EPCA Report No 102

BS III construction equipment: Report filed in compliance with Hon'ble Supreme Court direction dated 19.7.2019

August 19, 2019

On 19.7.2019, the Hon'ble Supreme Court directed that EPCA should submit the factual and tactical aspects on this matter after consultation with experts and also the authority under Rule 126 of the Motor Vehicles Rules framed under the Motor Vehicles Act.

To deliberate on the issue and to understand the way ahead, EPCA convened a meeting on August 8, 2019 with experts, including officials of the Ministry of Road Transport and Highways (MoRTH) and agencies listed under Rule 126, namely Automotive Research Association of India (ARAI), Pune and International Centre for Automotive Technology (ICAT), Manesar (**Annexure 1** for list of participants).

The meeting and deliberations suggested a way ahead, which EPCA is detailing in this report, with recommendations for the consideration of the Hon'ble Court.

1. Background

The North Delhi Municipal Corporation has applied to the Hon'ble Supreme Court for permission to register 25 backhoe loaders, Heman BSIII Diesel Vehicles. This is because, as per its application, the National Green Tribunal (NGT) vide its order dated December 11, 2015 had directed that no new diesel vehicles would be registered in NCT Delhi.

The North MCD has purchased 25 number of backhoe loaders for the purpose of garbage removal and desilting work by its engineering department. This was done, based on the clarifications issued by the Hon'ble Supreme Court through its orders dated 8.5. 2017, where construction equipment of BS III was not included in its order dated 29.3.2017 and 13.4.2017 – stopping the registration of BSIII vehicles as of April 1, 2017 across the country.

NGT has on a case to case basis permitted registration of commercial vehicles that are BS IV compliant. But backhoe loaders are only available in BS III emission norms. NDMC has applied to the Hon'ble Supreme Court for permission to register these vehicles, which are required for collection, transportation and disposal of garbage and desilting work, a crucial function and much needed for the city's sanitation.

The question that the Hon'ble Supreme Court has desired to know if why these vehicles are only available in BS III and what can be the options for improving the emissions profile of these vehicles, either through improving emission standards or by changing the fuel, from diesel to CNG.

EPCA examined the following issues:

1. What is this category of vehicles that are BS III?
2. What is the way ahead to improve the emission standards of these vehicles?

2. BS III construction equipment

The Central Motor Vehicles Rules 1989 has separate category (115 A) for emission standards from agricultural tractors, power tillers and construction equipment vehicles driven by diesel engines. The emission norms for this category of non-road vehicles is termed as BS (CEV/TREM), which is done to distinguish from on-road vehicles.

These construction vehicles are primarily non-road – that is they do the work on construction sites and landfills – and only travel to get to their place of work. The agricultural tractors are also included in this category.

According to data from the Indian Construction Equipment Manufacturers Association (ICEMA), the industry sold 93,100 vehicles in 2017-18, which was a jump because of infrastructure spending. In other years, the average vehicles sold are between 50,000-70,000 per year. These vehicles include those used for earth-moving, mining and concrete mixing.

Backhoe loaders are the main vehicle sold under construction equipment – unique to India – where they make up as much as 40 per cent of the vehicles. Backhoe loaders is the vehicle that moves work from manual labour to mechanisation. According to this, some 25,000 to 35,000 backhoe loaders are sold across the country.

In relative terms, the construction equipment industry is small as compared to petrol and diesel vehicles (cars, trucks and two-wheelers) sold in the country. In 2018, roughly 4.4 million passenger cars and commercial vehicles were sold. In addition some 20 million two-wheelers were sold. Therefore, construction equipment constitute some 0.3 per cent of personal and commercial vehicles and function in localised work environment.

Backhoe loader: bulk of the construction equipment market; used for digging and removal of garbage; silt and other material

In Delhi, the transport department has informed EPCA that between 9.8.2004 to 8.8.2019 a total of 342 such vehicles have been registered in the city **(Annexure 2).**

Therefore, this category of vehicles is distinct for the following reasons:

- These are largely non-road; and, are not included in the emission road map for personal and commercial vehicles
- The total number of these vehicles is insignificant as compared to personal and commercial vehicles.

However, it is clear that these vehicles also contribute to air pollution. Studies done in the US, where there are some 2 million of these heavy-duty construction equipment, have found that these vehicles are important sources of pollution[1]. Therefore, it is critical that even though these vehicles fall into a different category, the emissions need to be controlled.

[1] https://www.tandfonline.com/doi/full/10.1080/10962247.2014.978485

3. Emission standards for construction equipment

The applicable standards, as of 1.4.2011 for construction equipment are Bharat Stage (CEV Trem) III. These are more or less equivalent to US Tier 1 and 2 emission standards. Currently, the US has notified US Tier 4 emission standards for non-road construction vehicles.

On March 5, 2018, the MoRTh notified (GSR 201E) the emission road map for this category of vehicles – diesel engine between 37 to 560 Kw non-road vehicles: **(see Annexure 3)**

BS (CEV/TREM)-IV, with effect from October 1, 2020
BS (CEV/TREM) -V with effect from October 1, 2024

The notification also states: "Provided that the vehicles manufactured before the date of applicability of BS/CEV/TREM – IV or V, shall be registered up to six months after the respective date of implementation of this rule." In other words, BS/CEV/TREM III can be registered up to March 31, 2021.

There is substantial improvement in the emission profile between the different emission stages.

Table: Improvement in emissions between different stages of BS/CEV/TREM*

	CO (g/kWh)	HC+NOx (g/kWh)	NOX (g/kWh)	PM (g/kWh)
BS/CEV/TREM III	3.5-8	3.5-5		0.2-0.8
BS/CEV/TREM IV	3.5-5	0.19-4.7	0.4	0.025

The emission limits differ for different category of these vehicles, depending on engine size (kw).

This clearly shows that there will be substantial improvement in emissions as the BS IV emissions get rolled out. The tightening of emissions of NOx and PM is particularly significant.

ARAI has compared the difference between the two emission norms (BS (CEV/TREM) III and BS (CEV/TREM) IV and informed EPCA as follows:
(see Annexure 4)

- Particulate Matter (PM) will be reduced by the order of 87.5 to 93.5 per cent in BS (CEV/TREM) IV norms as compared to BS (CEV/TREM) III
- Particulate Matter Limits are further tightened by 40 percent in BS (CEV/TREM) V norms.
- There is a drastic decrease in HC and NOx limits in the next stage BS (CEV/TREM) V
- norms.
- At present visible smoke is measured at 80% of full load for the compliance whereas in BS
- (CEV/TREM) IV), smoke will be measured at full load (100%). This will ensure better fitness and enforcement of the vehicle to emission norms.

In the new standards deterioration factor, durability and test cycle has been aligned to EU IV and V emission standards. EU has moved to Stage V from January 2018 to January 2020.[2] This will involve emission testing using Portable Emission Monitoring Systems (PEMS) and make testing more stringent. EU Stage IV is not as tight as US Tier 4 (currently in operation). But EU Stage V is the global best standard currently. As per the notified timeline, India will adopt EU V equivalent standards in 2024.

EPCA also considered options for changing the fuel type of these vehicles – moving of CNG or improving the BS III vehicles by retrofitting with BS IV engines. What was explained by the experts consulted that this will not be possible, partly because these machines have manual and not electronic systems. Also currently, there is no best practice to use CNG for this category of vehicles. But by improving standards, bringing in BS IV and then BS V will substantially improve the emissions from these vehicles.

Therefore, the question is how soon will these new emission standards come into force; what is the state of preparedness of industry to meet these standards and can these deadlines be advanced?

The standard was notified in March 2018, but as yet no vehicle has been sent for type approval. **ARAI and ICAT told the meeting that as yet they have not received any vehicle for** certification – without this, no vehicle can go into production.

EPCA was informed that the protocol for test procedure has still not been finalized. The next meeting of the committee to finalise these is on August 22, 2019, when the process will be discussed and hopefully finalized. Only after

[2] https://theicct.org/sites/default/files/publications/EU-Stage-V_policy%20update_ICCT_nov2016.pdf

this can engine certification start. Therefore, it is not clear to EPCA if there is sufficient preparedness or urgency to move towards cleaner emission standards of BS Limits defined

4. Recommendations and suggested way ahead

Based on the above review, EPCA would like to present the following recommendations for the consideration of the Hon'ble Court.

	Issue	Examination of issue observations	Recommendations for consideration of Hon'ble Court
1.	Registration of 25 backhoe loaders, BS/CEV/TREM-III compliant	Backhoe loaders are needed for garbage and silt removal in the city. These are construction vehicles non-road and therefore, the emission category is not comparable with diesel private or commercial vehicles	May consider allowing the one-time registration of 25 backhoe loaders. May also consider directing the Delhi Transport Department to maintain separate entry for construction vehicles as provided for in Central Motor Vehicles Rules 1989, under section 115A.
2.	Strategy for improving emission profile of these vehicles	The use of retrofits or CNG is difficult for this category of vehicles. They are also small in number (as compared to personal and commercial vehicles). But emissions need to be controlled, which is possible once the new generation of BS BS/CEV/TREM IV come into force**. There will be a 90 per cent reduction in PM emissions between BS III and IV**	May consider directing advancement of the BS/CEV/TREM IV emission norms. Even though number of vehicles are

		and also major reduction in NOX and HC emissions. Therefore, all efforts must be made to bring these cleaner vehicles as fast as possible. Currently, BS/CEV/TREM **IV** will come into force by October 2020 and BS/CEV/TREM **V** by April 1, 2024. However, another six months is provided for registration of the new generation of these vehicles. There is also delay in finalising the test cycle, without which improved engines cannot be certified. These deadline needs to be tightened and advanced by at least 6 months.	small, the localised pollution can be high. An advancement of 6 months can be considered.

Annexure 1: List of participants at EPCA meeting to discuss improvement in standards for construction vehicles, August 8, 2019

1. Dr. Bhure Lal, Chairman, EPCA
2. Ms. Sunita Narain, Member, EPCA
3. Sh. Vishnu Mathur, Member, EPCA
4. Sh. N.K. Madan, AE, DJB
5. Sh. Zakir Hussain, Director, Dept. Of Heavy Industries
6. Sh. Sushil Lakra, Consultant, Dept. Of Heavy Industries
7. Sh. K.C. Sharma, SE, MoRTH
8. Sh. R.K.Mehta, SE, North MCD
9. Sh. Naurang Singh, CE, North MCD
10. Sh. Santosh, SE, North MCD
11. Sh. A.S. Yadav, EE, North MCD
12. Sh. K.K. Meena, EE, SDMC
13. Sh. Subhash Chand, MLO, Transport Dept. Delhi
14. Sh. H.S. Sohi, ICAT
15. Sh. Manohar Mandal, Sr. Manager, ICAT
16. Sh. Vikram Tandon, DGM, ARAI
17. Smt. Paromita Chatterjee, Deputy Director, ICEMA
18. Sh. Sanjay Deshpande, Asst. Vice president, ICEMA
19. Sh. Sh. K.V. Krishnamurthy, Technical Advisor, ICEMA
20. Sh. Vijay Kumar, Head, Tata Hitachi
21. Sh. Saurabh Sehgal, Sr. Manager
22. Sh. Alok Prasad, AGM, BEML Ltd.
23. Sh. R.K. Swain, BEML Ltd.

Annexure 2

Keshar Singh <keshar@cseindia.org>

Fwd: Information regarding Construction Equipments registered in Delhi between 09.08.2004 to 08.08.2019.

1 message

Sunita Narain <sunita@cseindia.org> Fri, Aug 16, 2019 at 7:26 PM
To: Sunita Narain <sunita@cseindia.org>
Cc: Keshar Singh <keshar@cseindia.org>

Was this mail you were referring to Kesar?

---------- Forwarded message ---------
From: **MLO (HQ) TPT DEPTT. DELHI** <mlohq1.delhi@gov.in>
Date: Tue, Aug 13, 2019 at 3:27 PM
Subject: Information regarding Construction Equipments registered in Delhi between 09.08.2004 to 08.08.2019.
To: <sunita@cseindia.org>, <ankush.cpcb@nic.in>

Respected Madam/ Sir,

The information asked in the EPCA meeting held on dated 08.08.2019 at 03:00 PM regarding Construction Equipment registered in Delhi between 09.08.2004 to 08.08.2019. The information is given below, as per record:-

Emission Norms	Quantity
BS III	342
BS II	---
BS I	01
Not Available	245
Total	**588**

This information received from Computer Branch, Transport Department, Delhi.

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WITH REGARDS
MLO (HQ)
Transport Dept. Delhi

(xvi) इस नियम के अधीन विनिर्दिष्ट यानों के लिए एआइएस-137 में अधिकथित और समय-समय पर यथा-संशोधित प्रक्रिया के अनुसार नियंत्रण क्षेत्र के भीतर उत्सर्जन नमूना क्रमश: भारत स्टेज (सीईवी/टीआरईएम) IV और भारत स्टेज (सीईवी/टीआरईएम) V के लिए सारणी 1 और सारणी 2 में विनिर्दिष्ट उत्सर्जन की सीमा दोगुने से अधिक नहीं होगा ।

परंतु कि भारत स्टेज (सीईवी/टीआरईएम) IV और भारत स्टेज (सीईवी/टीआरईएम) V को लागू किए जाने की तिथि से पूर्व विनिर्मित वाहनों को इस उप-नियम के संबंधित कार्यान्वयन की तिथि के पश्चात छह महीने तक रजिस्टर किया जाएगा" ।

[फा.सं. आरटी-11028/22/2016-एमवीएल]

अभय दामले, संयुक्त सचिव

टिप्पण: मूल नियमों को भारत के राजपत्र, असाधारण, भाग-।।, खंड 3, उप-खंड (i) में अधिसूचना संख्या सा.का.नि. 590(अ), तारीख 2 जून, 1989 द्वारा प्रकाशित किया गया था और अंतिम संशोधन अधिसूचना संख्या का.नि. 178(अ), तारीख. 20 फरवरी 2018 द्वारा किया गया था ।

MINISTRY OF ROAD TRANSPORT AND HIGHWAYS

NOTIFICATION

New Delhi, the 05th March, 2018

G.S.R. 201(E).—Whereas, the draft of certain rules further to amend the Central Motor Vehicles Rules, 1989 were published, as required under sub-section (1) of section 212 of the Motor Vehicles Act, 1988 (59 of 1988), *vide* notification of the Government of India in the Ministry of Road Transport and Highways number G.S.R.1114 (E), dated the 29th August, 2017, in the Gazette of India, Extraordinary, Part II, Section (3), Sub-section (i), inviting objections and suggestions from all persons likely to be affected thereby before the expiry of the period of thirty days from the date on which copies of the Official Gazette containing the said notification were made available to the public;

And whereas, copies of the said Gazette notification were made available to the public on the 29th August, 2017;

And whereas, the objections and suggestions received from the public in respect of the said draft rules have been considered by the Central Government;

Now, therefore, in exercise of the powers conferred by section 110 of the Motor Vehicles Act, 1988 (59 of 1988), the Central Government hereby makes the following rules further to amend the Central Motor Vehicles Rules, 1989, namely: -

1. **Short title and commencement.** -(1) These rules may be called the Central Motor Vehicles (Second Amendment) Rules, 2018.

   (2) They shall come into force on the date of their publication in the Official Gazette.

2. In the Central Motor Vehicle Rules, 1989,in rule 115A,after sub-rule (8), the following sub-rule shall be inserted, namely: –

   " (9) Every agricultural tractor, construction equipment vehicle and combine harvester shall be so manufactured that it complies with the following standards of gaseous pollutants emitted by them when tested on following duty cycle, namely :-

   (a) for variable-speed engines, the 8-mode test cycle or the corresponding ramped modal cycle and the transient cycle Non Road Transient Cycle (NRTC);

   (b) for constant-speed engines, the 5-mode test cycle or the corresponding ramped modal cycle;

   (c) emissions (g/kWh) shall be measured over applicable emission limit for Non Road Safety Cycle (NRSC) and Non Road Transient Cycle (NRTC) test cycle as per test applicability mentioned in Table 1 and Table 2given below and for NRTC test cycle, composite weighted emissions shall be computed by weighing the cold

start results 10 per cent. and the hot start results 90 per cent. weighted composite results shall meet the limits given in said- tables

Table 1

(Bharat Stage (CEV/ TREM) - IV

Applicable emission limit for Non Road Steady Cycle (NRSC) and Non Road Transient Cycle (NRTC) test cycle

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

*Test cycle as described in AIS: 137and as amended from time to time.

Table 2

(Bharat Stage (CEV/ TREM) - V

Applicable emission limit for Non Road Steady Cycle (NRSC) and Non Road Transient Cycle (NRTC) test cycle

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

Notes:- (i) The test shall be done on engine dynamometer.

(ii) The test procedure for measurement of gross power (without Fan) shall be as per procedure laid down in AIS: 137 and as amended time to time.

(iii) For gross power measurement the tolerance shall be applied for type approval and conformity of production as per table 3 given below –

Table 3

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

(iv) Test procedure for measurement of emission of visible and gaseous pollutant and particulate matter shall be as per procedure laid down in AIS: 137 and as amended from time to time.

(v)The emission of visible pollutant (smoke) shall not exceed the limit values of smoke density when expressed as light absorption coefficients as given in Annexure I of sub- rule (9) of rule 115, when tested on engine dynamometer at full load at six speeds as per procedure laid down in AIS: 137 and as amended from time to time.

(vi) (a) Engine manufacture may opt for an engine test as mentioned in table 4 given below for evaluating deterioration factors as per procedure laid down in AIS:137 and as amended from time to time-

Table 4

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

(b) As an alternative to use a service accumulation schedule to determine deterioration factors, engine manufacturers may select to use the assigned multiplicative deterioration factors as per table 5 given below-

Table 5

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

(vii) Conformity of Production (COP)frequency and selection procedure shall be as per procedure laid down in AIS: 137 and as amended time to time.

(viii) For Conformity of Production (COP),-

(a) for agricultural tractor, construction equipment and combine harvester with annual production or Import up to 200 nos (per engine family), it shall be once in two years per family or model.

(b) for agricultural tractor, construction equipment and combine harvester equipment with annual production or Import exceeding 200 nos (per engine family), it shall be once in every year per family or model.

(ix) For Conformity of Production (COP), the sampling size shall be one day's average production subject to a minimum of 10 and maximum of 100:

Provided that for engine family produced less than 200 in the yearly period sample size may be one.

(x) For Type approval and Conformity of Production (COP) test, fuel shall be Reference fuel or commercial fuel as specified in Annexure IV–T and Annexure IV-V respectively.

(xi) The vehicles specified in this rule fitted with engine, which rely on the use of a reagent in order to reduce emissions, shall ensure the correct operation of NOx control measures, as per procedure laid down in AIS:137 and as amended from time to time.

(xii) Emission of ammonia over the NRTC and NRSC for engines equipped with SCR shall not exceed a mean value of 25 ppm for engine power category less than or equal to 56 kW and 10 ppm for engine power category above 56 kW.

(xiii) The diesel engine Nox reduction agent AUS: 32 (Aqueous Urea Solution) shall conform to part 1 and part 2 of ISO: 22241.

(xiv) The vehicles specified under this rule and manufactured after the 1st April 2026 shall be monitored for gaseous pollutant 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.

(xv) The engine or vehicle fitted with engines shall be affixed with a conformance label meeting the requirements as specified in AIS: 137 and as amended from time to time.

(xvi) For the vehicles specified under this rule, the emission sampled within the control area as per procedure laid down in AIS-137 and as amended from time to time, shall not exceed more than two times the limit values of the emission specified in Table 1 and Table 2 for stages IV and V, respectively:

Provided that the vehicles manufactured before the date of applicability of Bharat Stage (CEV/TREM) IV or Bharat Stage (CEV/TREM) V, respectively, shall be registered up to six months after the respective date of implementation of this rule.".

[F. No. RT-11028/22/2016-MVL]

ABHAY DAMLE, Jt. Secy.

Note: The principal rules were published in the Gazette of India, Extraordinary, Part-II, section 3, sub-section (i) *vide* notification number G.S.R. 590(E), dated the 2nd June, 1989 and last amended *vide* notification number G.S.R. 178 (E), dated the 20th February, 2018.

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Annexure 84

Emission Roadmap for Construction Equipment Vehicle

From ARAI, Aug 19, 2019

Current Norms: BS (CEV/TREM) III norms

Power Band	CO	HC + NOx	PM
	g/kWh		
37 ≤ P < 75	5.00	4.70	0.40
75 ≤ P < 130	5.00	4.00	0.30
130 ≤ P < 560	3.50	4.00	0.20

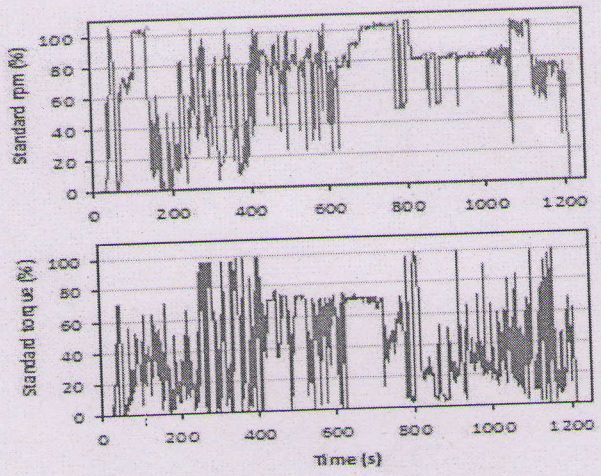
Norms from October 2020: BS (CEV/TREM) IV norms

Power Band	CO	HC	NOx	PM
	g/kWh			
37 ≤ P < 56	5.00	4.70 (HC + NOx)		0.025
56 ≤ P < 130	5.00	0.19	0.4	0.025
130 ≤ P < 560	3.50	0.19	0.4	0.025

Norms from October 2024: BS (CEV/TREM) V norms

Power Band	CO	HC	NOx	PM
	g/kWh			
37 ≤ P < 56	5.00	4.70 (HC + NOx)		0.015
56 ≤ P < 130	5.00	0.19	0.4	0.015
130 ≤ P < 560	3.50	0.19	0.4	0.015

- The power bands have been adjusted based on product portfolio in BS (CEV/TREM) IV norms. Comparison is presented only for similar power bands for ease of comparison.
- The present emission norms are based on test done on constant speed cycle (C1-8 Mode). The stage IV and Stage V norms are based on test to be done in transient cycles (NRTC- Non Road Transient Cycle) which will give even more realistic emission data.



- From the tables above it is evident that Particulate Matter (PM) is to be reduced by the order of 87.5 to 93.5 percent in BS (CEV/TREM) IV norms .
- Particulate Matter Limits are further tightened by 40 percent in BS (CEV/TREM) V norms.
- Also there is a drastic decrease in HC and NOx limits in the next stage BS (CEV/TREM) V norms.
- At present visible smoke is measured at 80% of full load for the compliance whereas in BS (CEV/TREM) IV), smoke will be measured at full load (100%).

- For BS (CEV/TREM) IV & V, Emissions sampled within the control area (Speed Vs Torque curve) as per the test procedure shall not exceed more than two times the limit values of the emission limits.
- Further, the vehicles manufactured after 1st April 2026 shall be monitored for gaseous pollutant emission from in-service internal combustion engines installed on the vehicles.
- Application wise use of Construction Equipment Vehicle is different from those of transport vehicles. Whereas on one hand there may be alternatives for personal transport, CEV have specific uses which may not have alternative.

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