

Maximal Acceleration: 0.833 m/s^2

Maximal Deceleration:1.389 m/s^2

Note: BS I and BS II : 40 sec Idle will be added to cycle at start (Total test time:1220 sec)

2. Indian Driving Cycle for 4W (1991, 92, 96 & 98 Norms)



Cold Start

6 sample cycles (108 sec each)

Total Test Time :	648 sec
Total Distance :	3.948
Max speed :	42 kmph
Maximal Acceleration :	0.65 m/s^2
Maximal Deceleration :	0 .63 m/s^2

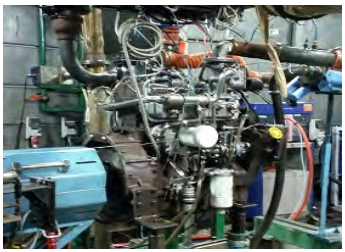
Dual Fuel Diesel – CNG Engine

ARAI upgraded an existing SUV diesel engine to operate on diesel-CNG dual fuel mode. Dual fuel engine was optimized on chassis dynamometer. Diesel replacement was achieved in the range of 20 – 60% and average diesel consumption reduced by 5%.

Tractor Engine Design & Development (for an Indian OEM)

ARAI designed and developed a new 4 Cylinder Tractor Diesel Engine from clean sheet for an Indian OEM to meet US EPA Tier-4 (MY 2013) Off-road Emission Norms. The emissions are met without DPF and SCR.

Tractor Engine Design & Development (for an Overseas OEM)



ARAI is designing and developing a family of new Tractor Diesel Engines from clean sheet for an overseas OEM to meet basically Tier3 emission norms with future upgradability to US EPA Tier-4 and Tier 5 Off-road Emission levels. Tier 3 emissions have been demonstrated on initial prototype engine for one configuration

The Emission Standards for Bharat Stage VI (BS-VI)

for category M and N vehicles having Gross Vehicle Weight
exceeding 3500kg., manufactured on or after 1st April 2020 for all models, as per GSR. 889(E) dt. 16th Sept 2016

Limit values for M&N category vehicles : BS-VI

	Limit values							
	CO mg/kWh	THC mg/kWh	NMHC mg/kWh	CH_4 mg/kWh	NOx mg/kWh	NH_3 (ppm)	PM mass mg/kWh	PM number (numbers/kWh)
WHSC (CI)	1500	130	—	—	400	10	10	$8.0x10^{11}$
WHTC (CI)	4000	160	—	—	460	10	10	$6.0x10^{11}$
WHTC (PI)	4000	–	160	500	460	10	10	$6.0x10^{11}$

Notes :
PI = Positive Ignition
CI = Compression Ignition

Deterioration Factors for BS-VI

Test cycle	CO	THC[1]	NMHC[2]	CH_4[2]	NOx	NH_3	PM mass	PM number
WHTC	1.3	1.3	1.4	1.4	1.15	1.0	1.05	1.0
WHSC	1.3	1.3	–	–	1.15	1.0	1.05	1.0

(1)Applies in case of a compression ignition engine.
(2)Applies in case of a positive ignition engine.

BSVI - OBD - I threshold for BS VI vehicles manufactured on or after 1st April 2020

	Limit in mg / kWh	
	NOx	PM Mass
Compression ignition engines	1500	Performance Monitoring (1)
Positive ignition engines	1500	—

(1) Performance Monitoring for wall - flow diesel particulate filter shall be as per AIS 137 and as amended time to time

BS-VI-OBD -II threshold for BS VI vehicles manufactured on or after 1st April 2023

	Limit in mg / kWh		
	NOx	PM Mass	CO
Compression ignition engines	1200	25	—
Positive ignition engines	1200	—	7500

World Not-To-Exceed (WNTE) Off-cycle laboratory testing limits for gaseous and particulate exhaust emissions.

Test cycle	CO mg/kWh	THC mg/kWh	NOx mg/kWh	PM mg/kWh
WNTE	2000	220	600	16

Applicability of Test Requirements for BS-VI

	Positive-ignition engines					Compression-ignition engines			Dual fuel engines
	Gasoline (E5)	CNG / Bio-methane/ Bio-Gas/LNG	LPG	E85	HCNG (Hydrogen + CNG)	Diesel (B7)	Ethanol (ED95)	Biodiesel blends up to 100% (1)	Diesel + (CNG/LNG)
Gaseous pollutants	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(2)
Particulate Mass	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(2)
PM number	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(2)
Durability	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(2)
OBD	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(2)
Off Cycle Emissions (WNTE)	--	--	--	--	--	Yes	Yes	Yes	Yes(2)
PEMS Demonstration test at Type Approval	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(2)
In-Service Conformity	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes(2)

(1) The vehicles/ engines fuelled with bio diesel blends up to 7% shall be tested with reference diesel (B7) and vehicles fuelled with Bio diesel blends above 7% will be tested with respective blends.

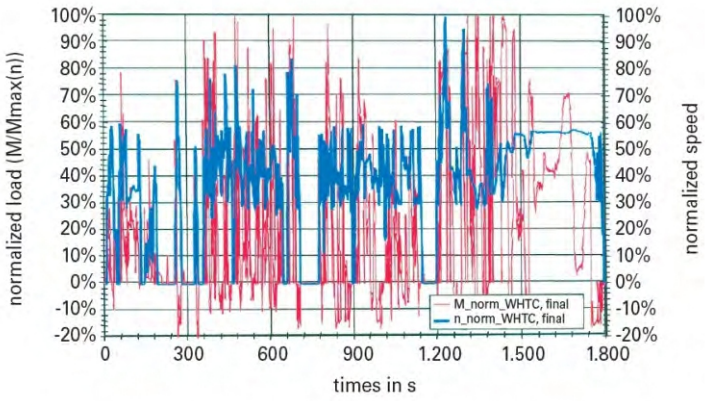
(2) The test applicability requirements for dual fuel engine is depending on the Gas Energy Ratio (GER) measured over the hot part of the WHTC test-cycle. GER classification shall be as per AIS 137 and as amended from time to time.

Minimum Service Accumulation Period - BS-VI

Category of vehicle in which engine will be installed	Useful Life Period	Minimum service accumulation period
Category N1 vehicles	1,60,000 km or 5 years	1,60,000 km
Category N2 vehicles	3,00,000 km or 6 years	1,88,000 km
Category N3 Vehicles with GVW equal to or less than 16,000 kg	3,00,000 km or 6 years	1,88,000 km
Category N3 Vehicles with GVW above 16,000 kg	7,00,000 km or 7 years	2,33,000 km
Category M2 vehicles	1,60,000 km or 5 years	1,60,000 km
Category M3 Vehicles with GVW equal to or less than 7,500 kg	3,00,000 km or 6 years	1,88,000 km
Category M3 Vehicles with GVW above 7,500 kg	7,00,000 km or 7 years	2,33,000 km

WHTC - World Heavy Duty Transient Cycle

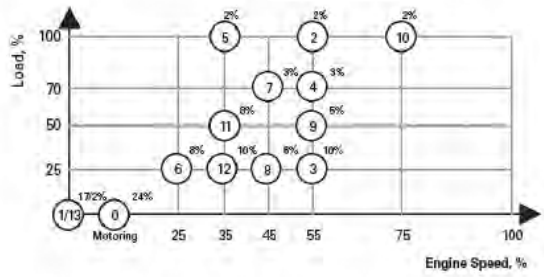
It is a second by second sequence of normalized speed and torque values



WHSC: World Heavy Duty Steady-State Cycle

WHSC - World Heavy Duty Steady-State Cycle
It consists of a number of speed and power modes which cover the typical operating range of HD engines

Idle mode is separated in 2 modes : Mode 1 : at the beginning of test cycle
Mode 13 : at the end of test cycle



Mode	Normalized Speed (%)	Normalized Torque (%)	Mode Length(s) incle .20 s Ramp
1	0	0	210
2	55	100	50
3	55	25	250
4	55	70	75
5	35	100	50
6	25	25	200
7	45	70	75
8	45	25	150
9	55	50	125
10	75	100	50
11	35	50	200
12	35	25	250
13	0	0	210
sum			1895

Notes :

- In case of vehicles equipped with Compression Ignition engines, the gaseous and particulate emissions shall be measured as per WHSC and WHTC cycles as per procedure described in AIS 137 as amended from time to time
- In case of vehicles equipped with positive Ignition engines, the gaseous and particulate emissions shall be measured as per WHTC cycle as per procedure described in AIS 137 as amended from time to time
- For CI engine vehicles, the emission of visible pollutants (smoke) shall not exceed the limit value of smoke density, page no 75. These smoke limits are without correction factor and engines are to be tested with conditioned air supplied to the engine to maintain atmospheric factor of 0.98 to 1.02.

Engine Net Power Measurement Tolerance

Engine Type	Engine Type	Rated net power(%)	Other measurement points on the curve (%)	Tolerance for engine speed (%)
Type Approval	All	±2	±4	±2
Conformity of production	All	±5	±10	±5

Note : The engine power shall be measured on engine dynamometer and the measured power shall conform to the power, specified and tested ap per procedure prescribed in AIS 137 as amended time to time.

- Idle Emissions:

  (a) The vehicles equipped with PI engine : Page No. 75

  (b) The vehicles equipped with CI engine : Page No. 76

- (a) During type approval and COP applicable from 1st April, 2020, emission measurement on vehicles using PEMS shall be carried out on road for data collection and from 1st April, 2023 in-service conformity factor shall be applicable. The detailed procedure is laid down in AIS137 and as amended from time to time

  (b) The type approval vehicle used for the PEMS demonstration test shall be representative for the vehicle category intended for the installation of the engine system. The vehicle may be a prototype vehicle or an adapted production vehicle.

  (c) For PEMS demonstration test at type approval, vehicle shall meet the requirements of in-service compliance from 1st April, 2023.

- The vehicles manufactured on or after 1st April, 2023 shall have the capability of assessing the in-use performance of on-board diagnostic, as per procedure laid down in AIS 137 and as amended time to time.

Emission Standards for Heavy Duty Commercial Engines

Heavy Duty Vehicles (GVW > 3500 kg)

	Effective date	Category	Test cycle	CO (g/kWh)	THC (g/kWh)	NOx (g/kWh)	NMHC (g/kWh)	CH4 (g/kWh)	PM[a] (g/kWh)	ELR smoke (m^{-1})[a]	Free accl. smoke (m^{-1})[a]
Diesel, CNG or LPG Engines	1.04.05 BS-III	Diesel, CNG or LPG vehicles with GVW >3500	Engine Steady state cycle (ESC)	2.10	0.66	5.00	NA	NA	0.10 / 0.13[b]	0.80	2.45
		Diesel , CNG or LPG vehicles with GVW >3500 with advanced exhaust after treatment system	Engine Transient Cycle (ETC)	5.45	0.78	5.00	NA	NA	0.16/ 0.21[b]	0.80	2.45
	1.04.10 BS-IV	Only Diesel vehicles with GVW >3500	Engine Steady state cycle (ESC)	1.50	0.46	3.50	NA	NA	0.02	0.50	1.62
		Diesel, CNG or LPG vehicles with GVW >3500	Engine Transient Cycle (ETC)	4.00	-	3.50	0.55[c]	1.10[d]	0.03	NA	NA

a - Only for Diesel Engines.
b - For engines having swept vol. <0.75 liter per cylinder & rated power speed >3000 rpm.
c - A manufacturer may choose to measure the mass of THC instead of NMHC
d - Only for CNG vehicles.

For BS IV

2010.04	NCR,13 cities
2015.07	Above plus 29 cities mainly in the states of Haryana, Uttar Pradesh, Rajasthan and Maharashtra
2015.10	North India plus bordering districts of Rajasthan(9 states)
2016.04	Western India plus parts of south and East India
2017.04	Nationwide

Deterioration Factor

i) Vehicle manufacture may opt for fixed deterioration factor

Engine Type	Test Cycle	CO	HC	NMHC	CH4	NOx	PM
Diesel Engine	ESC	1.1	1.05	----	----	1.05	1.1
Diesel Engine	ETC	1.1	1.05	----	----	1.05	1.1
CNG,LPG or Gaseous fulled engine	ETC	1.1	1.05	1.05	1.2	1.05	----

ii) Alternatively, vehicle manufacture may opt for evaluation of deterioration factor by minimum service accumulation period

Category of vehicle	Min. service accumulation period in km
Category N1 vehicles	100000
Category N2 vehicles	125000
Category N3 vehicles with GVW ≤ 16000kg	125000
Category N3 vehicles with GVW > 16000kg	167000
Category M2 vehicles	100000
Category M3 vehicles with GVW ≤ 7500kg	125000
Category M3 vehicles with GVW > 7500kg	167000

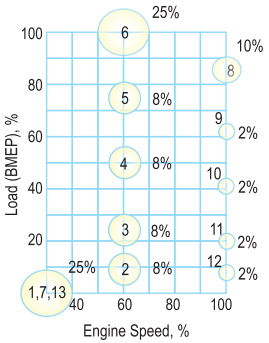
Heavy Duty Vehicles (GVW>3500 kg) Emission Regulation History

	Effective date	CO (g/kWh)	THC (g/kWh)	NOx (g/kWh)	PM (g/kWh)[d]	Free accl. smoke (m^{-1})	Remarks
Diesel, CNG or LPG Engines	1.4.1991 -1.4.1992 (1991 -1992 Norms)	14.00	3.50	18.00	NA	2.45	Exhaust gas opacity standard was effective from 01.04.1991
	1.4.1996 (1996 Norms)	11.20	2.40	14.40	NA	2.45	
	1.4.2000 (BS-I)	4.50	1.10	8.00	0.36 [a]	2.45	For diesel vehicles with GVW >3500
		4.50	1.10	8.00	0.36 [b]		For diesel vehicles with GVW ≤ 3500
					0.61 [c]		
	24.10.01 in NC Territory of Delhi (BS-II)	4.00	1.10	7.00	0.15	2.45	For diesel vehicles with GVW >3500 & For diesel vehicles with GVW ≤ 3500

a- For engines with power exceeding or not exceeding 85 kw.
b- For engines with power exceeding 85 kw.
c- For engines with power equal to or less than 85 kw.
d- Only for Diesel engines

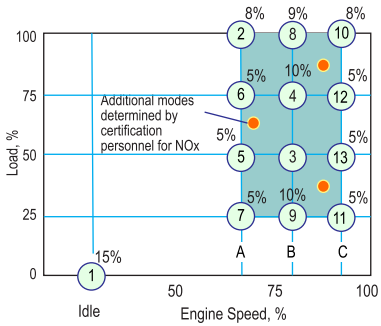
Test Cycles

Indian 13 Mode Emission Cycle (BS-I & BS-II)



Mode No.	Speed	Load %	Weighting Factors
1	idle	--	0.25/3
2	Maximum torque speed	10	0.08
3		25	0.08
4		50	0.08
5		75	0.08
6		100	0.25
7	idle	--	0.25/3
8	Rated power speed	100	0.1
9		75	0.02
10		50	0.02
11		25	0.02
12		10	0.02
13		--	0.25/3

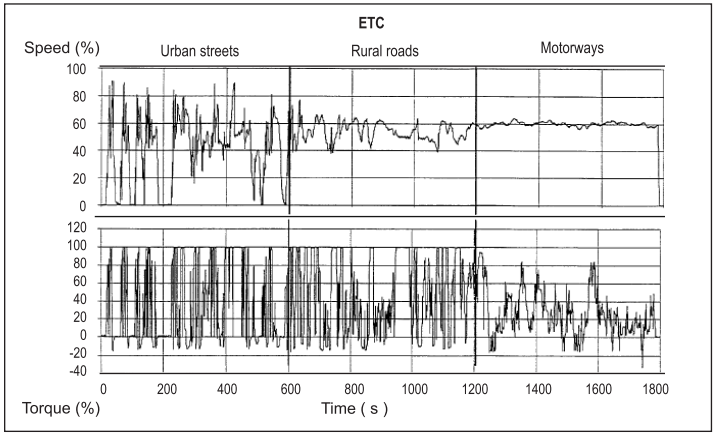
Engine Steady state cycle (ESC) (BSIII & BSIV)



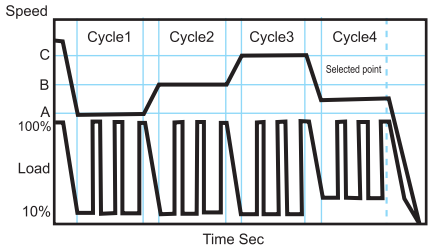
Mode No.	Speed	Load %	Weight Factors
1	Low idle	0	15
2	A	100	8
3	B	50	10
4	B	75	10
5	A	50	5
6	A	75	5
7	A	25	5
8	B	100	9
9	B	25	10
10	C	100	8
11	C	25	5
12	C	75	5
13	C	50	5

Engine Transient Cycle (ETC) (BS - III & BS - IV)

ETC Dynamometer Schedule



ELR Test Sequence (BS - III & BS - IV)



Prototype of Real-time Simulator

Laboratory level prototype of Real-time Simulator for EV / HEV systems

Portable on-board driver's aid system 'SAARATHI-OTG' (SAARTHI – On The Go)

This is a portable system which can be fitted on the vehicle dash board and run on 12 V DC power supply from vehicle battery. The system is easy to use and any drive cycle / pattern can be programmed using simple tools like MS Excel.

Battery Health Monitoring System

This BHMS has varied applications ranging from traction batteries, SLI batteries, UPS/inverter batteries, etc. It can be integrated on the battery, to monitor and evaluate battery performance & use pattern in terms of voltage, current, abuse, etc

Emission Standards For CNG & LPG Driven Vehicles

I) Mass emission standards for vehicles when operating on CNG shall be same as are applicable for gasoline vehicles with the exception that HC shall be replaced by NMHC, where NMHC= 0.3 x HC

II) Mass emission standards for vehicles when operating on LPG shall be same as are applicable for gasoline vehicles with the exception that HC shall be replaced by RHC, where RHC= 0.5 x HC

III) Crank case emission and SHED test are not applicable in CNG/LPG mode.

IV) Applicable emission norms for CNG & LPG driven vehicle

Category	Applicable Emission Norms
OE CNG / LPG Category M and Category N Vehicles with GVW ≤ 3500kg, 3 wheelers and 2 wheelers	Prevailing gasoline norms *
CNG / LPG Category M and Category N Vehicles with GVW ≤ 3500kg, 3 wheelers and 2 wheelers retro fitment from Gasoline	Prevailing gasoline norms
CNG / LPG Category M and Category N Vehicles with GVW ≤ 3500kg, 3 wheelers and 2 wheelers retro fitment from Diesel	Prevailing diesel norms**
CNG / LPG Category M and Category N Vehicles with GVW > 3500kg, manufactured upto1st April 2010	Prevailing diesel engine norms based on 13-mode steady-state engine dynamometer test or 13 -mode Engine steady state cycle as applicable **
CNG / LPG Category M and Category N Vehicles with GVW > 3500kg, manufactured on and from 1st April 2010	Prevailing diesel engine norms **

* - Vehicle having option for bi-fuel operation and fitted with limp-home gasoline tank of capacity not exceeding 2 liters, 3 liters and 5 liters respectively on 2W, 3W and 4W are exempted from emission test, crankcase emission test and SHED test in gasoline mode.

** - PM limit is not applicable

Mass Emission Standards for Diesel driven Agricultural Tractor, Construction Equipment Vehicle and Combine Harvester

As per GSR: 201(E) dt. 5th March 2018

Applicable emission limit for NRSC and NRTC test cycle (Bharat (Non-road) Stage IV)

Category, kW	Applicable with effect from	CO	HC	NOx	PM	Test Cycle*
		g/ kWh				
37 ≤ P < 56	1st October 2020	5.0	4.7 (HC+NOx)		0.025	NRSC & NRTC
56 ≤ P < 130	1st October 2020	5.0	0.19	0.4	0.025	
130 ≤ P < 560	1st October 2020	3.5	0.19	0.4	0.025	

*Test Cycle as describe in AIS: 137 and as amended from time to time.

Engine Test: To Determine Deterioration factor

Category (Power Band)	Emission durability period (hours)
≤ 37kW (constant speed Engines)	3000
≤ 37kW (Variable speed Engines)	5000
> 37 kW	8000

Engine manufacturers may select to use the following assigned multiplicative DFs.

Test cycle	CO	HC	NOx	PM
NRSC	1.3	1.3	1.15	1.05
NRTC	1.3	1.3	1.15	1.05

Applicable emission limit for NRSC and NRTC test cycle (Bharat (Non-road) Stage V)

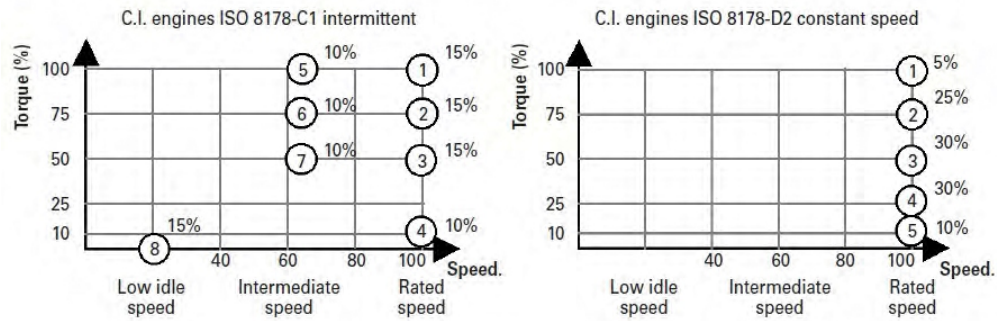
Category, kW	Applicable with effect from	CO	HC	NOx	PM	PN	Test Cycle
		g/kWh				#/kWh	
P < 8	1st April 2024	8.0	7.5 (HC+NOx)		0.4	—	NRSC
8 ≤P < 19	1st April 2024	6.6	7.5 (HC+NOx)		0.4	—	
19 ≤P < 37	1st April 2024	5.0	4.7 (HC+NOx)		0.015	1×10^{12}	NRSC and NRTC
37 ≤P < 56	1st April 2024	5.0	4.7 (HC+NOx)		0.015	1×10^{12}	
56 ≤P < 130	1st April 2024	5.0	0.19	0.4	0.015	1×10^{12}	
130 ≤P < 560	1st April 2024	3.5	0.19	0.4	0.015	1×10^{12}	
P≥ 560	1st April 2024	3.5	0.19	3.5	0.045	—	NRSC

Tolerance for gross power measurement

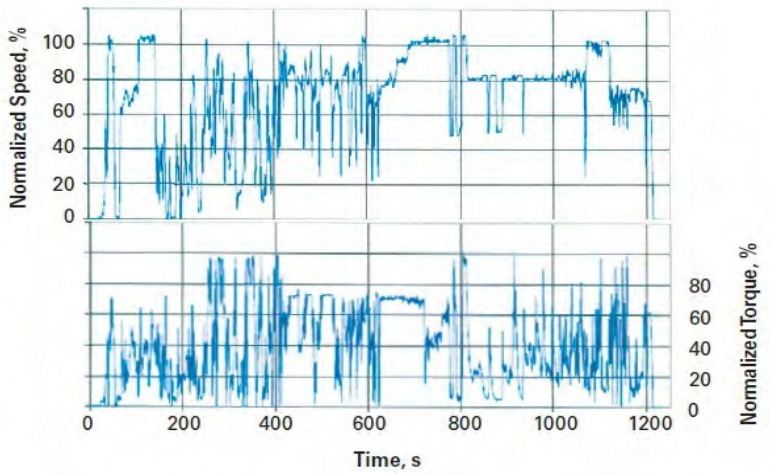
Engine Type	Rated power (%)	Other measurement points	Tolerance for engine
		on the curve (%)	speed (%)
Type approval	± 2	± 4	± 1.5
Conformity of production	± 5	± 10	± 5

Note: The Vehicles specified under this rule and manufactured after the 1st April 2026 shall be monitored for gaseous pollutants emission from in-service internal combustion engines installed on vehicles, as per procedure laid down in AIS: 137 and as amended from time to time.

NRSC (Non Road Steady State Cycle)



NRTC (Non Road Transient Cycle)



Off Road Vehicles / Engines - Diesel

I) Emission Standards for Agricultural Tractor

Bharat Stage Norms	Category	Effective date	Test cycle	CO (g/kWh)	HC (g/kWh)	NOx (g/kWh)	HC + NOx (g/kWh)	PM (g/kWh)	80% of full load smoke (m^{-1})
-	-	01.10.1999	ISO 8178-4 "C1" 8 mode cycle	14.00	3.50	18.00	-	-	3.25
-	-	28.07.2000	ISO 8178-4 "C1" 8 mode cycle	14.00	3.50	18.00	-	-	3.25
Trem II	-	01.06.2003	ISO 8178-4 "C1" 8 mode cycle	9.00	-	-	15.00	1.00	3.25
Trem III	-	01.10.2005	ISO 8178-4 "C1" 8 mode cycle	5.50	-	-	9.50	0.80	3.25
Trem III A	kW<8	01.04.2010	ISO 8178-4 "C1" 8 mode cycle	5.50	-	-	8.50	0.80	3.25
	8 ≤ kW<19			5.50	-	-	8.50	0.80	
	19 ≤ kW<37			5.50	-	-	7.50	0.60	
	37 ≤ kW<56	01.04.2011		5.00	-	-	4.70	0.40	
	56 ≤ kW<75			5.00	-	-	4.70	0.40	
	75 ≤ kW<130			5.00	-	-	4.00	0.30	
	130 ≤ kW<560			3.50	-	-	4.00	0.20	

The durability of engine is determined either by an actual durability run as per below table on engine dynamometer or by application of a fixed deterioration factor

Category (Power Band)	Useful life (hrs) (Emission Durability Period)
<19kW	3000
19< kW ≤ 37	5000
>37kW	8000

Fixed Deterioration Factor

CO	HC	NOx	PM
1.1	1.05	1.05	1.1

II) Emission Standards for Diesel Driven Power Tiller

Bharat Stage Norms	Category	Effective date	Test cycle	CO (g/kWh)	HC + NOx (g/kWh)	PM (g/kWh)	80% of full load smoke (m^{-1})
Trem II	-	01.10.2006	ISO 8178-4 "C1" 8 mode cycle	9.00	15.00	1.00	3.25
Trem III	-	01.04.2008	ISO 8178-4 "C1" 8 mode cycle	5.50	9.50	0.80	3.25

III) Emission Standards for Gasoline driven Power Tiller, Gasoline Driven Multi-utility Industrial Power Sweeper and Gasoline Driven Agriculture Tractor

Bharat Stage Norms	Category	Effective date	Test cycle	CO (g/kWh)	HC + NOx (g/kWh)
BS III	Power tiller	01.07.2013	ISO 8178-4 "C1" 8 mode cycle	14	24
BS III	Multi-utility Industrial power sweeper and agriculture tractor	01.10.2014	ISO 8178-4 "C1" 8 mode cycle	14	24

Emission Standards for Construction Equipment Vehicle (CEV)

Bharat Stage Norms	Category	Effective date	Test cycle	CO (g/kWh)	HC (g/kWh)	NOx (g/kWh)	HC+NOx (g/kWh)	PM (g/kWh)	80% of full load smoke (m^{-1})
-	-	18.01.96	ISO 8178-4 "C1" 8 mode cycle	14.00	3.50	18.00	-	-	3.25
-	-	28.07.00	ISO 8178-4 "C1" 8 mode cycle	14.00	3.50	18.00	-	-	3.25
BS-II	kW<8	01.10.08	ISO 8178-4 "C1" 8 mode cycle for Variable Speed Engines or	8.00	1.30	9.20	-	1.00	3.25
	8 ≤ kW<19			6.60	1.30	9.20	-	0.85	
	19 ≤ kW<37	01.10.07		6.50	1.30	9.20	-	0.85	
	37 ≤ kW<75		ISO 8178-4 "D2" 5 mode cycle for Constant Speed Engines	6.50	1.30	9.20	-	0.85	
	75 ≤ kW<130			5.00	1.30	9.20	-	0.70	
	130 ≤ kW<560			5.00	1.30	9.20	-	0.54	
BS-III	kW<8	01.04.2011	ISO 8178-4 "C1" 8 mode cycle for Variable Speed Engines or	8.00	-	-	7.50	0.80	3.25
	8 ≤ kW<19			6.60	-	-	7.50	0.80	
	19 ≤ kW<37			5.50	-	-	7.50	0.60	
	37 ≤kW<75		ISO 8178-4 "D2" 5 mode cycle for Constant Speed Engines	5.00	-	-	4.70	0.40	
	75 ≤kW<130			5.00	-	-	4.00	0.30	
	130 ≤kW<560			3.50	-	-	4.00	0.2	

Category (Power Band)	Useful life (hrs) (Emission Durability Period)
<19kW	3000
19 < kW ≤ 37 (constant speed)	3000
19 < kW ≤ 37 (variable speed)	5000
> 37kW	8000

Fixed Deterioration Factor

CO	HC	NOx	PM
1.1	1.05	1.05	1.1

The durability of engine is determined either by an actual durability run as per below table on engine dynamometer or by application of a fixed deterioration factor

Emission Standards for Genset Application
as per GSR 281(E) dt. 7th march 2016

Genset Application : Dedicatedly NG or LPG driven Engine (Up to 800 kW)

Power Category	Date of Implementation	CO (g/kW-hr)	NOx + NMHC or NOx + RHC (g/kW-hr)	Test Cycle
Upto 19 kW	1st July 2016	≤ 3.5	≤7.5	D1 – 3 mode Cycle Specified Under ISO – 8178 – Part 4
More than 19 kW upto 75 kW		≤3.5	≤4.7	
More than 75 kW upto 800 kW		≤3.5	≤4.0	

Genset Application : Petrol and NG or Petrol and LPG (Up to 19 kW) Powered by SI Engines (up to 400 CC)

Class	Date of Implementation	Engine Displacement (cc)	CO (g/kWh)	NOx + THC+ NOx + NMHC+ NOx + RHC (g/kWh)	Test Cycle
1	1st August 2016	Upto 99	≤ 250	≤ 12	D1 – 3 mode Cycle Specified Under ISO – 8178 –Part 4
2		>99 and upto 225	≤ 250	≤ 10	
3		> 225 ≤ 400	≤ 250	≤ 8	

Genset run on Diesel and Natural Gas (NG) or Diesel and Liquid Petroleum Gas (LPG) (Up to 800 kW)

Power Category	Date of Implementation	NOx + THC or NOx + NMHC or RHC (g/kWh)	CO (g/kWh)	PM	Smoke Limit (M^{-1})	Test Cycle
Upto 19 kW	1st July 2016	≤7.5	≤3.5	≤0.3	≤0.7	D2 – 5 mode Cycle Specified Under ISO – 8178 – Part 4
More than 19 kW upto75 kW		≤ 4.7	≤3.5	≤0.3	≤0.7	
More than 75 kW upto 800 kW		≤ 4.0	≤3.5	≤0.2	≤0.7	

Note: The emission standards for smoke and particulate matter shall be applicable, when diesel is used as fuel. Smoke limit prescribed in above Table shall not exceed throughout the operating load points of the test cycle

Emission Standards for Generator Sets
Generator Sets (upto19 kilowatt) run on Petrol and Kerosene

Displacement (CC)	Date of implementation	CO (g/kW-hr)		HC + NOx (g/kW-hr)		Test Cycle
		2 - Stroke engine	4 - Stroke engine	2 - Stroke engine	4 - Stroke engine	
≤ 65	01.06.2000	603	623	166	65	D1 -3 mode Cycle specified under ISO-8178-Part 4
> 65 ≤ 99		-	623	-	36	
>99 ≤ 225		-	623	-	19.3	
> 225		-	623	-	16.1	
≤ 65	01.06.2001	519		54		
> 65 ≤ 99		519		30		
>99 ≤ 225		519		16.1		
> 225		519		13.4		
≤ 99	01.08.2014	250		12		D1-3 mode Cycle specified under ISO-8178-Part 4
> 99 ≤ 225		250		10		
> 225		250		8		

Diesel Engines up to 800 kW, for Gensets Applications

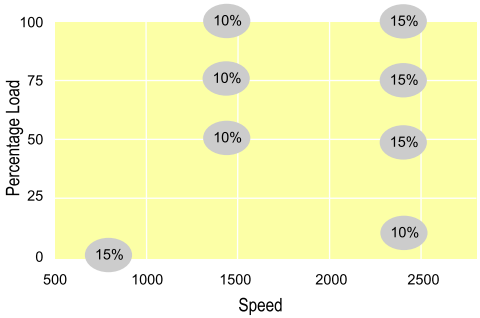
Power Category	Date of implementation	NOx (g/kW-hr)	THC (g/kW-hr)	NOx+THC (g/kW-hr)	CO (g/kW-hr)	PM (g/kW-hr)	Smoke (m^{-1}) at full load	Test Cycle
≤19 kW	1.7.2003	9.20	1.30	–	5.00	0.60	0.70	D2 - 5mode Cycle specified under ISO 8178 Part 4
	1.7.2004	9.20	1.30	–	3.50	0.30	0.70	
> 19 kW ≤ 50kW	1.7.2003	9.20	1.30	–	5.00	0.50	0.70	
	1.7.2004	9.20	1.30	–	3.50	0.30	0.70	
> 50 kW ≤ 260kW	1.7.2003	9.20	1.30	–	3.50	0.30	0.70	
> 260 kW ≤ 800kW	1.7.2004	9.20	1.30	–	3.50	0.30	0.70	
≤19 kW	1.7.2005	9.20	1.30	–	3.50	0.30	0.70	
>19 kW ≤176 kW	1.7.2004	9.20	1.30	–	3.50	0.30	0.70	
>176 kW ≤ 800 kW	1.11.2004	9.20	1.30	–	3.50	0.30	0.70	
≤ 19kw	1.07.2014	–	–	7.5	3.5	0.3	0.7*	D2 - 5mode Cycle specified under ISO 8178 Part 4
> 19kw ≤ 75kw	1.07.2014	–	–	4.7	3.5	0.3	0.7*	
> 75kw ≤ 800kw	1.07.2014	–	–	4.0	3.5	0.2	0.7*	

Note: 1) * Smoke shall not exceed above value throught the operating load of the test cycle

Test Cycles for Agriculture Tractors, CEV, Power Tiller Vehicles and Genset Engines

ISO 8178-4 "C1" 8 Mode Cycle

ISO 8178 C1 Cycle



ISO 8178 Cycles

Mode number	1	2	3	4	5	6	7	8	9	10	11
Torque %	100	75	50	25	10	100	75	50	25	10	0
Speed	Rated speed					Intermediate speed					Low idle
Off-road vehicles											
Type C1	0.15	0.15	0.15	-	0.10	0.10	0.10	0.10	-	-	0.15
Constant speed											
Type D1	0.30	0.50	0.20								
Type D2	0.05	0.25	0.30	0.30	0.10	-	-	-	-	-	-

Cycle C1 –Diesel powered, Agricutural tractor, Power tiller & CEV (variable speed)
Cycle D1 –Petrol & Kerosene powered Gensets
Cycle D2 –Diesel powered CEV (constant speed) & Gensets

Conformity of Production

2 Wheeler & 3 Wheeler (BS-II,BS-III,BS-IV & BS-VI) and Quadricycle (BS-IV)

Type of Vehicle	Annual Production / Import		COP Frequency	COP Sample
	Exceeding	Upto		
2,3 Wheeler and Quadricycle	250 per 6 months	10000 per year	Once every year	3
2 Wheeler	10000 per year	150000 per 6 months	Once every 6 months	3
2 Wheeler	150000 per 6 months	---	Once every 3 months	3
3 Wheeler and Quadricycle	10000 per year	75000 per 6 months	Once every 6 months	3
3 Wheeler and Quadricycle	75000 per 6 months	----	Once every 3 months	3

Note: For Quadricycle where the production of volume in 6 months is less than 250 per model including its variant the provisions contained in the provisos to rule 126A shall apply.

4 Wheeler Vehicles & Heavy Duty Engines greater than 3500 kg GVW

Category	COP Frequency	COP Sample
BS II*	Every 6 Months	1
BSIII**, BS IV **,BS VI**	Yearly	3

*In case of vehicle / engine model and its variants produced/imported are less than 5000 in any consecutive period of six months in a year, COP interval shall be one year.

**In case of vehicle / engine model and its variants produced/imported are less than 250 in any consecutive period of six months in a year, one vehicle / engine shall be tested for COP yearly

Agricultural Tractor, Power Tiller & CEV Engines

Category	COP Frequency	COP Sample
Annual production upto 200 Per Family/model	Once in 2 years	1
Annual production exceeding 200 Per Family/model	Once in Every Year	1

Conformity of Production

Genset

Category		COP Frequency	COP Sample
1. Domestically manufactured engines of more than 19 kW rated output		Once for every 1000 units, or once a year, whichever is earlier	1 per 1000 units
2. Imported engines of all ratings		Once for every 1000 units, or once a year, whichever is earlier	1 per 1000 units
3. Domestically manufactured engines of upto19 kW rated output			
Total No. of families	No.of families to be tested		
1 ~ 3	1	Once every year	4
4 ~ 7	2	Once every year	8
8 ~ 11	3	Once every year	12
12 ~ 15	4	Once every year	16
>15	5	Once every year	20

Emission Control From In-Use Vehicles

Pollution Under Control (PUC) Tests:

- Idle CO HC Emission Test for Gasoline vehicles

PETROL/CNG/LPG DRIVEN VEHICLES

PUC Tests – Revised Norms from 1st October 2014

Vehicle Type	CO (vol%)	HC (ppm)
Two wheelers (2/4 -stroke) (Vehicles manufactured on and before 31st March 2000)	4.5	9000
Two wheelers (2 -stroke) (Vehicles manufactured between 31st March 2000 and 31st March 2010)	3.5	6000
Two wheelers (4 -stroke) (Vehicles manufactured between 31st March 2000 and 31st March 2010)	3.5	4500
Two wheelers (2 -stroke) (Vehicles manufactured after 31st March 2010)	3.0	4000
Two Wheelers (4 - Stroke) (Vehicles manufactured after 31st March, 2010)	3.0	3000
Three Wheelers (2/4 - Stroke) (Vehicles manufactured on and before 31st March, 2000)	4.5	9000
Three Wheelers (2 - Stroke) (Vehicles manufactured after 31st March, 2000)	3.5	6000
Three Wheelers (4 - Stroke) (Vehicles manufactured after 31st March, 2000,	3.5	4500
Four Wheelers manufactured as per pre-Bharat Stage II emission norms	3.0	1500
Four Wheelers manufactured as per Bharat Stage-II or Bharat Stage-III Emission norms	0.5	750

For CNG Vehicles, NMHC = 0.3 x HC; For LPG Vehicles, RHC = 0.5 x HC

Emission Control From In-Use Vehicles

Pollution Under Control (PUC) Tests:

Diesel Vehicles

- Free Acceleration Smoke test for Diesel vehicles

Free acceleration test for turbo charged engine and naturally aspirated engine complying BSIII and below norms	65 HSU (2.45 m^{-1})
Free acceleration test for turbo charged engine and naturally aspirated engine complying BSIV and above norms	50 HSU (1.62 m^{-1})

PUC Tests – BS-IV compliant 4 wheelers

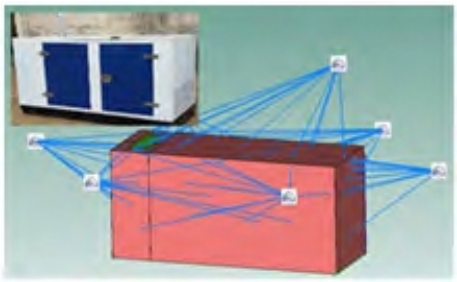
Vehicle Type	Idle		High Idle	
	CO (vol%)	HC (ppm)	CO (vol%)	Lamda (2500+/-200 rpm)
BS-IV compliant 4 Wheeler Petrol Vehicle	0.3	200	0.2	1+/ - 0.03
BS-IV compliant 4 Wheeler CNG/LPG Vehicle	0.3	200	–	--
BS-IV compliant 4 Wheeler Diesel Vehicles	50 HSU (1.62 m^{-1})			

Limits for smoke Density

Nominal Flow G(½)	Light Absorption K(1/m)	Nominal Flow G(½)	Light Absorption K(1/m)
42	2.26	120	1.37
45	2.19	125	1.345
50	2.08	130	1.32
55	1.985	135	1.30
60	1.90	140	1.27
65	1.84	145	1.25
70	1.775	150	1.205
75	1.72	160	1.19
80	1.665	165	1.17
85	1.62	170	1.155
90	1.575	175	1.14
95	1.535	180	1.125
100	1.495	185	1.11
105	1.465	190	1.095
110	1.425	195	1.08
115	1.395	200	1.065

Note: The Smoke Limits are without correction factors and engines are to be tested with conditioned air supplied to the engine to maintain atmospheric factor of 0.98 to 1.02.

Acoustic Enclosure Design using SEA



ARAI has developed capability for SEA based high frequency noise simulations aided by conventional CAE tools to provide much needed complete frequency range solutions for automotive and non-automotive applications.

SIZE INDIA – Anthropometrical Data of Indian Driving Population

This is one of the largest anthropometric survey in India for civilian population. It has Anthropometric measurements of more than 5000 people, more than 100 body dimensions along with 3-D surface data for every subject . a comprehensive report providing detailed analysis of Size India Survey is available

BS VI Petrol (E5)

Parameter	Unit	Limits1		Test method
		Minimum	Maximum	
Research octane number, RON		95.0	--	EN25164/prENISO5164
Motor octane number, MON		85.0	–	EN25163/prENISO5163
Density at 15°C	kg/m^3	743	756	ENISO 3675/ENISO12185
Vapour pressure	kPa	56.0	60.0	ENISO 13016-1(DVPE)
Water content	%v/v		0.015	ASTME 1064
Distillation:				
–Evaporated at 70°C	%v/v	24.0	44.0	ENISO 3405
–Evaporated at 100°C	%v/v	48.0	60.0	ENISO 3405
–Evaporated at 150°C	%v/v	82.0	90.0	ENISO 3405
–Final boiling point	°C	190	210	ENISO 3405
Residue	%v/v	__	2.0	ENISO 3405
Hydro-carbon analysis:				
–Olefins	% V/V	3.0	13.0	ASTMD 1319
–Aromatics	% V/V	29.0	35.0	ASTMD 1319
–Benzene	% V/V	--	1.0	EN 12177
–Saturates	% V/V	Report		ASTM 1319
Carbon/hydrogen ratio		Report		
Carbon/oxygen ratio		Report		
Induction period [2]	minutes	480		ENISO 7536
Oxidation content [4]	%m/m	Report		EN1601
Existent gum	mg/m1	–	0.04	ENISO 6246
Sulphur content [3]	mg/kg	–	10	ENISO 20846/ENISO20884
Copper corrosion		–	Class 1	ENISO 2160
Lead content	mg/1	–	5	En237
Phosphorus content	mg/1	–	1.3	ASTMD 3231
Ethanol[5]	% V/V	4.7	5.3	EN 1601 / EN 13132

1 The values quoted in the specifications are "truevalues". For establishing the limit values, the terms of ISO4259:2006 (Petroleum products— Determination and application of precision data in relation to methods of test) have been applied and for fixing a minimum value, a minimum difference of 2 R above zero has been taken into account; for fixing a maximum and minimum value, the minimum difference is 4R (R=reproducibility). Notwithstanding this measure, which is necessary for technical reasons, the fuel manufacturer shall nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value when quoting maximum and minimum limits. Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of ISO4259:2006 shall be applied.

2 The fuel may contain oxidation inhibitors and metal deactivators normally used to stabilize refinery petrol streams, but detergent/dispersive additives and solvent oils shall not be added.

3 The actual sulphur content of the fuel used for the type I test shall be reported.

4 Ethanol meeting the specification of prEN15376 is the only oxygenate that shall be intentionally added to the reference fuel.

5 There shall be no intentional addition to this reference fuel of compounds containing phosphorus, iron, manganese or lead.

BS VI Reference Fuel (E85)

Parameter	Unit	Limits[1]		Test method [2]
		Minimum	Maximum	
Research octane number, RON		95.0	–	EN ISO 5164
Motor octane number, MON		85.0		EN ISO 5163
Density at 15°C	kg/m^3	Report		ISO 3675
Vapour pressure	kPa	40.0	60.0	EN ISO 13016-1 (DVPE)
Sulphur content [3,4]	mg/kg	–	10.0	EN ISO 20846 EN ISO 20884
Oxidation stability	minutes	360		EN ISO 7536
Existent gum content (solvent washed)	mg / (100ml)	–	5	EN-ISO 6246
Appearance This shall be determined at ambient temperature or 15°C whichever is higher		Clear and bright, visibly free of suspended or precipitated contaminants		Visual inspection
Ethanol and higher alcohols[7]	% V/V	83	85	EN 1601 EN 13132 EN 14517
Higher alcohols (C3-C8)	% V/V		2.0	
Methanol	% V/V		0.5	
Petrol [5]	% V/V	Balance		EN 228
Phosphorus	mg/1		0.3[6]	ASTM D 3231
Water content	% V/V		0.3	ASTM D 1064
Inorganic chloride content	mg/1		1	ISO 6227
pHe		6.5	9.0	ASTM D 6423
Copper strip corrosion (3h at 50°C)	Rating	Class 1		EN ISO 2160
Acidity (as acetic acid CH_3COOH)	%m/m mg/1		0.005 (40)	ASTM D 1613
Carbon/hydrogen ratio		Report		
Carbon/oxygen ratio		Report		

1. The values quoted in the specifications are "true values". In establishment of limit values the terms of ISO 4259 Petroleum products-Determination and application of precision data in relation to methods of test have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a Maximum and minimum value, the minimum difference is 4R (R=reproducibility). Notwithstanding this measure, which is necessary for technical reasons, the manufacturer of fuels shall nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of ISO 4259 shall be applied.
2. In case of dispute, the procedure for dissolving the dispute and interpretations of the results based on test method precision, describe in EN ISO 4259 shall be used.
3. In case of national dispute concerning sulphur content, either EN ISO 20846 or EN IS) 20884 shall be called up similar to the reference in the National annex of EN 228.
4. The actual sulphur content of the fuel used for the Type I Test shall be reported.
5. The unleaded petrol content can be determined as 100-minus the sum of the per cent content of water and alcohol.
6. There shall be no intentional addition of compounds containing phosphorus, iron, manganese, or lead to this reference fuel.
7. Ethanol to meet the specification of EN 15376 is the only oxygenate that shall be intentionally added to this reference fuel.

BS VI ReferenceFuel (ED95)[1]

Parameter	Unit	Limits[2] Minimum	Maximum	Test method[3]
Total alcohol (Ethanol including content on higher saturated alcohols)	% m/m	92.4		EN 15721
Other higher saturated mono-alcohols (C3-C5)	% m/m		2.0	EN 15721
Methanol	% m/m		0.3	EN 15721
Density 15°C	kg/m3	793.0	815.0	EN ISO 12185
Acidity, calculated as acetic acid	% m/m		0.0025	EN 15491
Appearance	Bright and clear			
Flashpoint	°C	10		EN 3679
Dry residue	mg/kg		15	EN 15691
Water content	% m/m		6.5	EN 15489[4] EN-ISO 12937 EN15692
Aldehydes calculated as acetaldehyde	% m/m		0.0050	ISO 1388-4
Esters calculated as ethylacetat	% m/m		0.1	ASTM D1617
Sulphur content	mg/kg		10.0	EN 15485 EN 15486
Sulphates	mg/kg		4.0	EN 15492
Particulate contamination			24	EN 12662
Phosphorus	mg/1		0.20	EN 15487
Inorganic chloride	mg/kg		1.0	EN 15484 or EN 15492
Copper	mg/kg		0.100	EN 15488
Electrical conductivity	µS/cm		2.50	DIN 51627-4 or prEN 15938

1 Additives are necessary to fulfil the ED95 fuel specification such as cetane improver as specified by the engine manufacturer, shall be added to the ethanol fuel, as long as no negative side effects are known. If these conditions are satisfied, the maximum allowed amount is 10% m/m.

2 Denaturants for ED95 fuel, if required, shall be approved by the vehicle manufacturer or shall be either Ethyl Tert Butyl Ether (ETBE); or Iso butanol; or Methyl Ethyl Ketone (MEK); or Tert butanol or Iso Propanol.
The values quoted in the specifications are "true values". In establishment of their limit values the terms of ISO 4259 Petroleum products - Determination and application of precision data in relation to methods of test have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R ® =reproducibility). Notwithstanding this measure, which is necessary for technical reasons, the manufacturer of fuels shall nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of ISO 4259 shall be applied.

3 Equivalent EN/ISO methods will be adopted when issued for properties listed above.

4 Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of EN 15489 shall be applied".

BS VI Ethanol Fuel : E100 as per IS 15464:2004

Sr. No.	Characteristic	Requirement
1	Relative density at 15.6/15.6 OC, max	0.7961
2	Ethanol content percent by volume at (excluding denaturant)	99.5
3	Miscibility with water	Miscible
4	Alkalinity	Nil
5	Acidity (as CH3COOH) mg/l, max	30
6	Residue on evaporation percent by mass, Max	0.005
7	Aldehyde content (as CH3CHO) mg/l, max	60
8	Cooper mg/kg, max	0.1
9	Conductivity, µ S/m, max	300
10	Methyl alcohol, mg/litre, max	300
11	Appearance	Clear and bright

BS VI Hydrogen Fuel

Characteristics	Units	Limits		Test Method
		Minimum	Maximum	
Hydrogen Purity	% mole	98	100	ISO 14687-1
Total Hydrocarbon	µmol/mol	0	100	ISO 14687-1
Water[1]	µmol/mol	0	2	ISO 14687-1
Oxygen	µmol/mol	0	2	ISO 14687-1
Argon	µmol/mol	0	2	ISO 14687-1
Nitrogen	µmol/mol	0	2	ISO 14687-1
CO	µmol/mol	0	1	ISO 14687-1
Sulphur	µmol/mol	0	2	ISO 14687-1
Permanent Particulates[3]				ISO 14687-1

(1) Not to be condensed

(2) Combined water, oxygen, nitrogen, argon: 1.900 µmol/mol.

(3) The hydrogen shall not contain dust, sand, dirt, gums, oils or other substances in an amount sufficient to damage the fuelling station equipment of the vehicle (engine) being fuelled.

BS VI Diesel Fuel (B7)

Parameter	Unit	Limits1		Test method
		Minimum	Maximum	
Cetane Index		46.0		EN ISO 4264
Cetane number [2]		52.0	56.0	EN ISO 5165
Density at 15°C	kg/m3	833.0	837.0	EN ISO 12185
Distillation:				
- 50% point	°C	245.0	—	EN ISO 3405
- 95% point	°C	345.0	360.0	EN ISO 3405
- final boiling point	°C	—	370.0	EN ISO 3405
Flash point	°C	55	—	EN ISO 2719
Cloud point	°C	—	-10	EN 23015
Viscosity at 40°C	mm^2/s	2.30	3.30	EN ISO 3104
Polycyclic aromatic hydrocarbons	%m/m	2.0	4.0	EN I12916
Sulphur content	mg/kg	—	10.0	EN ISO 20846 EN ISO 20884
Copper corrosion 3hrs 50 °C		—	Class1	EN ISO 2160
Conradson carbon residue (10 % DR)	% m/m	—	0.20	EN ISO 10370
Ash content	% m/m	—	0.010	EN ISO 6245
Total contamination	mg/kg	—	24	EN 12662
Water content	mg/kg	—	200	EN ISO 12937
Acid number	mg KOH/g	—	0.10	EN ISO 6618
Lubricity (HFRR wear scan diameter at 60°C)	µm	—	400	EN ISO 12156
Oxidation stability@110 °C[3]	h	20.0		EN 15751
FEME [4]	%v/v	6.0	7.0	EN 14078

1 The values quoted in the specifications are 'true values'. In establishment of their limit values the terms of ISO 4259 Petroleum products – Determination and application of precision data in relation to methods of test have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility). Notwithstanding this measure, which is necessary for technical reasons, the manufacturer of fuels shall nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of ISO 4259 shall be applied.

2 The range for cetane number is not in accordance with the requirements of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms of ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

3 Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice shall be sought from the supplier as to storage conditions and life.

4 FAME content to meet the specification of EN 14214.

BIO Diesel

Biogas (Biomethane) As Per IS 16087 : 2013

Sr No.	Characteristic	Requirement	Method of Test
1	CH_4 percent Min	90	S 15130 (Part 3)
2	Moisture ,mg/m^3 Max	16	IS 15641 (Part 2)
3	H_2S,mg/m^3 Max	30.3	ISO 6326-3
4	CO_2 +N_2+O_2,percent Max (v/v)	10	IS 15130 (Part 3)
5	CO_2 percent Max (v/v) (when intended for filling in cylinders)	4	IS 15130 (Part 3)
6	O2,Percent Max (v/v)	0.5	IS 15130 (Part 3)

Reference Diesel Fuel Specification for BHARAT STAGE (Non Road) BS IV & BS V

Parameter	Unit	Limit (1)		Test method
		Min	Max	
Cetane Index		46.0		EN-ISO 4264
Cetane number [2]		52.0	56.0	EN-ISO 5165
Density at 15°C	kg/m^3	833.0	837.0	EN-ISO 12185
Distillation:				
-50% point	°C	245.0	-	EN-ISO 3405
-95% point	°C	345.0	360.0	EN-ISO 3405
-final boiling point	°C	-	370.0	EN-ISO 3405
Flash point	°C	55	-	EN-ISO 2719
Cloud point	°C	-	-10	EN 23015
Viscosity at 40°C	mm^2/s	2.30	3.30	EN-ISO 3104
Polycyclic Aromatic Hydrocarbons	% m/m	2.0	4.0	EN 12916
Sulphur content	mg/kg	-	10.0	EN-ISO 20846 EN-ISO 20884
Copper corrosion 3hrs, 50°C		-	Class 1	EN-ISO 2160
Conradson carbon residue (10% DR)	% m/m	-	0.20	EN-ISO 10370
Ash content	% m/m	-	0.010	EN-ISO 6245
Total contamination	mg/kg	-	24	EN 12662
Water content	mg/kg	-	200	EN-ISO 12937
Acid number	mg KOH/g	-	0.10	EN-ISO 6618
Lubricity (HFRR wear scan diameter at 60°C)	µm	-	400	EN-ISO 12156
Oxygen stability at 110°C [3]	h	20.0		EN 15751
FAME [4]	%v/v	6.0	7.0	EN 14078

1 The values quoted in the specifications are 'true values'. In establishment of their limit values the terms of ISO 4259 Petroleum products – Determination and application of precision data in relation to methods of test have been applied and in fixing a minimum value, a minimum difference of 2R above zero has been taken into account; in fixing a maximum and minimum value, the minimum difference is 4R (R = reproducibility). Notwithstanding this measure, which is necessary for technical reasons, the manufacturer of fuels shall nevertheless aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify whether a fuel meets the requirements of the specifications, the terms of ISO 4259 shall be applied.

2 The range for cetane number is not in accordance with the requirements of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms of ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

3 Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice shall be sought from the supplier as to storage conditions and life.

4 FAME content to meet the specification of EN 14214.

BS - IV Petrol

Parameter	Unit	Limit (1)		Test method
		Min	Max	
Research Octane Number, RON		95.0	-	EN 25164
Motor Octane Number, MON		85.0	-	EN 25163
Density at 15 °C	kg/m^3	740.0	754.0	ISO 3675
Reid Vapour Pressure	kPa	56.0	60.0	Pr EN ISO 13016-1(DVPE)
Distillation:				
evaporated at 70 °C	% v/v	24.0	40.0	EN-ISO 3405
evaporated at 100 °C	% v/v	50.0	58.0	EN-ISO 3405
evaporated at 150 °C	% v/v	83.0	89.0	EN-ISO 3405
final boiling point	°C	190.0	210.0	EN-ISO 3405
Residue	% v/v	-	2.0	EN-ISO 3405
Hydrocarbon Analysis				
Olefins	% v/v	-	10.0	ASTM D 1319
Aromatics	% v/v	29.0	35.0	ASTM D 1319
Benzene	% v/v	-	1.0	ASTM D 1319
Saturates	% v/v	Report		EN 12177
Carbon/ Hydrogen ratio		Report		ASTM D1319
Induction Period [2]	minutes	480	-	EN ISO 7536
Oxygen content	% m/m	-	1.0	EN 1601
Existent gum	mg/ml	-	0.04	EN ISO 6246
Sulphur content[3]	mg/kg	-	10	ASTM D 5453
Copper corrosion		-	Class 1	EN ISO 2160
Lead content	mg/l	-	5	EN 237
Phosphorus content	mg/l	-	1.3	ASTM D 3231

1 The values quoted in the specifications are “true values”. In establishment of their limit values the terms of ISO4 259 “Petroleum products – Determination and application of precision data in relation to methods of test” have been applied and infixing a minimum value, a minimum difference of 2R above zero has been taken in to account; in fixing a maximum and minimum value, the minimum difference is 4R (R=reproducibility)

2 Not with standing this measure, which is necessary for technical reasons, the manufacturer of fuels should never the less aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the questions as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

3 The range for cetane number is not in accordance with the requirements of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms of ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

4 The actual sulphur content of the fuel used for the Type I test shall be reported.

BS - IV Diesel

Parameter	Unit	Limit (1)		Test method
		Min	Max	
Cetane number [2]		52.0	54.0	EN-ISO 5165
Density at 15°C	kg/m^3	833	837	EN-ISO 3675
Distillation:				
-50% point	°C	245	-	EN-ISO 3405
-95% point	°C	345	350	EN-ISO 3405
-final boiling point	°C	-	370	EN-ISO 3405
Flash point	°C	55	-	EN 22719
CFPP	°C	-	-5	EN 116
Viscosity at 40°C	mm^2/s	2.3	3.3	EN-ISO 3104
Polycyclic Aromatic Hydrocarbons	% m/m	3.0	6.0	IP 391
Sulphur content [3]	mg/kg	-	10	ASTM D 5453
Copper corrosion		-	Class 1	EN ISO 2160
Conradson carbon residue (10% DR)	% m/m	-	0.2	EN-ISO 10370
Ash content	% m/m	-	0.01	EN-ISO 6245
Water content	% m/m	-	0.02	EN-ISO 12937
Neutralisation (strong acid) number	mg KOH/g	-	0.02	ASTM D 974
Oxidation stability [4]	mg/ml	-	0.025	EN-ISO 12205
Lubricity (HFRR wear scan diameter at 60°C)	µm	-	400	CEC F-06-A-96
FAME		PROHIBITED		

1 The values quoted in the specifications are “true values”. In establishment of their limit values the terms of ISO4 259 “Petroleum products – Determination and application of precision data in relation to methods of test” have been applied and infixing a minimum value, a minimum difference of 2R above zero has been taken in to account; in fixing a maximum and minimum value, the minimum difference is 4R (R=reproducibility)

2 Not with standing this measure, which is necessary for technical reasons, the manufacturer of fuels should never the less aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the questions as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

3 The range for cetane number is not in accordance with the requirements of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms of ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

4 The actual sulphur content of the fuel used for the Type I test shall be reported.

5 Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life

BS IV - CNG

For Category M and Category N Vehicles not exceeding 3,500 Kgs GVW

Characteristic	Units	Basis	Limits		Test method
			Min	Max	
Reference fuel G_{20}					
Composition:					
Methane	% mole	100	99	100	ISO 6974
Balance (1)	% mole	-	-	1	ISO 6974
N_2	% mole				ISO 6974
Sulphur content	mg/m^3 (2)	-	-	10	ISO 6326- 5
Wobbe Index (net)	MJ/m^3 (3)	48.2	47.2	49.2	
Reference fuel G_{25}					
Composition:					
Methane	% mole	86	84	88	ISO 6974
Balance (1)	% mole	-	-	1	ISO 6974
N_2	% mole	14	12	16	ISO 6974
Sulphur content	mg/m^3 (2)	-	-	10	ISO 6326- 5
Wobbe Index (net)	MJ/m^3 (3)	39.4	38.2	40.6	

(1) Inerts(different from N_2) + C_2+ C_{2+}.
(2) Value to be determined at 293, 2 K (20°C) and 101.3 kPa.
(3) Value to be determined at 273,2 K (0°C) and 101.3 kPa.

For Vehicles above 3,500 Kgs GVW

Characteristic	Units	Basis	Limits		Test method
			Min	Max	
Reference fuel G_R					
Composition:					
Methane		87	84	89	
Ethane		13	11	15	
Balance (1)	% -mole	-	-	1	ISO 6974
Sulphur content	mg/m^3 (2)	-	-	10	ISO 6326-5
(1) Inerts (different from N2) + $C2_+$					
Reference fuel G_{23}					
Composition:					
Methane		92.5	91.5	93.5	
Balance (1)	% mole	-	-	1	ISO 6974
N_2		7.5	6.5	8.5	
Sulphur content	mg/m^3 (2)	-	-	10	ISO 6326-5
Reference fuel G_{25}					
Composition:					
Methane		86	84	89	
Balance (1)	% mole	-	-	1	ISO 6974
N_2		14	12	16	
Sulphur content	mg/m^3 (2)	-	-	10	ISO 6326-5

(1) Inerts (different from N2) + C2+ C2+.
(2) Value to be determined at standard conditions (293.2 K (20°C) and 101.3 kPa).

Note : Commercial CNG fuel shall be used for testing till availability of reference fuel

BS - IV LPG

For Category M and Category N Vehicles not exceeding 3,500 Kgs GVW

Parameter	Unit	Fuel A	Fuel B	Test method
Composition				ISO 7941
C_3-content	% vol.	30± 2	85±2	
C_4-content	% vol.	balance	balance	
$<C_3, >C4$	% vol.	max. 2	max. 2	
Olefins	% vol.	max. 12	max. 15	
Evaporation residue	mg/kg	max. 50	max. 50	ISO 13757
Water at 0 ° C		free	free	Visual inspection
Total sulphur content	mg/kg	max. 10	max. 10	EN 24260
Hydrogen sulphide		none	none	ISO 8819
Copper strip corrosion	Rating	Class 1	Class 1	ISO 6251 (1)
Odour		Characteristic	Characteristic	
Motor Octane Number		min. 89	min. 89	EN 589 Annex B

(1) This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited.

For Category M and Category N Vehicles above 3,500 Kgs GVW

Parameter	Unit	Fuel A	Fuel B	Test method
Composition				ISO 7941
C_3-content	% vol.	50± 2	85 ±2	
C_4-content	% vol.	balance	balance	
$<C_3, >C4$	% vol.	max. 2	max. 2	
Olefins	% vol.	max. 12	max. 14	
Evaporation residue	mg/kg	max. 50	max. 50	ISO 13757
Water at 0 ° C		free	free	Visual inspection
Total sulphur content	mg/kg	max. 10	max. 10	EN 24260
Hydrogen sulphide		none	none	ISO 8819
Copper strip corrosion	Rating	Class 1	Class 1	ISO 6251 (1)
Odour		Characteristic	Characteristic	
Motor Octane Number		min. 92.5	min. 92.5	EN 589 Annex B

(1) This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited.

BS-III Petrol

Parameter	Unit	Limits (1)		Test Method
		Minimum	Maximum	
Research Octane Number, RON		95	-	EN 25164
Motor Octane Number, MON		85	-	EN 25163
Density at 15 °C	kg/m^3	748	762	ISO 3675
Reid Vapour Pressure	kPa	56	60	EN 12
Distillation:				
- Initial Boiling Point	°C	24	40	EN-ISO 3405
- Evaporated at 100°C	% v/v	49	57	EN-ISO 3405
- Evaporated at 150°C	% v/v	81	87	EN-ISO 3405
- final boiling point	°C	190	215	EN-ISO 3405
Residue	% v/v	-	2	EN-ISO 3405
Hydrocarbon analysis:				
Olefins	% v/v	-	10	ASTM D 1319
Aromatics	% v/v	28	40	ASTM D 1319
Saturates	% v/v	Balance		ASTM D 1319
Benzene	% v/v	-	1	pr. EN 12177
Carbon/Hydrogen ratio		Report		
Oxidation Stability(2)	minutes	480	-	EN -ISO 7536
Oxygen content	% m/m	-	2.3	EN 1601
Existent gum	mg/ml	-	0.04	EN -ISO 6246
Sulphur content (3)	mg/kg	-	100	Pr-EN ISO /Dis 14596
Copper corrosion		-	class 1	EN -ISO 2160
Lead content	mg/l	-	5	EN 237
Phosphorus content	mg/l	-	1.3	ASTM D 3231

1 The values quoted in the specifications are “true values”. In establishment of their limit values the terms of ISO 4259 “Petroleum products–Determination and application of precision data in relation to methods of test” have been applied and infixing a minimum value, a minimum difference of 2R above zero has been taken in to account; in fixing a maximum and minimum value, the minimum difference is 4R (R=reproducibility).
Not withstanding this measure, which is necessary for technical reasons, the manufacturer of fuels should never the less aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the questions as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

2 The fuel may contain oxidation inhibitors and metal deactivator normally used to stabilize refinery gasoline streams ,but detergent /dispersive additives and solvant oils must be added

3 The actual sulphur content of the fuel used for the Type I test shall be reported.

BS-III Diesel

Parameter	Unit	Limits(1)		Test Method
		Minimum	Maximum	
Cetane number (2)		52	54	EN - ISO 5165
Density at 15°C	kg/m^3	833	837	EN - ISO 3675
Distillation :				
-50% point	°C	245	-	EN - ISO 3405
-95% point	°C	345	350	EN - ISO 3405
-final boiling point	°C	-	370	EN - ISO 3405
Flash Point	°C	55	-	EN 22719
CFPP	°C	-	-5	EN 116
Viscosity at 40°C	mm^2/s	2.5	3.5	EN - ISO 3104
Polycyclic Aromatic Hydrocarbons	% m/m	3	6	IP 391
Sulphur content (3)	mg/kg	-	300	Pr. EN-ISO/DIS14596
Copper corrosion		-	1	EN - ISO 2160
Conradson carbon residue (10% DR)	% m/m	-	0.2	EN - ISO 10370
Ash content	% m/m	-	0.01	EN - ISO 6245
Water content	%m/m	-	0.05	EN - ISO 12937
Neutralisation (strong acid) number	mg KOH/g	-	0.02	ASTM D 974-95
Oxidation stability (4)	mg/ml	-	0.025	EN - ISO 12205
New and better method for poly-cyclicaromatics under development	%m/m	-	-	EN 12916

1 The values quoted in the specifications are “true values”. In establishment of their limit values the terms of ISO4 259 “Petroleum products – Determination and application of precision data in relation to methods of test” have been applied and infixing a minimum value, a minimum difference of 2R above zero has been taken in to account; in fixing a maximum and minimum value, the minimum difference is 4R (R=reproducibility)
Not with standing this measure, which is necessary for technical reasons, the manufacturer of fuels should never the less aim at a zero value where the stipulated maximum value is 2R and at the mean value in the case of quotations of maximum and minimum limits. Should it be necessary to clarify the questions as to whether a fuel meets the requirements of the specifications, the terms of ISO 4259 should be applied.

2 The range for cetane number is not in accordance with the requirements of a minimum range of 4R. However, in the case of a dispute between fuel supplier and fuel user, the terms of ISO 4259 may be used to resolve such disputes provided replicate measurements, of sufficient number to archive the necessary precision, are made in preference to single determinations.

3 The actual sulphur content of the fuel used for the Type I test shall be reported.

4 Even though oxidation stability is controlled, it is likely that shelf life will be limited. Advice should be sought from the supplier as to storage conditions and life

BS - III CNG

Characteristics	Units	Basis	Limits		Test method
			Min	Max.	
Reference fuel G 20					
Composition:					
Methane	% mole	100	99	100	ISO 6974
Balance [Inerts (different from N2) + C2 +C2+]	% mole	-	-	1	ISO 6974
N_2	% mole	-	-	-	ISO 6974
Sulphur content	mg/m 3 (1)	-	-	50	ISO 6326-5
Reference fuel G 23					
Composition:					
Methane	% mole	92.5	91.5	93.5	ISO 6974
Balance [Inerts (different from N2) + C2 +C2+]	% mole	-	-	1	ISO 6974
N_2	% mole	7.5	6.5	8.5	ISO 6974
Sulphur content	mg/m 3 (1)	-	-	50	ISO 6326-5
Reference fuel G 25					
Composition:					
Methane	% mole	86	84	88	ISO 6974
Balance [Inerts (different from N2) + C2 +C2+]	% mole	-	-	1	ISO 6974
N_2	% mole	14	12	16	ISO 6974
Sulphur content	mg/m 3 (1)	-	-	50	ISO 6326-5

(1) Value to be determined at 293.2 K (20 °C) and 101.3 kPa

BS - III LPG

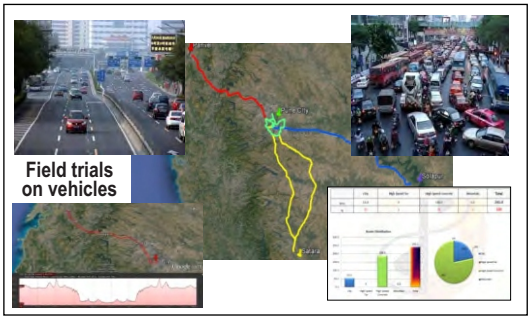
Parameter	Unit	Fuel A		Fuel B		Test method
		Min	Max	Min	Max	
Motor Octane Number		93.5		93.5		EN 589 Annx B
Composition :						
C3-content	% vol	48	52	83	87	ISO 7941
C4-content	% vol	48	52	13	17	ISO 7941
Olefins	% vol	0	12	9	15	ISO 7941
Evaporation residue	mg/kg		50		50	NFM 41-015
Total sulphur content	pmm weight (1)	-	50		50	EN 24260
Hydrogen sulphide	-		None		None	ISO 8819
Copper strip corrosion	Rating		class 1		Class1	ISO 6251 (2)
Water at 0 °C			Free		Free	Visual inspection

(1) Value to be determined at standard conditions 293.2K (20°C) and 101.3kPa

(2) This method may not accurately determine the presence of corrosive materials if the sample contains corrosion inhibitors or other chemicals which diminish the corrosivity of the sample to the copper strip. Therefore, the addition of such compounds for the sole purpose of biasing the test method is prohibited

Note : Commercial CNG / LPG fuel shall be used for testing till availability of reference fuel

Material Compatibility and Emission Performance Measurement with Alternate Fuels



Laboratory Evaluation through Immersion Study

Engine system component evaluation for wear rating

Fuel Consumption Calculation

The fuel consumption FC expressed in km per liter (in case of petrol, LPG & diesel) or in km/m3 (in case CNG) are calculated by carbon balance method using measured emissions of carbon dioxide (CO_2) and other carbon related emissions (hydrocarbons HC, carbon monoxide CO) in g/km.

i) For vehicles with a positive ignition engine fuelled with petrol:
$FC= 100 * D /\{(0.1154)*[(0.866*HC)+(0.429*CO)+ (0.273*CO_2)]\}$

ii) For vehicles with a positive ignition engine fuelled with LPG
$Fc_{norm}= 100 * (0.538) /\{(0.1212)*[(0.825*HC)+(0.429*CO)+ (0.273*CO_2)]\}$

If the composition of the fuel used for the test differs from the composition that is assumed for the calculation of the normalised consumption, on the manufacturer's request a correction factor cf may be applied, as follows:

$Fc_{norm} = 100 * (0.538) / \{(0.1212) \cdot (cf) \cdot [(0.825 \cdot HC) + (0.429 \cdot CO) + (0.273 \cdot CO_2)]\}$

The correction factor cf, which may be applied, is determined as follows:

$cf = 0.825 + 0.0693 \cdot n_{actual}$

where:
n_{actual} = the actual H/C ratio of the fuel used.

iii) For vehicles with a positive ignition engine fuelled with NG
$Fc_{norm} = 100 * (0.654) /\{(0.1336)*[(0.749*HC)+(0.429*CO)+ (0.273*CO_2)]\}$

iv) For vehicles with a compression ignition engine
$FC= 100 * D /\{(0.1155)*[(0.866*HC)+(0.429*CO)+ (0.273*CO_2)]\}$

In these formulae:

D = the density of the test fuel.

For the purpose of these calculations, the fuel consumption shall be expressed in appropriate units and the following fuel characteristics shall be used,

(a) Density: measured on the test fuel according to ISO 3675 or an equivalent method. For petrol and diesel fuel density measured at 15° C will be used; for LPG and natural gas a reference density will be used, as follows:
0.538 kg/liter for LPG
0.654 kg/m3 for NG*/
*/ Mean value of G20 and G23 reference fuels at 15°C.

(b) Hydrogen - carbon ratio: fixed values will be used which are:
1.85 for petrol
1.86 for diesel fuel
2.525 for LPG
4.00 for NG

For Vehicles with PI Engines

With Petrol E(5)Fuel:FC = (0.118/D)x[(0.848xHC)+(0.429xCO)+(0.273xCO_2)]

With Petrol E (10) Fuel :FC = (0.120/D)x[(0.830xHC)+(0.429xCO)+(0.273xCO_2)]

With Ethanol E(85) Fuel :FC = (0.120/D)x[(0.830xHC)+(0.429xCO)+(0.273xCO_2)]

H_2CNG Fuel: $FC = \left\{ \frac{(910.4 \times A + 13.600)}{(44.655 \times A^2 + 667.08 \times A)} \right\} X \left\{ \frac{(7.848 \times A)}{(9.104 \times A + 136)} \times HC + 0.429 \times CO + 0.273 \times CO_2 \right\}$

For Vehicles with CI Engines

With Diesel (B5) Fuel: FC = (0.116/D) X [(0.861xHC)+(0.429xCO)+(0.273xCO_2)]

With Diesel (B7) Fuel: FC = (0.116/D) X [(0.859xHC)+(0.429xCO)+(0.273xCO_2)]

For Vehicle Fuelled by gaseous hydrogen

$$FC = 0.024 \frac{V}{d} \left[\frac{1}{Z_1} \frac{P_1}{T_1} - \frac{1}{Z_2} \frac{P_2}{T_2} \right]$$

HC = the measured emission of hydrocarbons in g/km
CO= the measured carbon monoxide in g/km
Co_2 = the measured carbon dioxide in g/km
H_2O = the measured emission of H_2O in g/km
H_2 = the measured emission of H_2 in g/km
A = Quantity of NG/biomthane within the H2CNG mixture,in %V

D = Density of Test fuel .In case of gaseous fuels this is density at 15 °C
d = theoretical distance covered by vehicle tested under the Type I test in km
p_1= Pressure in gaseous fuel tank before operating cycle in Pa
p_2 = Pressure in gaseous fuel tank after operating cycle in Pa
T_1 = Temperature in gaseous fuel tank before the operating cycle in K
T_2 = Temperature in gaseous fuel tank after the operating cycle in K
Z_1 = Compressibility factor of the gaseous fuel at p_1 & T_1
Z_2 = Compressibility factor of the gaseous fuel at p_2 & T_2
V = Inner volume of the gaseous fuel tank in m^3

Note: The fuel consumption ,expressed in litres per 100 km (in case of petrol (E5/E10),LPG,ethanol (E 85),and diesel (B5/B7) in m^3 per 100km (in the case of NG/biomethane and H2NG) or in Kg per 100 km(in case of hydrogen) is calculated by these formulae.

Compressibility Factor

		T (K)									
		5	100	200	300	400	500	600	700	800	900
p(bar)	33	0.859	1.051	1.885	2.648	3.365	4.051	4.712	5.352	5.973	6.576
	53	0.965	0.922	1.416	1.891	2.338	2.765	3.174	3.57	3.954	4.329
	73	0.989	0.991	1.278	1.604	1.923	2.229	2.525	2.81	3.088	3.358
	93	0.997	1.042	1.233	1.47	1.711	1.947	2.177	2.4	2.617	2.829
	113	1	1.066	1.213	1.395	1.586	1.776	1.963	2.146	2.324	2.498
	133	1.002	1.076	1.199	1.347	1.504	1.662	1.819	1.973	2.124	2.271
	153	1.003	1.079	1.187	1.312	1.445	1.58	1.715	1.848	1.979	2.107
	173	1.003	1.079	1.176	1.285	1.401	1.518	1.636	1.753	1.868	1.981
	193	1.003	1.077	1.165	1.263	1.365	1.469	1.574	1.678	1.781	1.882
	213	1.003	1.071	1.147	1.228	1.311	1.396	1.482	1.567	1.652	1.735
	233	1.004	1.071	1.148	1.228	1.312	1.397	1.482	1.568	1.652	1.736
	248	1.003	1.069	1.141	1.217	1.296	1.375	1.455	1.535	1.614	1.693
	263	1.003	1.066	1.136	1.207	1.281	1.356	1.431	1.506	1.581	1.655
	278	1.003	1.064	1.13	1.198	1.268	1.339	1.409	1.48	1.551	1.621
	293	1.003	1.062	1.125	1.19	1.256	1.323	1.39	1.457	1.524	1.59
	308	1.003	1.06	1.12	1.182	1.245	1.308	1.372	1.436	1.499	1.562
	323	1.003	1.057	1.116	1.175	1.235	1.295	1.356	1.417	1.477	1.537
	338	1.003	1.055	1.111	1.168	1.225	1.283	1.341	1.399	1.457	1.514
	353	1.003	1.054	1.107	1.162	1.217	1.272	1.327	1.383	1.438	1.493

In the case that the needed input values for p and T are not indicated in the table , the compressibility factor shall be obtained by linear interpolation between the compressibility factors indicated in the table , choosing the once that are closest to the sought value

Fuel Consumption Standards for M1 Vehicles with GVW<3.5 ton as per S.O 1072(E)

Each Manufacturer of motor vehicle shall comply with energy consumption standard in terms of average fuel consumption standards

Average fuel consumption standard = a x (w-b) + c

a = constant multiplier

Average fuel consumption standard = Average fuel consumption standard of manufacturer in petrol equivalent liter per 100 kilimeter;

b = fixed constant;

c = fixed constant;

W = Weighted average of unladen mass in kilogram (kg) for all new said motor vehicle,manufactured or imported for sale by the manufacturer

Constant Multiplier and Fixed Constant Table

For fiscal years 2017-18 to 2021-22

a	0.0024
b	1037
c	5.4922
Average Fuel Consumption standard for manufacturer	= 0.0024 x (W-1037) + 5.4922

For fiscal year 2022-23 onwards

a	0.002
b	1145
c	4.7694
Average Fuel Consumption standard for manufacturer	= 0.002 x (W-1145) + 4.7694

Weighted average Unladen mass (W) = $W = \Sigma N_i W_i / \Sigma N_i$

N_i = Number of the said motor manufactured or imported for sale in India of a model I in the respective fiscal year;

W_i = Unladen mass in kilogram of a model i in the respective fiscal year

Average of Actual Fuel Consumption = $W = \Sigma K_i N_i FC_i / \Sigma N_i$

Where

N_i = Number of vehicles manufactured or imported for sale of a model i

FC_i = Petrol equivalent fuel consumption in liter per 100 kilometer of a model i

K_i = Equivalent vehicle credits for electric vehicles;

(a)The actual fuel consumption of every model in terms of the liter per 100 kilometer)in case of petrol, LPG or diesel) and in kilogram per one hundred kilometer in case of CNG shall be calculated by following formulae:

FC petrol	= 0.04217 X CO_2
FC diesel	= 0.03776 X CO_2
FC LPG	= 0.06150 X CO_2
FC CNG	= 0.03647 X CO_2

CO_2 = the measured emission of carbon dioxide in gram per kilometer as per type approval ;

(b) The Actual fuel consumption of every electrically driven model shall be measured in terms of kwh per one hundred kilometer as per type approval

(c) The actual fuel consumption in petrol equivalent for diesel ,LPG,CNG and electricity driven motor vehicles shall be obtained by multiplying the actual fuel consumption referred to in (a) and (b) above with correction factors specified below

Fuel Type	Conversion Factor to Petrol equivalent
Diesel	1.1168
LPG	0.6857
CNG	1.1563
Electricity	0.1028

Transmission & Gearbox Test Center (TGTC) at HTC

Transmission & Gearbox Test Centre at ARAI-Homologation & Technology Centre, Chakan is a state-of-the-art transmission development lab in the country, engaged in research, development & evaluation of all types of transmission systems, such as Manual, Automatic, Continuously Variable (CVT), Automated Manual (AMT), Dual Clutch, and Hybrid Driveline for vehicles ranging from three wheelers, passenger cars, light & heavy commercial vehicles, tractors and earth movers.

International Maritime Organization(IMO) Regulation
Emission Norms applicable for Indian Vessels plying to International Waters

NOx Implementation Scheme

Ship Constructed (≥1 January)	Application of Standard	Emission Limits	Compliance at engine's delivery except as below
1990 to 2000 Retroactive to existing engines	Engine size > 5000kW and ≥ 90 liters per cylinder displ.	Tire I	1st IAPP Renewal Survey ≥ 12 mo after IMO advised by party of availability (physical & cost) of "upgrade kit"
2000 ≤ X < 2011	> 130kW		-----
2011 ≤ X < 2016		Tire II	
≥ 2016	Ship ≥ 24m L or total propulsion power ≥ 750 kW		Operation outside of ECA
		Tire III	Operation within ECA

NOx Emission Standards

RPM	Total weight of NO2 Emission (g/kWh)			Relative No2 Reduction from Tire I
	<130	130≤n<2000	≥2000	
Tire I	17	$45*n^{(-0.2)}$	9.8	Current
Tire II	14.4	$44*2^{(-0.23)}$	7.7	15.5% - 12.8%
Tire III	3.4	$9*n^{(-0.2)}$	2	80%

AdBlue specification data sheet

	Unit	Min. Limit	Max. Limit
DIN 70070 ISO 22241			
Urea concetration	% by weight	31.8	33, 2
Density at 20 °C	kg/cm³	1087	1093
Refractive index at 20°C		13814	13, 843
Alkalinity	% by weight	-	0,2
Carbonate	% by weight	-	0,2
Biuret	% by weight	-	0,3
Aldehyde	mg/kg	-	5
Insoluble	mg/kg	-	20
Phosphate	mg/kg	-	0,5
Calcium	mg/kg	-	0,5
Iron	mg/kg	-	0,5
Copper	mg/kg	-	0,2
Zinc	mg/kg	-	0,2
Chromium	mg/kg	-	0,2
Nickel	mg/kg	-	0,2
Aluminium	mg/kg	-	0,5
Magnesium	mg/kg	-	0,5
Sodium	mg/kg	-	0,5
Potassium	mg/kg	-	0,5

National Ambient Air Quality Standard (CPCB)

Rev on 16th Nov 2009 as per GSR 826 (E)

Sr. No.	Pollutants	Time Weighted Average	Concentration in Ambient Air		Method of Measurement
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Govt.)	
1	Sulphur Dioxide (SO2), µg/m^3	Annual *	50	20	Improved West and Gaeke Method
		24 hours**	80	80	Ultraviolet Fluorescence
2	Nitrogen Dioxide (NO2), µg/m^3	Annual *	40	30	Modified Jacob & Hochheiser Modified
		24 hours**	80	80	(Na-Arsenite) Method / Chemiluminescence
3	Particulate Matter (size less than 10 µm) or PM 10, µg/m^3	Annual *	60	60	Gravimetric / TEOM / Beta Attenuation
		24 hours**	100	100	
4	Particulate Matter(size less than 2.5 µm) or PM2.5, µg/m^3	Annual *	40	40	Gravimetric / TEOM / Beta Attenuation
		24 hours**	60	60	
5	Ozone (O3), µg/m^3	8 hours**	100	100	UV Photometric technology
		1 hour*	180	180	Chemiluminescence / Chemical Method

continued..

6	Lead (Pb), µg/m^3	Annual*	0.5	0.5	AAS /ICP Method after sampling using EPM 2000 or equivalent
		24 hours**	1	1	ED XRF using Teflon Filter
7	Carbon Monoxide (CO), mg/m^3	8 hours**	2	2	Non Dispersive Infra Red (NDIR) Spectroscopy
		1 hour*	4	4	
8	Ammonia (NH3) , µg/m^3	Annual *	100	100	Chemiluminescence
		24 hours**	400	400	Indophenol- blue method
9	Benzene(C6H6), µg/m^3	Annual *	5	5	Gas Chromatography based continuous analyzer/ Adsorption & desorption followed by GC analysis
10	Benzo a Pyrene (BaP) (particulate phase only), ng/m^3	Annual *	1	1	Solvent extraction followed by HPLC/GC analysis
11	Arsenic, ng/m^3	Annual *	6	6	AAS /ICP Method after sampling on EPM 2000 or equivalent filter paper
12	Nickel, ng/m^3	Annual *	20	20	

* Annual Arithmatic Mean of minimum 104 measurments in a year at a particular site taken twice in a week 24 hrly at uniform intervals
** 24 hourly or 08 hourly or 01 hourly monitored values as applicable shall be complied with 98% of the time, they may exceed the limits but not on two consecutive days of monitoring

Note : Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be consider adequate reason to institute regular or continuous monitoring and further investigation

Ambient Air Quality Standards in respect of Noise (CPCB) Under the Noise Pollution (Regulation and Control) Rules, 2000

The Principal Rules were published in the Gazette of India, vide S.O. 123(E), dated 14.2.2000 and subsequently amended vide S.O. 1046(E), dated 22.11.2000, S.O. 1088(E), dated 11.10.2002, S.O. 1569 (E), dated 19.09.2006 and S.O. 50 (E) dated 11.01.2010 under the Environment (Protection) Act, 1986.)

Area Code	Category of Area / Zone	Limits in dB (A) Leq*	
		Day Time	Night Time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

Note :

1. Day time shall mean from 6.00 a.m. to 10.00 p.m.
2. Night time shall mean from 10.00 p.m. to 6.00 a.m.
3. Silence zone is an area comprising not less than 100 metres around hospitals, educational institutions, courts, religious places or any other area which is declared as such by the competent authority
4. Mixed categories of areas may be declared as one of the four above mentioned categories by the competent authority.

* dB(A) Leq denotes the time weighted average of the level of sound in decibels on scale A which is relatable to human hearing.

A “decibel” is a unit in which noise is measured.

“A”, in dB(A) Leq, denotes the frequency weighting in the measurement of noise and corresponds to frequency response characteristics of the human ear.

Leq: It is an energy mean of the noise level over a specified period.

Global Warming Potential of Green House Gases (GHGs)

Green House Gases	Formula	Pre-industrial conc.	1995 conc.	Global Warming Potential (Over Time Horizon of 100 years)
Carbon Dioxide	CO2	278 ppm	360 ppm	1
Methane	CH4	700 ppb	1721 ppb	23
Nitrous Oxide	N2O	275 ppb	315 ppb	296
Dichlorodifluoro Methane (CFC-12)	CCI2F2	0	0.5 ppb	6200 - 7100
Chlorodifluoro Methane (HCFC-22)	CHCIF2	0	0.1 ppb	1300 - 1400
Perfluoro Methane	CF4	0	0.07 ppb	6500
Sulfur hexa fluoride	SF6	0	0.03 ppb	23900

Lead (Pb), µg/m^3	• Absorbed into blood; similar to calcium • Accumulates in blood, bones, muscles, fat • Damages organs – kidneys, liver, brain, reproductive system, bones (osteoporosis) • Brain and nervous system – seizures, mental retardation, behavioral disorders, memory problems, mood changes, • Young children - lower IQ, learning disabilities • Heart and blood – high blood pressure and increased heart disease
Carbon Monoxide (CO) mg/m^3	• Reacts with hemoglobin in blood • Forms carboxyhemoglobin (HbCO) rather than oxyhemoglobin (HbO2) • Prevents oxygen transfer • Low-level: cardiovascular and neurobehavior • High-level: headaches/nausea/fatigue to possible death • Oxygen deficient people esp. vulnerable (anemia, chronic heart or lung disease, high altitude residents, smokers) • Cigarette smoke: 400-450 ppm; • smoker's blood 5-10% HbCO vs 2% for non-smoker
Ammonia (NH3) , µg/m^3	• Causes immediate burning of the eyes, nose, throat and respiratory tract and can result in blindness, lung damage or death • Inhalation of lower concentrations can cause coughing, and nose and throat irritation.
Benzene(C6H6), µg/m^3	Short Term Exposure Headaches, vomiting, disorientation, shakiness, elevated heart rate, and loss of consciousness Long Term Exposure Exposed to it over a long period of time are at the highest risk for developing benzene-related illnesses, which range from anemia to cancer like Leukemia.

Benzo a Pyrene (BaP) (particulate phase only), ng/m^3	Short-term health effects • Skin rash or eye irritation with redness and/or a burning sensation. • Exposure to sunlight and the chemical together can increase these effects. Long-term health effects • probable cancer-causing agent in humans • it causes skin, lung, and bladder cancer in humans and in animals
Arsenic, ng/m^3	Exposure to inorganic arsenic can cause various health effects, viz., • irritation of the stomach and intestines, • decreased production of red and white blood cells, • skin changes and lung irritation • damage DNA Uptake of significant amounts of inorganic arsenic can intensify the • chances of cancer development especially development of skin cancer, lung cancer, liver cancer and lymphatic cancer • high exposure to inorganic arsenic can cause infertility and miscarriages with women, • skin disturbances, declined resistance to infections, • heart disruptions and brain damage with both men and women • inorganic arsenic can poisoning of livestock near various industrial processes can penetrate into human body after their consumption.
Nickel, ng/m^3	An uptake of too large quantities of nickel has the following consequences: - Higher chances of development of lung cancer, nose cancer, larynx cancer and prostate cancer - Sickness and dizziness after exposure to nickel gas - Lung embolism and Respiratory failure - Birth defects - Asthma and chronic bronchitis - Allergic reactions such as skin rashes, mainly from jewellery - Heart disorders

Details of Health Effects of Various Air Pollutants

Sulphur Dioxide (SO2), µg/m^3

Short-term intermittent exposures
- Bronchoconstriction (temporary breathing difficulty)
- E/N/T irritation
- Mucus secretion

Long-term exposures
- Respiratory illness
- Aggravates existing heart disease
- Intensified in presence of PM

Nitrogen Dioxide (NO2), µg/m^3

Long Term exposure
- Pulmonary fibrosis, emphysema, and higher LRI (lower respiratory tract illness) in children
- Toxic acute effects at 10-30 ppm
- Nose and eye irritation
- Lung tissue damage and Pulmonary edema (swelling)
- Bronchitis /Effect on Defense mechanisms
- Pneumonia / Aggravate existing heart disease

Particulate Matter (size less than 10 µm) or PM 10 µg/m^3

Short-term exposure effects
- Lung inflammatory reactions
- Respiratory symptoms
- Adverse effects on the cardiovascular system
- Increase in medication usage and hospital admissions
- Increase in mortality

Particulate Matter (size less than 2.5 µm) or PM2.5, µg/m^3

Long-term exposure effects
- Increase in lower respiratory symptoms
- Reduction in lung function in children
- Increase in chronic obstructive pulmonary disease
- Reduction in lung function in adults
- Reduction in life expectancy, owing mainly to cardiopulmonary mortality and probably to lung cancer

Ozone (O3), µg/m^3

Acute Health effects
- Severe E/N/T (ear/nose/throat) irritation
- Eye irritation at 100 ppb
- Interferes with lung functions
- Coughing at 2 ppm

Chronic Health Effects
- Irreversible, accelerated lung damage

EMISSION LABORATORY

- Type Approval (TA), Conformity of production (COP) and Development evaluation for
  - 2/3 wheelers, Passenger Cars, Light Commercial Vehicles
  - Heavy Commercial Vehicle (HCV) engines, Tractor, Construction equipment, Stationary and Gen- set engines
- Nano particle measurement facility
- Evaporative emission measurement in SHED facility
- State-of-art utilities for temperature & humidity control in all test areas, central gas handling system, eco friendly fire fighting system and emergency power back-up
- Accredited & Certified -
  NABL - ISO / IEC 17025; 2005 , ISO 9001:2008, ISO 14001: 2004 & OHSAS 18001:2007

Our Capabilities and Competence

- Emission System / Laboratory / Facility approval at Vehicle / Engine Manufacturers place for COP tests.
- Certification as per EPA, CARB , European and Japanese Standards.
- Evaluation of alternate fuel vehicles / engines - CNG, LPG, Hydrogen, Ethanol, Methanol, Bio-diesel.
- Development assignments to optimize engines, assessment of after treatment devices (cat. con., particulate trap) and pollution control devices (Secondary air injection, EGR, FIPs) for performance & durability.
- Development assignments to evaluate Buses and Trucks for pollution control devices for emissions, fuel efficiency etc.
- Special assignments on evaluation of oil / fuel / additive for performance, emission and fuel consumption
- Study of Particulate matters for toxicity and evaluation of Nano-particles
- Ambient air quality Management:- Air Quality Monitoring, Emission factor determination & source profile, Inventory generation (line/area/point sources), forecasting studies and health impact assessment.
- Formulation of Regulations / Procedures on Emission and related issues
- Knowledge sharing through workshop / seminar and special training courses on emission / alternate fuels
- Secretariat for standing Commitee on implementation of Emission Legislation.
- Secretariat for working party on pollution and energy (GRPE) under WP 29

TWO WHEELER EMISSION TEST FACILITY

- Compliance to BSII, BSIII, BSIV, BSVI,European, EPA Norms
- Equipped with Chassis dynamometer ,CVS system, Emission analyzer bench, Weather station
- To ensure accuracy of measurement, fully automated test bench with controlled ambient air parameter like humidity and temperature.
- Chassis Dyno capacity: Power : 70 KW, Inertia Range :100-550kg, Max Speed : 200 Kmph

TWO / THREE WHEELER EMISSION TEST FACILITY

- Compliance to BSII, BSIII, BSIV, BSVI, European Norms
- Equipped with Chassis dynamometer, CVS system with Dilution tunnel, Emission analyzer bench, Weather station, 2.5 µm PM measurement system.
- To ensure accuracy of measurement, fully automated test bench with controlled ambient air parameter like humidity and temperature
- Chassis Dyno capacity :- Power : 50 kW, Inertia range : 100 to1500 kg, Max Speed : 200kmph

FOUR WHEELER EMISSION TEST FACILITY

- Compliance to BS III, BS IV, BS VI, Euro IV, Euro V, EPA and future norm
- Equipped with Universal chassis dynamometer, CVS system with dilution tunnel and latest generation exhaust gas analyzer bench with dirty /clean line concept for distinguishing between clean & dirty vehicles during emission measurement
- To ensure accuracy of measurement, fully automated test bench with controlled ambient air parameter like humidity and temperature.
- Chassis Dyno capacity :- Power : 150 kW, Inertia range : 120 -5443 kg, Max Speed : 200kmph
- Impinger system for carbonyl emission measurement from ethanol/ methanol fueled vehicles

HCV EMISSION TEST FACILITY

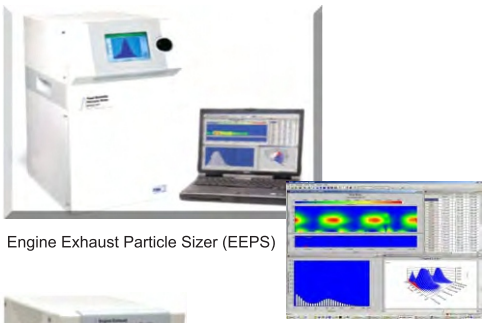
- Unique facility for development tests for vehicle evaluation, mass emission, fuel consumption and performance evaluation of oil and lubricants on trucks and buses.
- It is equipped with Chassis dynamometer ,CVS system with PM measurement, Emission analyzer system & Weather control with temperature conditioning test cell.
- Chassis dyno capacity: - Power :150 kW, Inertia range Up to 32000 kg, Max. Speed : 100 kmph

SEALED HOUSING FOR EVAPORATIVE DETERMINATION (SHED)

- Compliance to Indian, European, EPA and CARB Regulations
- Capable of measuring evaporative emission from 2, 3 and 4 Wheeler vehicles
- The 87.48 m^3 volume SHED facility has wide temperature range of 15 °C - 50 °C
- Fully Automated facility.

Engine Dynamometer Test Facilites

- Compliance to BS II, BS III ,BS IV ,BS VI, Euro IV, Euro V, Euro VI, EPA and future norms
- Evaluation of engine emission (Engine Steady State Cycle & Engine Transient cycle), power test, smoke test
- Steady state dynamometer facility is equipped with Engine dynamometer, Raw emission analyzer bench ,Partial flow PM sampling system, Dynamic fuel meter, Fuel and coolant conditioning unit, Smoke meter.
  - Steady state dynamometer capacity:-20 kW,150 kW
- Transient state dynamometer facility is equipped with Engine dynamometers, Full flow CVS & Dilution tunnel system ,Dilute emission analyzer bench. Dynamic Fuel meter, Fuel and coolant conditioning unit, Smoke meter, FTIR for NH_3 measurement, PN measurement system. High altitude simulation up to 5500 feet
  - Transient dynamometer capacity :- 220 kW, 500 kW, 250 kW
- To ensure accuracy of measurement, fully automated test benches with controlled engine intake air parameter like temperature, pressure and humidity



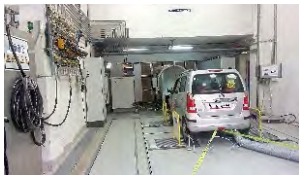
Engine Exhaust Particle Sizer (EEPS)

Condensation Particle Counter (CPC)

Rotating Disk Thermodiluters and Thermal Conditioner Air Supply

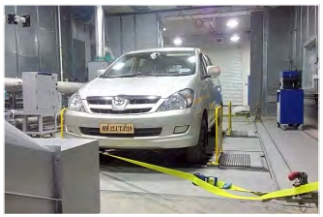
Nano Particle Evaluation Facility

- Facility is based on GRPE - PMP group recommendation, which includes dilution tunnel with PCF (Pre-classifier) to cut down exhaust particles below 2.5 µm, HEPA (High Efficiency Particulate Filter) to provide dilution air with filtering efficiency 99.99%, VPR (Volatile Particle remover) and CPC (Condensation Particle Counter).
- Fast Response Particle Sizer (FRPS) for online nano particle measurement in terms of number, surface area and size distribution pattern, which is useful for R&D work.
- Evaluation of nano particle emission for 2,3 and 4-wheeled vehicles, buses and heavy commercial vehicles operating on diesel, gasoline, alternate fuels like CNG / LPG.
- Well equipped Chemical Laboratory to carry out chemical speciation of nano particulate in terms of SOF and IOF analysis



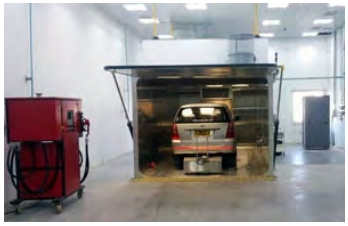
Climatic Vehicle Test Cell (CVTC)

- Climatic Chamber & Low temperature soak room with temperature range from -30°C to 55 °C
- Emission Testing for Vehicle up to 3.5 T GVW
- Capability for Type-VI Regulatory Test - Measurement of Cold CO and HC at -7°C
- For Solar Simulation with Radiation area:7500 mm x 2500 mm
- Chassis Dynamometer with 220kW Power, Inertia Simulation from 454 to 5448 Kg and Max Speed 250 Km/h
- Data Acquisition and Complete Test Cell Automation
- Mileage Accumulation Chassis Dynamometer (MACD)
- Endurance Testing of 2WD and 4WD Vehicle
- Chassis Dyno with 220 kW Power, Inertia Simulation from 454 to 5448 Kg and Max Speed 250 Km/h
- Robot Driver for all Global Driving Cycles for Actuation of Gear ,Throttle,Clutch,Brake & Ignition key
- Automatic Refuelling system to handle liquid Fuels like Petrol,Diesel,Ethanol,Methanol & various blends and Gaseous fuels like LPG ,CNG and other alternate fuels
- Data Acquisition System with 33 Channels



Vehicle Test Cell (VTC 1)

- Domestic Certification for the current BS-III,BS-IV Emission Regulations and forthcoming BS-V ,BS-VI Regulations
- Export Homologation Testing as per UNECE, EEC Directives and US EPA and Japanese Emission Regulation
- Emission Testing on Vehicles fueled with Liquid fuels such as Diesel, Petrol, Methanol,and their blends and Gaseous fuel such as LPG, CNG and it blends with Hydrogen
- Chassis Dyno with 150 kW Power and Inertia Simulation up to 5448 Kg and Max. Speed 250 km/h
- Additional Dilution Tunnel for Gasoline Direct Injection Vehicles with PM and PN Measurement
- Test Cell Temperature : 25°C +/- 5°C ,Controllable within 25°C+/-1°C,Test Cell Humidity : 9 +/- g of H2O/Kg dry air, Soak Room Temperature: Controllable within 23 °C +/- 2°C
- PM Conditioning Chamber with Microbalance having readability of 0.1 Mg and
- Temperature and Humidity Control
- Opacimeter for Smoke Measurement ,Dynamic Fuel flow meter for measurement of continuous fuel flow
- Central gas handling system for operating and calibration gases



VV-VT SHED for Evaporative Determination

- Capacity to Test the Gasoline and Ethanol fuelled 3wh and 4wh vehicle as per Euro III and Euro VI Regulation
- Volume Compensation System: Movable roof with test volume range from 47 cu-m to 54.0 cu-m
- Temperature Range : 10°C to 60°C, Controllability : +/- 0.3°C
- SHED Chamber Size : 6500mm(L) x 2600mm(W) x 2500mm(H)
- Independent, Sequential and Multiple Canister Loading Bench with Auxiliary Canister and scale for Breakthrough Test, having feature for Certification and Development purpose
- Onboard Refueling Vapor Recovery (ORVR) Test facility
- Fuel Cart with adjustable Fuel Conditioning
- Temperature Range : 10°C to 32°C
- Adjustable flow rate : 3-12 Gallons per minute

Glossary

BS	Bharat Stage
CC	Cubic Capacity
CEV	Construction Equipment Vehicle
CNG	Compressed Natural Gas
CO	Carbon Monoxide
CO_2	Carbon Dioxides
ESC	Engine Steady state Cycle
ETC	Engine Transient Cycle
FC	Fuel Consumption
GVW	Gross Vehicle Weight
HC	Hydrocarbon
IDC	Indian Driving Cycle
LPG	Liquefied Petroleum Gas
M category	A Motor vehicle with at least four wheels used for carrying passengers
M1 category	A vehicle used for carriage of passengers, comprising not more than eight seats in addition to the driver's seat
M2 category	A vehicle used for carriage of passengers, comprising nine or more seats in addition to the driver's seat, and having a maximum Gross Vehicle Weight (GVW) not exceeding 5 ton
MIDC	Modified Indian Driving Cycle
M3 category	A vehicle used for the carriage of passengers, comprising nine or more seats in addition to the driver's seat and having a GVW exceeding 5 ton.
N category	A Motor vehicle with at least four wheels used for carrying goods
N1 category Vehicles	Vehicle used for the carriage of goods and having a GVW not exceeding 3.5 ton
N2 category	Vehicle used for the carriage of goods and having a GVW exceeding 3.5 tons but not exceeding 12 ton
N3 category	Vehicle used for the carriage of goods and having a GVW exceeding12 ton.
NMHC	Non - Methane Hydrocarbon
NOx	Nitrogen Oxides
OBD	On-Board Diagnostic
PM	Particulate Matter
RHC	Relative Hydrocarbon
SHED	Sealed Housing Evaporative Determination

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