POLICY UPDATE

REMOTE SENSING: MONITORING REAL WORLD EMISSIONS FROM VEHICLES

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Contents

Spotlight: Reinventing On-road emissions surveillance

As vehicle production, sales and usage increase rapidly in the country it brings in its wake serious concerns around toxic tailpipe emissions and exposures. Regulations have evolved to track emissions performance of vehicles at the time of production and certification as well as during the use phase.

Despite the evolving techniques of surveillance it has remained a constant battle to tame the real world emissions performance. But the technology treadmill to evolve and address newer challenges and its adoption for implementation must continue and stay ahead of the pollution curve.

Vehicle technology develops to meet the new emissions benchmark as defined by the mass emissions standards to decide the level of emissions control technologies to be integrated in new vehicles. But newer challenges keep surfacing with respect to their durable emissions performance on the road.

The simple and the fundamental objective of any vehicle surveillance programme is to ensure that the vehicles remain low emitting all through their useful life on the road and not deviate from the expected performance level. This requires a surveillance technique that can effectively assess the real world emissions and how it changes according to age, usage pattern, and fuel types.

The gap between emissions levels at the time of testing of vehicles at the certification stage and the real world driving emissions during the use phase of the vehicles, is widening. The infamous diesel gate (incidents of emissions fraud with help of defeat devices in new diesel cars), is the lasting reminder of that.

Since then considerable improvement in real world emissions regulations for new vehicles certification has happened globally and in Europe. India has also begun their implementation from April 2023 onwards -- though more needs to be done to align with the global best. Now on-road emissions testing with portable emissions monitors (PEMs) in real world driving conditions is needed for vehicle certification. This along with on-board diagnostic systems has made in-vehicle monitoring of emissions and technical defects possible. There is also a move towards in-service compliance requirements.

However, the current emissions inspection for identification of the worst polluters on road is still very weak in India.

From this perspective, the Centre for Science and Environment has outlined this policy brief to capture the limitations of the current policy framework for on-road emissions monitoring and the related policies on fleet renewal to highlight why it is necessary to make a paradigm shift in the on-road emissions monitoring.

This builds on CSE's earlier primer on the remote sensing strategy in 2022 and further updates including a rapid guide on essential facts.

This builds the case for advancement to the new generation remote sensing monitoring of on-road vehicles with remote sensing devices (RSD) to go beyond the simplistic and ineffective testing regime of Pollution Under Control (PUC) Certificate, which is urgently needed.

Remote sensing is a light source and a detector that is placed on the side of the road or at a height to transmit a laser beam to measure exhaust emissions remotely via spectroscopy as vehicles pass by and cross the light path. This can measure exhaust plume, and detect a range of pollutants including opacity, nitric oxide, carbon monoxide, hydrocarbons, and carbon monoxide in 0.5 seconds in the exhaust plumes of vehicles. Many of these measurements are not possible in PUC programme.[1]

RSD allows emissions measurements of large number of vehicles when they are being driven on the road and thus, do not require physical tests. This can record emission rates from thousands of individual vehicles along with speed and acceleration across all driving conditions daily. This can test several vehicles per hour and within an interval of one second. A camera captures the image of the vehicle's number plate which, if connected with a vehicle registration database, can identify the make, model, certified emission standard, fuel type, rated power and other details. This system can screen large number of vehicles in a day.

This can not only help to screen a much larger number of vehicles more efficiently and quickly, but also identify the worst polluters more effectively, provide feedback on emissions performance of vehicles according to age, fuels and genre. This can also enable better co-relation between on-road emissions performance and results of the lab tests. Moreover, fleet emissions profile can also go as an input for creation of low emissions zones in cities.

A strong opportunity has emerged from the July 2024 directive of the Supreme Court. This directive refers to its earlier directives of 2018 and 2019, as well as the recommendations from its former monitoring body Environment Pollution (Prevention and Control) Authority (EPCA) in 2018-19. The SC has directed the Ministry of Road Transport and Highways (MoRTH) to implement RSD programme and has sought priority implementation in Delhi and National Capital Region (NCR).

This Supreme Court directive had originally come in response to the recommendations made by EPCA in 2018-19. This was triggered by an audit of the PUC programme in Delhi NCR which was directed by the Supreme Court in 2017. CSE had participated in that process. The audit had exposed the weaknesses and ineffectiveness of the PUC programme and need for an advanced monitoring system.

This directive led to the framing of the Automotive India Standards 170 (AIS 170) rules by the MoRTH for implementation of remote sensing. However, this has not yet been notified and there are gaps that need to be addressed.

The mandate for RSD implementation is taking shape due to the Supreme Court interventions,

Nonetheless, an additional boost to this initiative has come from the recently concluded pilot demonstration of RSD monitoring in Delhi and NCR by the International Council on Clean Transportation (ICCT) along with the Transport Department of National Capital Territory of Delhi and Gurugram Authorities under the global True Initiative.

This has provided strong insights into the actual emissions profile of the fleet. This shows:

- Bharat Stage VI (BS VI) compliant vehicles have substantially lower emissions levels. While Nitrogen oxide (NOx) levels are 81 per cent lower in private cars, it is 95 per cent lower in buses.[2] Yet despite this improvement, real-world emissions from BS VI vehicles in many cases remain higher than type approval limits, particularly for NOx.

- It is also evident that across the range of BS VI vehicles, emissions from CNG vehicles are 1.5 – 14 times greater than the limits.[3]

- However, average emissions from commercial vehicles are much higher than from private vehicles, with NOx emissions from BS VI taxi and light goods vehicle fleets being 2.4 and 5.0 times more, respectively, than their private car counterparts.[4] Certain BS VI vehicle fleets fueled by CNG also showed high NOx emissions.

This kind of emissions profiling and identification of worst emitters, as well as vehicles with non-functional emissions control equipment, is not possible under the PUC regime.

Simultaneously, the central government's effort to implement fleet renewal programme, along with a scrappage policy, aims to upgrade the testing of vehicle fitness and roadworthiness in Automatic Testing Centres. This is intented to enable identification of unfit and end-of-life (ELV) vehicles effectively. However, these initiatives cannot be implemented properly unless the testing method and benchmarks change radically.

CSE's analysis of the current status of implementation of PUC and automated testing centres as well as scrappage policy for unfit vehicles bring out that only a small proportion of vehicles in the country come within the orbit of these programmes. Even though policy thrust is on fleet renewal, and scrappage of unfit and old vehicles, the mechanism and systems for identification of these vehicles have remained a challenge.

A lot of these challenges can be addressed through an upgraded on-road emissions monitoring.

THE NEXT STEPS

In view of the challenges associated with the current systems, urgent action is needed to enable reinvention of the on-road emissions surveillance systems and adoption of remote sensing monitoring system to align with the global good practices.

RSD program needs to meet a diverse set of objectives

(a) Identify high emitting vehicles that are the super emitter through "dirty screening" and to pull them over for proper checks and repair. This 'dirty screening' identifies vehicles that are not in compliance and need to be sent for proper inspection.

(b) Identify low emitting vehicles through the "clean screening" so that they do not have to unnecessarily go for physical emission inspection tests. This reduces the cost of inspection testing and improves public acceptance of the program.

(c) Improve detection of tampering with emission control systems in vehicles: Individual vehicles may have non-functional emissions control systems, either due to malfunction or tampering. RSD application can detect and discourage tampering and identify malfunctioning vehicles for repair.

(d) Characterize the emission factors of the on-road fleet to evaluate the established inspection and maintenance program and to provide feedback on the technology's performance. This can help to assess vehicle deterioration over several years and help to develop deterioration factors for policy implementation.

(e) Address real world emissions performance.

(f) Public awareness to build support for developing new policy based on real-world emissions data. Cities can build public support and encourage low emissions zones and scrappage policy.

Roadmap for implementation of RSD in the NCR region: To implement the July, 2024 directive of the Supreme Court on implementation of RSD programme on a priority basis in Delhi-NCR, MoRTH, Commission for Air Quality Management in NCR and the four state governments in NCR – Delhi, Uttar Pradesh, Haryana and Rajasthan need to develop the roadmap and timeline for implementation of RSD urgently. The progress needs to be monitorable.

Strengthen technical regulations AIS 170 and notify the rules for implementation under the Central Motor Vehicles Act and Rules to create a mandate for nation-wide implementation: Even though Automotive Industry Standard (AIS) 170 have been developed, the MoRTH has not yet notified the rules and threshold values for identification of gross polluters. Moreover, the AIS 170 itself requires further strengthening to address gaps including process for site selection, data analysis requirements, criteria for selection of suitable remote sensing technologies, improve certain aspects of measurements methods, state the interface with the VAHAN database, provide technology requirements for accessing VAHAN data among others.

Initiate the monitoring phase to generate vehicle emissions data using remote sensing in cities to help define the accurate polluter thresholds: The MoRTH has already proposed a measurement and monitoring phase only to generate data to enable development of threshold value and also assess other aspects of operations. The timeline for this may be fixed and rolled out quickly to generate data for setting emissions cut points, integrating remote sensing with PUC checks, and specifying regulatory actions for high emitters.

In the meantime, the cities that plan to roll out RSD or are already implementing like Kolkata need to be provided with clear guidelines on corelating the PUC programme and how the two need to co-exist. These programmes will have to be supported and enabled for further scaling up.

Develop certification system for RSD machines to enable procurement and deployment: AIS 170 needs to set the required technical parameters for testing and certification of remote sensing devices that the state governments require for procurement and deployment. Automotive Research Association of India (ARAI) and International Centre for Automotive Technology (ICAT) need to upscale facilities for testing and certification.

Develop national guidance framework for implementation of RSD

National-level enforcement framework needs to be defined under the Central Motor Vehicles Act and Rules to enable implementation of RSD program across the country. Ministry of Road Transport and Highways needs to amend the Motor vehicle Rules to incorporate the provision of remote sensing monitoring for enforcement and to provide legal back up to its implementation and enforcement in cities.

Support roll out of lighthouse projects on RSD in selected cities

As this is a very new area of intervention and cities do not have experience, it is necessary to support the first set of programs in selected cities including those that have already taken steps in this direction including Delhi and Kolkata to implement the RSD program. These can be the lighthouse projects to demonstrate the pathways and systems for implementation and enforcement in Indian cities.

Implement more advanced chassis dynamometer based emissions testing for confirmatory tests in the automatic testing centres: Once the RSD programme is rolled out and the polluting vehicles are netted in, they will require

confirmatory tests. Currently, only idle testing under PUC programmes are available for on-road vehicles. While in the absence of an alternative, properly done PUC tests will still be the reference point, more upgraded systems are needed as is evident globally – like in Hong Kong.

Upscaled programme can help to establish the markets for RSD devices and reduce costs: Legally enforceable can help to establish the market and bring adequate numbers of technology providers for matured technologies and improve the cost effectiveness of the programme. This will help to build local market for RSD technologies in India. This is needed to build confidence and capacity of the implementing agencies in cities. State governments with support from the central government can plan the time bound phase-in and designing of the program.

Provide technical knowledge support to implement of RSD program and build awareness: Vehicle testing agencies and the appropriate technical bodies need to provide technical knowledge support to the state governments related to instrumentation, data analytics, network and system design, adoption of gross polluter threshold, and clean and dirty screening approaches, among others. Such application can open several opportunities for regulatory interventions for pollution control. These include enforcement of low emissions zones.

Align RSD programme with other programmes on identification of unfit and end-of-life vehicles for scrappage and fleet renewal: The current efforts of the government to reform the PUC programme, or augment automated testing centre and push state governments to set up scrappage infrastructure are not adding up to effectively screen all vehicles and identify unfit vehicles, ELVs and vehicles with non-functional emissions control systems. RSD system is needed for better leveraging of all other programmes. Otherwise, the investments in testing facilities and scrappage centres will remain sub-optimal.

Need quicker transition to Bharat State VII emissions standards along with stronger real world emissions regulations: It is necessary to align with the latest real world emissions regulations enforced in Europe (Euro VI-e/E standard with tighter real-world emissions regulations). Also enable quicker adoption of BS VII standards with tighter real-world emissions requirements and on-board emissions monitoring.

Need ambitious implementation plan and target for zero emissions vehicles: It is evident from the pilot programme in Delhi that even though CNG programme

has helped to curb toxic diesel particulate emissions, NOx emissions from CNG vehicles can be a matter of concern. This builds the case for a quicker uptake of battery operated vehicles with zero tailpipe emissions to curb vehicular pollution.

1. THE CONCERNS AROUND ON-ROAD EMISSIONS MONITORING

Several programmes have evolved in India to address on-road emissions. These encompass both the certification stage as well as the use phase of vehicles.

The process begins when new vehicles are tested in the laboratory for compliance with the mass emissions standards. Already, India has gone through five successive stages of improvement from Bharat Stage I norms to Bharat Stage VI norms (skipped the stage V altogether).

When vehicles are produced and certified, about six government-owned test agencies conduct type approval and Conformity of Production (COP) testing for vehicle emissions. Manufacturers submit new vehicles for certification, and if they fail, they're sent back for rectification. COP tests are conducted periodically. To pass, the statistical mean of emissions must be below set norms. If a vehicle fails, the test agency reports to MoRTH, which may withdraw type approval. Manufacturers can rectify and resubmit, but repeated failures may lead to vehicle recalls.

Despite this system in place, there were concerns around the emissions performance of the new technologies in the real world. Evidence have mounted globally to show how even after complying with the certification requirements of Euro VI emissions standards several light duty diesel vehicle models have remained high emitters on road.

Diesel gate was the evidence of what may go wrong in the real world. At one level, deliberate use of defeat devices or rigged software can be used at the manufacturing level to circumvent the rules to pass the vehicle certification tests. The emission control strategy can be optimized to meet particular conditions of laboratory emission test, instead of designing effective emission controls for sustained and durable performance during real-world driving. This increased emissions during real-world operations.

The incentive for such manipulation is usually the fuel economy penalty associated with advanced NOx controls that fight against the consumer

interest in fuel savings. Thus, globally, several car models were found to have NOx emissions rates significantly higher than prescribed limits when driven in real-world conditions. This has exacerbated air pollution problems in urban centers.

It may also be noted that the emission from vehicles is certified on standard chassis dynamometer drive cycles which are a predetermined time-speed profile that the vehicle under test must follow in a laboratory while its exhaust emissions are measured. The drive cycles are laid out in such a way that they provide realistic approximation of actual conditions that vehicle encountered during real driving.

During the standard drive cycle test there is a narrow boundary such as ambient temperature, ambient pressure, vehicle speed and load profile etc. which must be followed as a part of standard procedure. This standardization is also important to ensure that results from different vehicles can be directly compared, and that all vehicles sold in each market are held to the same standards. However, this is not always possible in real driving where the ambient temperature, pressure, vehicle speed and engine load profile can be totally different than one in which the vehicle is certified. The type approved road load values underestimate the chassis dynamometer load and lead to emission benefits.

Increased level of stringency in controlling the regulated emissions from vehicles and lack of updates to vehicle certification procedure have encouraged engineering strategies that ensure good fuel economy within the prescribed emission limits for as long as vehicle is driven in narrow boundary conditions of the standardized test.

A spate of reforms have followed in Europe to control real world emissions from vehicles. The adoption of new real world emissions (RDE) regulations are expected to address some of these challenges. These reforms are related to vehicle testing methods, in-service compliance requirements and real-world driving emissions monitoring with the help of portable emissions monitors.

As some of these requirements were already adopted for heavy-duty vehicles, it was time to shape such regulations for the light-duty vehicles. This has helped to reduce the emissions gaps between certification level and the real-world driving emissions from new vehicles in Europe. Thus, real-world driving emissions has become the central focus.

India is also following similar trajectory for the new vehicles. Post adoption of BSVI emissions standards in 2020, regulations related to real world driving

emission (RDE) tests using portable emission measurement systems (PEMS) for certification of vehicles and in-service compliance requirements, among other reforms for new vehicles have rolled out from 2023 onwards. A more exacting driving test cycle is also awaited by 2027. In-use conformity testing can ensure vehicles are meeting emission standards within set deterioration rates.

Moreover, India has already adopted vehicle recall program to address failure of vehicle emission compliance at any stage of vehicle lifecycle. The laws recognize the right of the central government and state governments to recall vehicles from the market when they are not in compliance. This requires a more effective official procedure to carry this out in practice. The threat of an emissions recall, and the costs associated with it, are strong incentives for manufacturers to produce vehicles that meet standards throughout their useful life.

While emission regulations and testing parameters for new vehicle certification are being reformed in India and substantial changes are underway to improve real world emissions regulations and in service compliance requirements, the on-road surveillance have lagged behind.

2. WHAT AILS PUC PROGRAMME

Currently, the on-road vehicle inspection program called the Pollution Under Control (PUC) certificate program, is based on simple idle testing of carbon monoxide and hydrocarbon at two speed idle tests along with Lambda test for petrol vehicles and smoke density test for diesel vehicles. The PUC norms have progressed over time to align with the improvement in the mass emissions standards. A simple idling test is conducted that only passes or fails a vehicle. A full-scale mass emission test would be more representative of actual vehicle condition.

However, in this highly decentralized programme that encompasses very large number of small and poorly staffed testing centres across the geography, it is very difficult to do quality control to ensure authentic tests to get credible emissions results. Moreover, the overall compliance level in terms of number of vehicles turning up for tests is also very low in most parts of India.

PUC is not designed for that due to the inherent weaknesses of the PUC program (plagued by very low level of compliance, inadequate calibration of equipment, lack of audit of PUC centers, improper tests, and vulnerability to fraud)—there is virtually no alternative effective mechanism for robust surveillance.

This poses serious risks as all emissions control equipment are designed for certain efficiency and durability for the life span of the vehicles. If vehicles are not watched carefully for good maintenance practices, quality manufacturing and emissions cheating, the polluted cities of India can be in serious trouble.

This came out sharply from the audit of the PUC programme that was directed by the Supreme Court in 2017 in Delhi and NCR (in the ongoing public interest litigation on air pollution in Delhi and the National Capital Region -NCR) following the recommendation from its former monitoring body Environment Pollution (Prevention and Control) Authority (EPCA). The Department of Transport had conducted the audit and the Centre for Science and Environment was part of this initiative.

The PUC programme that originated in the mid-nineties was designed as a very simple testing system for the old generation carburetor technologies. These are not designed to address emission performance of new generation emissions control technologies and related surveillance requirements.

Moreover, currently, only commercial vehicles require annual fitness tests after two years, while private vehicles are exempt until 15 years post-registration. Fitness tests are more elaborate that includes series of tests related to safety, emissions and overall roadworthiness of the vehicles.

While India has strengthened its compliance program, improvements are still needed to keep pace with advancing emission control technologies.

3. GOING BEYOND PUC – REMOTE SENSING

In response to the findings of the PUC audit and the recommendations of the EPCA, the Supreme Court passed an order on 2.8.2018, on use of remote sensing technology for pollution checks and centralized testing centers for diesel vehicles.

The Supreme Court on 10 May, 2018, while responding to the recommendations from the EPCA had instructed the Delhi government to look into the implementation of remote sensing technology for screening of polluting vehicles on-road. This was among the recommendations of EPCA in response to an earlier Supreme Court order of 23 March, 2018, that had asked EPCA to examine the new parameters that could help to improve the current vehicle inspection system.

Simply put, remote sensing is a light source and a detector that is placed on the side of the road or at a height to transmit a laser beam to measure exhaust emissions remotely via spectroscopy as vehicles pass by and cross the light path. This can measure exhaust plume, and detect a range of pollutants including opacity, nitric oxide, carbon monoxide, hydrocarbons, and carbon monoxide in 0.5 seconds in the exhaust plumes of vehicles. This allows emissions measurements of large number of vehicles when they are being driven on the road and thus, do not require physical tests.

This can record emission rates from thousands of individual vehicles along with speed and acceleration across all driving conditions daily. This can test several vehicles per hour and within an interval of one second. A camera captures the image of the vehicle's number plate which, if connected with a vehicle registration database, can identify the make, model, certified emission standard, fuel type, rated power and other details. This system can screen large number of vehicles in a day.

Around that time ICAT had initiated a pilot on RSD in Delhi. On 8 July, 2019 the Supreme Court directed EPCA to submit a proposal based on the report submitted by ICAT. It was also pointed out and taken on board by the Supreme Court that the technology was found to be working well in Kolkata.

As part of that deliberation, the Supreme Court had directed EPCA: "With respect to remote sensing technology a report has been filed by International Centre for Automotive Technology (ICAT). It is pointed out by Amicus Curiae that remote sensing technology has been found to be helpful in reducing the pollution level and it is a finding of the ICAT that it is effective method to check pollution. As to put it into operation, time prayed on behalf of the EPCA to consider and submit a report. As the matter is urgent and is in connection with the reduction of pollution, we grant only fifteen days time to the EPCA to submit a proposal after consulting various stakeholders."

In response to this directive the EPCA initiated consultation with all concerned agencies including MoRTH and Transport Department of National Capital Territory of Delhi to identify the key steps needed for implementation and submitted a report on 26 July, 2019. In this EPCA made the following recommendations:

- Within three months, MORTH to frame rules under CMVR for use of remote sensing, including penalties so that enforcement is possible and notify the gross polluter threshold under CMVR as recommended by ICAT.

- Within two months MoRTH to issue technical guidance on design of program, including equipment, networking, and data sharing.

- Within three months Department of Transport of Delhi to issue global tender for purchase of five machines and its operation as well as finalize sites and sampling plan.

On 29 July, 2019, the Supreme Court took these recommendations on board and issued notices to the MORTH and the Department of Transport, NCT of Delhi.

This was taken note of by the Supreme Court. Following the recommendations from EPCA, the Supreme Court had directed the Ministry of Road Transport and Highways (MoRTH) to frame the appropriate rules for its implementation and directed the Delhi government to implement the program during 2018-19. In response MoRTH has drafted the rules under the Automotive Indian Standard 170 in 2020.

4. SUPREME COURT STEPS IN ONCE AGAIN

In 26 July, 2024, the Supreme Court intervened once again to raise the issue of compliance with the PUC (Pollution Under Control) programme. When the MORTH pointed out difficulties in linking vehicle insurance with PUC certificates to ensure compliance, the bench noted the earlier recommendations of EPCA that had sought "the introduction of remote sensing technology in addition to PUC tests for controlling vehicular pollution."

This recommendation was made in light of the limitations of current PUC tests. In fact, the court referenced its earlier direction from 19 August, 2019, which had instructed MoRTH and the Ministry of Law to make a final decision on this matter and file a status report.

The bench said: "When a body like EPCA had recommended the use of remote sensing technology in addition to PUC tests, MoRTH sought to have taken the suggestion seriously."

The court has therefore directed MoRTH to reconsider implementing remote sensing technology. The order noted: "We are of the view that somewhere a beginning has to be made by commencing the use of remote sensing technology. Therefore, to begin with, it will be appropriate if the use of remote sensing technology can commence in NCR States."

The court suggested starting the implementation of remote sensing technology in NCR (National Capital Region) states. It has instructed MoRTH to seek cooperation from the relevant authorities in these states.

The court directed the Secretary of MoRTH to "immediately convene a meeting of his counterparts and Secretaries of the concerned Departments of the NCR States" to discuss the implementation of remote sensing technology.

The Supreme court has stated that if MoRTH encounters non-cooperation from the NCR state authorities, it can approach the court for issuance of notices to these authorities. MoRTH was given a two-month period to "reconsider its position and make an appropriate decision based on our suggestions above" by the bench.

5. REMOTE SENSING PART OF THE CLEAN AIR ACTION PLANS

In the meantime, several other cities that have been designated as non-attainment and are implementing their respective clean air action plans under the National Clean Air Program (NCAP), have included remote sensing measurements as part of their mitigation strategy for vehicular pollution. These cities include Mumbai in Maharashtra, Kolkata, Asansol, Barrackpore, Durgapur, Haldia, Raniganj in West Bengal and Bhubaneswar in Odisha among others. Delhi has already been mandated to implement the RSD program by the Supreme Court of India.

These cities and others need large scale screening of emissions performance of the fleet, identification of the worst polluters for effective remedial action, profiling of emissions from different genre of vehicle technologies and fuel types, provide feedback on real world emission performance of the technologies, ensure more effective enforcement, and implement new generation strategies like low emissions zones.

Consistent with the global trend, application of remote sensing needs to gather momentum in India along with appropriate regulatory framework. It is therefore necessary to pay attention to the following aspects of the RSD program design and implementation.

6. OBJECTIVE OF RSD BASED MONITORING

Globally, cities are moving towards more advanced systems of remote sensing monitoring to replace or supplement simple physical tests that are difficult to monitor and enforce, with more smart remote monitoring approaches that have now become possible. Cities of Europe, the US, United Kingdom, China, and Hong Kong have already taken the lead to implement RSD programme with good results.

Remote sensing is implemented with certain key objectives – i) Identify high emitting vehicles that are the worst polluters on road to pull them over for proper checks and repair; ii) Clean screening of vehicles so that low emitting vehicles do not have to unnecessarily go for physical emissions inspection tests and avoid adding to the cost of inspection; iii) characterize the emissions profile of the on-road fleet that can help to evaluate the established inspection and maintenance programs and also provide feedback on the technology performance; and iv) Use this monitoring system to regulate and restrict movement of polluting vehicles in low emissions zones earmarked in cities.

Moreover, remote sensing helps to detect individual high-emitting vehicles that are caused by poor vehicle maintenance, or removal and tampering of emission control systems, or accidental malfunctioning of emission control equipment among others. Even though India has not generated systematic evidence on this, the anecdotal evidence suggests that this could already be a challenge in India.

The problem could also be with the manufacturing of vehicles that may lead to poor design or defects in the emissions control components or poor durability of the emissions control-related components and intentional cheating of emissions standards and the use of defeat devices. Thus, an advanced emissions monitoring system can help to address a diverse set of objectives.

7. NASCENT GROWTH OF RSD PROGRAM IN INDIA

First-generation field trial of remote sensing application was carried out in Delhi and Pune way back in 2004-05. The Union Ministry of Road Transport and Highways (MORTH) had set up a committee under Automotive Research Association of India (ARAI) to make recommendations on inspection and certification centers in India. The committee had recommended that if the ongoing field trials are found to be effective in identifying grossly polluting vehicles, then this could be adopted to supplement the I/M system in India. At that time, the cost of RSD was considered prohibitive.

A field trial of RSD was carried out in Delhi and Pune by Automotive Research Association of India (ARAI) during 2004-05. Reportedly, the ARAI Report of the Technical Committee on Inspection and Certification System in India for MORTH noted that out of the total measurements in the pilot scheme, 92 per cent of the total results for cars and 78 per cent of the total results for buses and trucks were valid. But for two wheelers, only 28 per cent of the results were valid. The capture rate was low. The emissions measurement of two-three wheelers was highly uncertain due to low exhaust volume from small tailpipes of these vehicles. It was explained that the devices were not aligned with the tailpipes of these small vehicles with relatively smaller plumes of emissions that decay quite fast before a minimum number of readings can be taken. However technology has progressed considerably since then.

RSD program takes roots in Kolkata

Subsequently, Kolkata became the first and the only city to implement remote sensing program on a limited scale. This was catalyzed by the directive from the Calcutta High Court in relation to the phase out of older vehicles in 2009. This had also directed improvement in in-use emissions surveillance. Currently, Kolkata has two RSD devices and one mobile RSD unit.

According to the Department of Transport, it is possible to collect approximately 4,000 data-points daily, and measure the emissions of CO, CO_2, HC, NOx, and smoke. These devices operate for 8 working hours and five days a week at strategic locations.

There is an extensive system in place that records and issues show-cause notices to the vehicle owners whose vehicles are found to be high emitting based on remote sensing measurements. The mobile remote sensing devices are placed in strategic locations by rotation. The show cause notices are sent directly to the vehicle owners. The notice carries the picture of the vehicle with registration plate, date and location of testing and the emissions result.

To identify the high emitting vehicles, the PUC norms including the smoke opacity value as per rules 115 and 116 of the Central Motor Vehicles Rules, 1989 is applied. The vehicle owners are requested to bring the vehicle to a specified inspection centre for further verification within 15 days. Failing that, the owner is liable to pay a fine under section 190(2) of Motor Vehicle Act and such other action per law.

When vehicle owners are intimated by the department about their polluting vehicles, they often challenge on the grounds that they have a valid PUC certificate and should not be penalized. This requires MORTH to clarify how remote sensing monitoring will co-exist with the PUC program.

Department of Transport, West Bengal, has taken the initiative to analyze a data set from the RSD application during 2015 to 2020 (see *Graph 1: Vehicles screened from the year 2015 to 2020 in Kolkata using RSD* and *Graph 2: Screening of vehicles based on different vintage, fuel type, and vehicle category*). Based on this several observations have been highlighted.

- About 51 lakh vehicles were screened during five years with RSD. Overall, 3.4 and 3.7 per cent of vehicles were found to be highly polluted. Notably, about 6-7 per cent of total vehicles were found to be dirty/or high emitters according to the yardstick adopted.

- In 2018 and 2019, Kolkata city has reported seven months of vehicle inspection using RSD. A smaller data set for that period show that 7 per cent of vehicles were identified as dirty vehicles. In 2020, about 19,0367 vehicles were screened in four months and amongst them 9 per cent of the screened vehicles were identified as high emitters.

- As expected, more than 10 years old vehicles recorded higher emission by a factor of 2 as compared to less than 10 years old diesel vehicles. Among petrol vehicles, more than 15 years old have recorded three-times higher compared to the less than 10-year-old vehicles.

- Among the less than 10 years diesel vehicles, 4.3 per cent transport that are commercial vehicles were high emitters and 1.2 per cent non-transport or privately owned vehicles were high emitters. Among transport vehicles, 3.4 per cent buses, 5.3 per cent emergency vehicles, and 4.2 per cent goods vehicles were identified as high emitters.

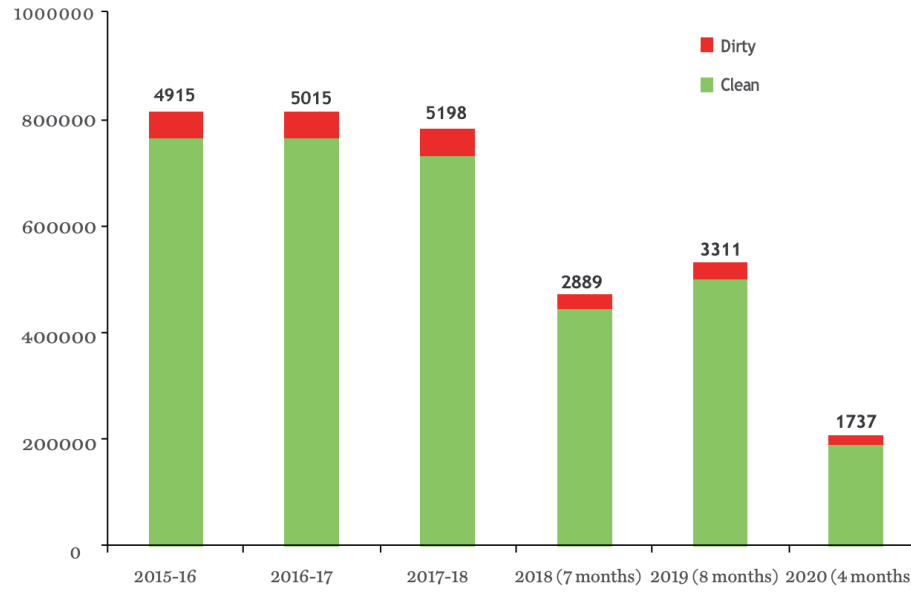
- The more than 10-year-old diesel vehicle category had three-times higher emitters compared to the non-transport vehicles. Among them, 11 per cent taxis, 10.1 per cent goods vehicles, 7.7 per cent buses and 5.1 per cent Omni buses were found to be high emitters.

- In the category of less than 15-year-old petrol vehicles, 3.2 transport vehicles and 3.6 per cent non-transport vehicles were identified as high emitters. In the transport/commercial petrol vehicles category, the highest emitters were emergency vehicles (16.4 per cent), followed by goods vehicles (11.9 per cent) and Omni buses (7.1 per cent). However, in non-transport petrol category omni buses (19.4 per cent) were more polluting compared to transport omni-buses.

- In the more than 15 years old petrol vehicles category, transport vehicles had two-times lower high emitters compared to non-transport vehicles. In the transport/commercial category, emergency vehicles were highly polluting (15.4 per cent), while in non-transport category, 10.1 per cent cars and 12.3 per cent omni buses were identified as high emitters.

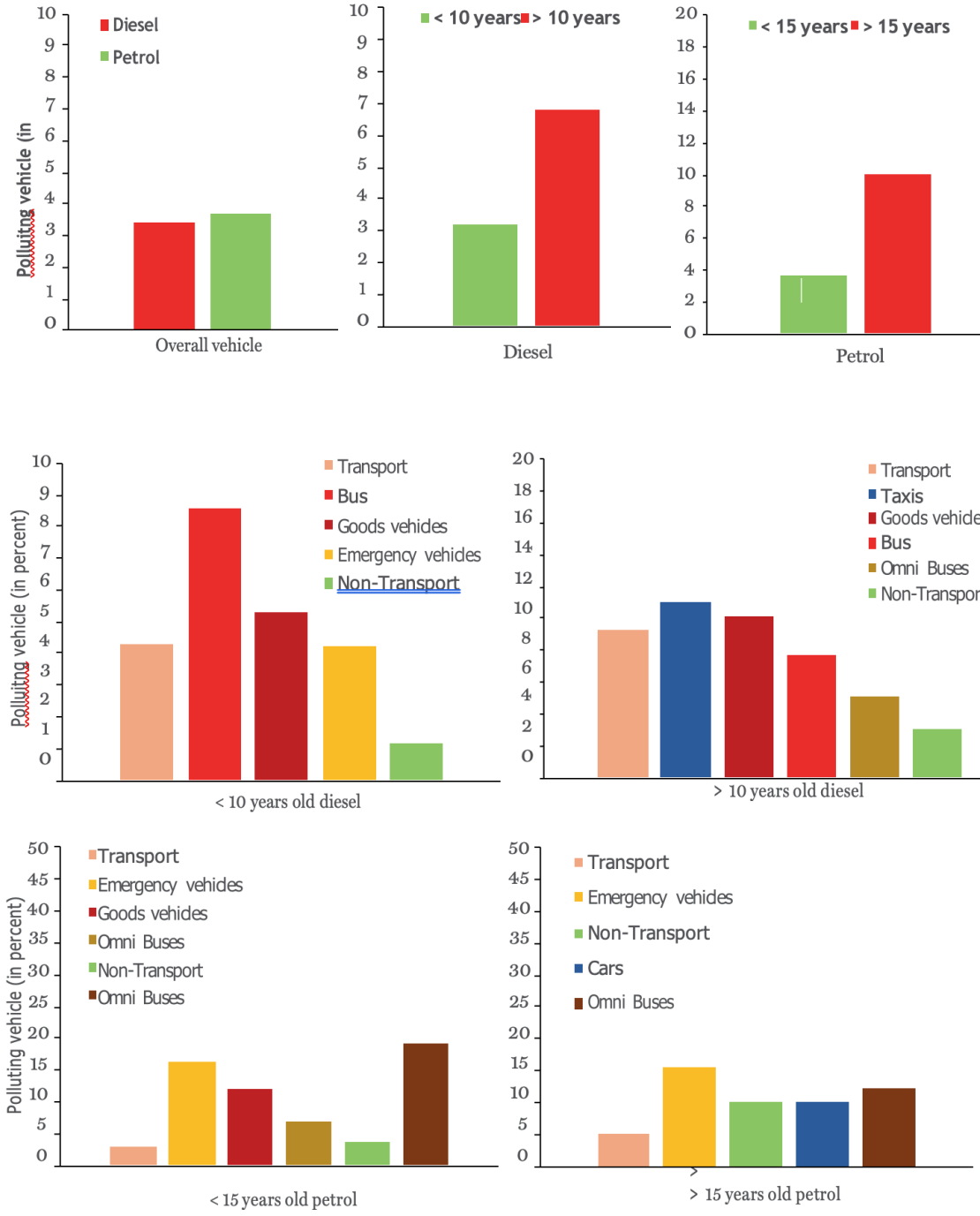
Based on this program the Transport Department has collected Rs. 8 lakh penalty charges during 2019–20. Moreover, RSD in Kolkata have exhibited how this helps the regulators to evaluate the vehicle emission performance on the road. The Supreme Court of India in its order dated 10 May, 2018, has highlighted the remote sensing program of Kolkata in the context of its implementation in Delhi.

Graph 1: Vehicles screened from 2015 to 2020 in Kolkata using RSD



Source: Transport Department, Government of West Bengal

Graph 2: Screening of vehicles based on different vintage, fuel type and vehicle category



Source: CSE

Remote sensing monitoring in Kolkata

The current challenge is to position the RSD program vis-à-vis the PUC program for enforcement. There is also an expectation of guidance framework for RSD monitoring and technical regulations.

The Government of West Bengal has decided to expand the programme to all six non-attainment cities by procuring new machines. The catalyst is the clean air programme that is being implemented under the National Clean Air Programme (NCAP). The State Pollution Control Board along with the Department of Transport is now taking this forward to leverage the fund available under the National Clean Air Programme to expand the RSD programme in all the six non-attainment cities of West Bengal. The state has recently procured two more RSD machines and in addition, they will procure 18 more in next few years.

However, these machines require certification. This process is being expedited by the Automotive Research Association of India (ARAI).

8. INSIGHT FROM THE ICCT PILOT RSD STUDY IN DELHI

The International Council on Clean Transportation (ICCT), in collaboration with the Delhi and Gurugram authorities as part of the global TRUE initiative, has conducted a remote sensing pilot testing in Delhi during 2023-24. This has provided insight into the real-world tailpipe emissions of the Delhi and Gurugram vehicle fleets.

This has also helped to demonstrate remote sensing technology that can be mainstreamed in India. It has provided an independent evaluation of tailpipe emissions from on-road vehicles, contributing to policymaking.

The highlights of the ICCT findings are as follows[5]:

- India's strategy of leapfrogging from BS IV to BS VI emission standards led to significant reductions in tailpipe emissions across all pollutants measured and vehicle types captured. For example, real-world NOx emissions from private cars showed a reduction of 81 per cent and emissions from buses showed a reduction of nearly 95 per cent[6].

- Despite this improvement, real-world emissions from BS VI vehicles in many cases remain higher than type approval limits, particularly for NOx. Across the range of BS VI vehicles measured fueled by CNG, emissions were 1.5 – 14 times greater than the limits[7].

- Average emissions from commercial vehicles are much higher than from private vehicles, with NOx emissions from BS–VI taxi and light goods vehicle fleets being 2.4 and 5 times more, respectively, than their private car counterparts[8].

- Certain BS VI vehicle fleets fueled by CNG also showed high NO_X emissions.

This study is an opportunity to inform policy making on RSD programme – programme design, technology application and selection of test locations, methods and protocol for data analytics, integration of emissions data with VAHAN database, step by step approach to setting up of this programme, among others. Moreover, emissions profiling of the fleet is an important policy feedback on the performance of different technology genre and fuel types.

9. WHY MAINSTREAMING OF RSD PROGRAMME IS INEVITABLE?

From time to time PUC programme has been reformed. Several other programmes are underway aiming for fleet renewal to phase out old vehicles, scrap the end-of-life vehicles for material recovery and modernize the vehicle testing centres with more automated systems to improve fitness and road worthiness tests.

While PUC remains ineffectual, upgraded fitness tests and expanding scrappage facilities are unable to identify and generate adequate number of

unfit and end-of-life vehicles (ELVs) to make a difference or to keep the new scrappage centres viable.

Even though there are challenges of leakages of scrapped vehicles in the informal recycling sectors, it is still a challenge that the formal scrappage centres being implemented under the public-private partnership are grossly underutilized. Thus, the investments and the ability to recover material from the ELVs remain sub-optimal.

It is necessary to understand from the ground reality why these efforts are not adding up?

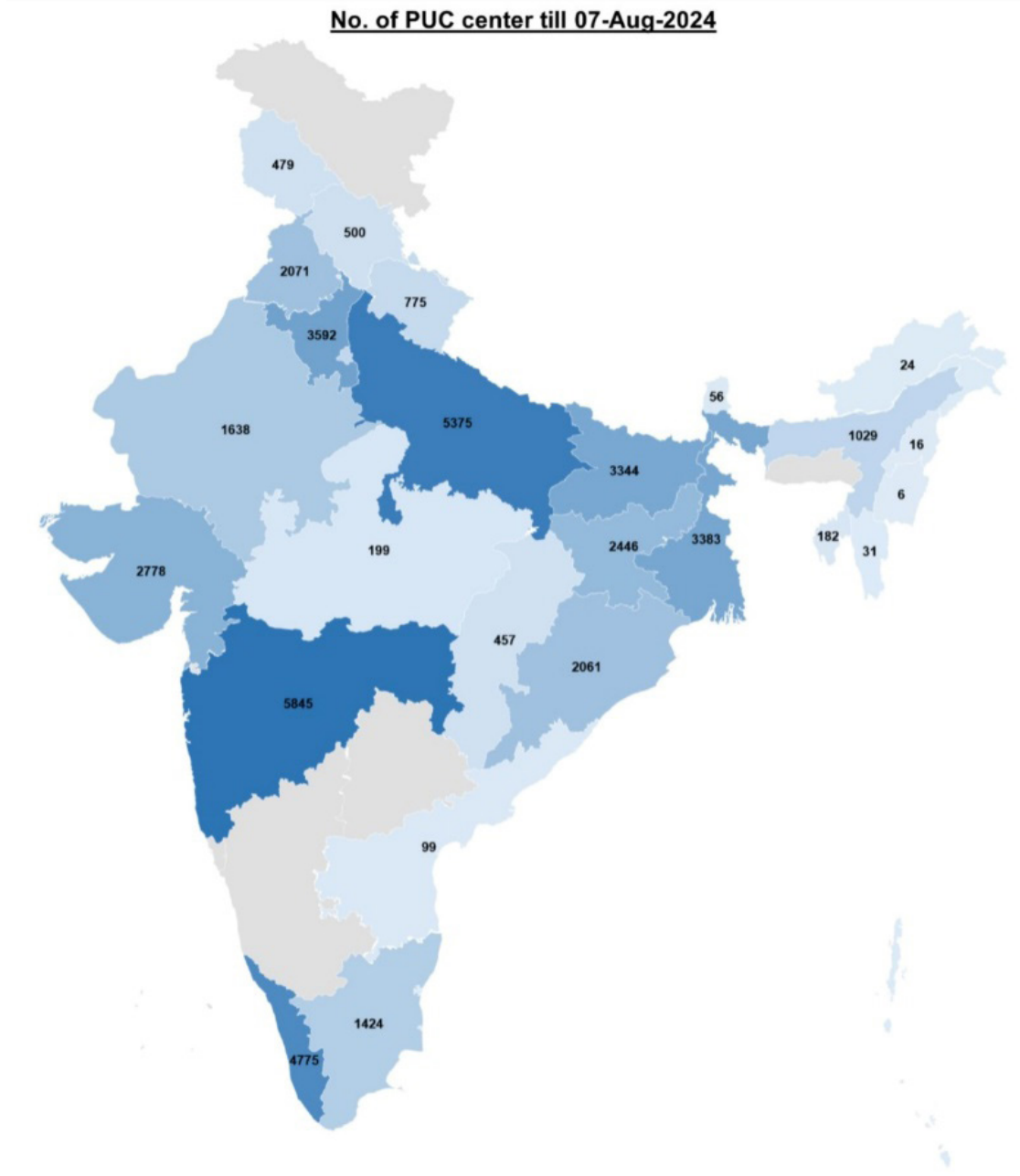
PUC implementation: emerging insights

Currently, there are 43,810 PUC centres across India as indicated by VAHAN portal. These PUC centres have been integrated by the centralised portal but there are a few states such as Telangana and Karnataka where the PUC centres are yet to be connected to the central server of VAHAN.

The highest number of PUC centres are in Maharashtra (5845), Uttar Pradesh (5373), Kerala (4788), and Haryana (3601), while the lowest numbers are in the North-eastern states, Andhra Pradesh (96), Chandigarh (113), and Madhya Pradesh (195). *(see Map 1: Number of PUC centres as of 7 August, 2024 across India).*

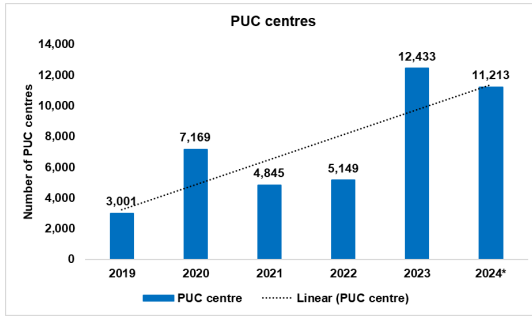
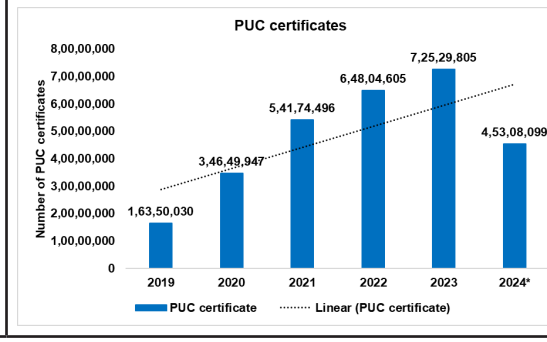
The number of PUC centres and certificates issued has drastically increased from 2019 compared to 2023. Although there was a slight decrease in the number of PUC centres after the pandemic in 2021 and 2022, there is a possibility of closure of PUC centres across India. The same trend was not observed in the issuance of certificates, as there was an increasing trend in the number of vehicles registered. *(see Graph 3: Status of PUC certificates issued in India).*

Map 1: Number of PUC centres as of 7 August, 2024 across India



Source: Based on the data available on VAHAN database, data for 2024 is until 7 August, 2024

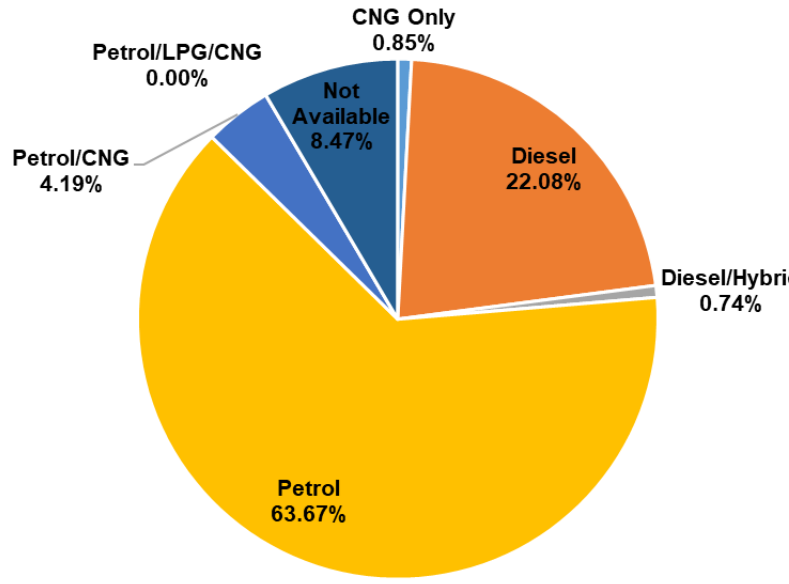
Graph 3: Status of PUC certificates issued in India

PUC centres across India	PUC certificates issued across India
	

Source: Based on the data available on VAHAN database, data for 2024 is until 7 August, 2024

When looking at the fuel-wise PUC certificates distributed across the country in 2024, it was seen that most PUC certificates are issued to petrol vehicles (63.67 per cent), followed by diesel vehicles (22.08 per cent), reflecting the predominance of these fuel types in the vehicle population. Alternative fuels like CNG and hybrids have minimal representation. *(Graph 4: Fuel-wise PUC certificates issued to vehicles in 2024)*

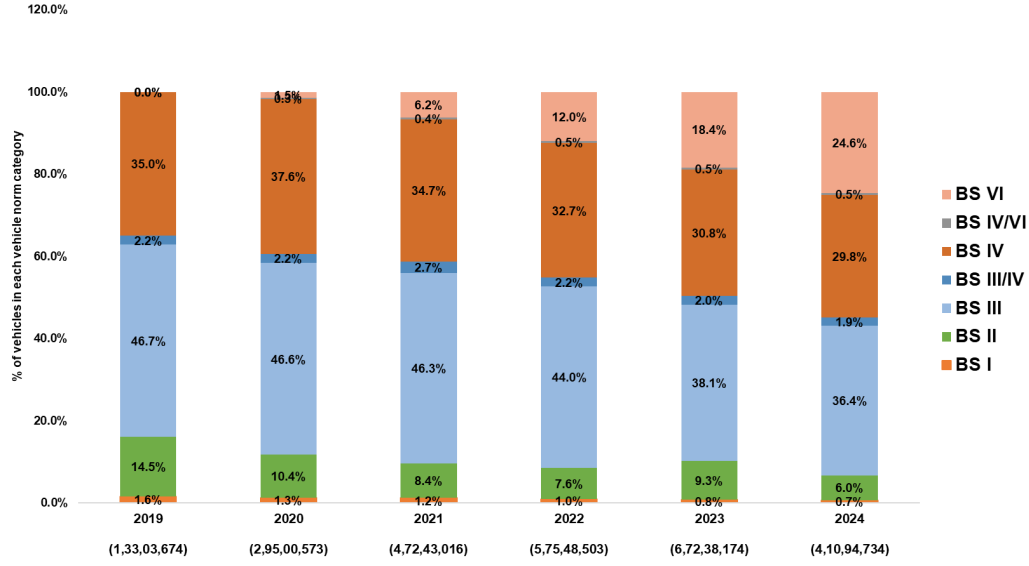
Graph 4: Fuel-wise PUC certificates issued to vehicles in 2024



Source: Based on the data available on VAHAN database, data for 2024 is until 7 August, 2024

Norm-wise PUC certificates issued for motor vehicles show that in 2024, approximately 7 per cent of vehicles are almost 15 years old across India. A declining trend in the number of BS III vehicles getting PUC certificates indicates that older vehicles are being replaced by newer technology vehicles. However, there is a problem in feeding data on the VAHAN as BS III/IV and BS IV/VI cannot be clubbed together. *(see Graph 5: Number of PUC Certificates Issued by Norm for Motor Vehicles).*

Graph 5: Number of PUC Certificates issued by norm for motor vehicles



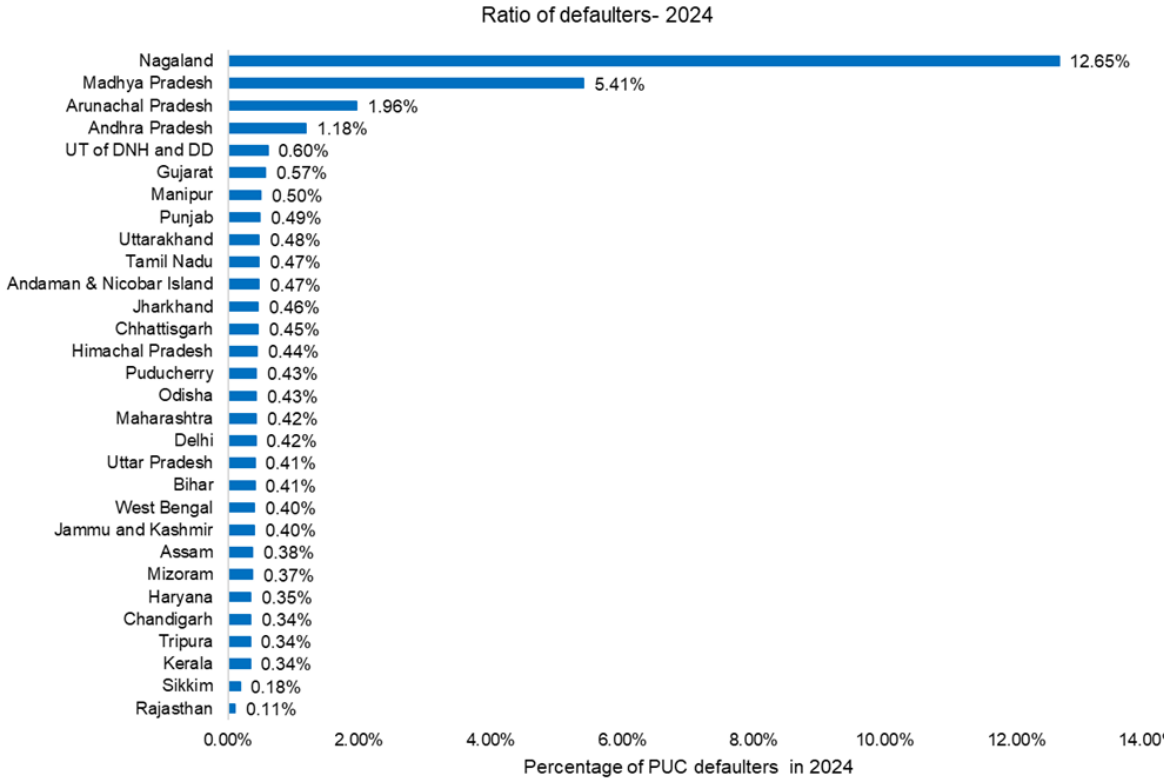
Source: Based on the data available on VAHAN database, data for 2024 is until 7 August, 2024

According to VAHAN's PUC data, states like Nagaland and Madhya Pradesh reported the highest number of defaulters in 2024, while most states averaged around 0.5 per cent of defaulters. This shows that even if the number of certificates being issued has drastically increased, there is no evidence in terms of the catching of the defaulters.

This poses serious risks as all emissions control equipment is designed for certain efficiency and durability for the life span of the vehicles. If vehicles are not watched carefully for good maintenance practices, quality manufacturing and emissions cheating, the polluted cities of India can be in serious trouble.

Remote sensing can certainly help with large-scale screening, surveillance, and compliance. *(see Graph 6: Ratio of defaulters to the total number of PUC certificates issued, 2024).*

Graph 6: Ratio of defaulters to the total number of PUC certificates issued, 2024



Source: Based on the data available on VAHAN database, data for 2024 is until 7 August, 2024

The PUC program is plagued by inherent weaknesses, including low compliance, inadequate equipment calibration, lack of audits, improper tests, and vulnerability to fraud, leaving a significant gap in robust surveillance.

Fitness programme: Very few unfit vehicles identified

In most of India, vehicle fitness tests are mostly conducted manually checking the braking efficiency, emissions, light, and steering among others but manual inspections have led to many unfit vehicles passing these tests. The very low detection rate of unfit vehicles has pushed India to shift towards automated testing centres which offer a better reliable result by eliminating human interventions.

To address this issue the central government is promoting Automated Testing Stations (ATS) to upgrade the testing regime.

The most important development is official notification on the mandatory fitness of motor vehicles only through an Automated Testing Station. GSR

652(E) dated 23 September 2021, mandates that the fitness shall be done only through an ATS registered following rule 175 for the recognition, regulation, and control of ATS.

Heavy Goods and Passenger Motor Vehicles earlier had to comply from 1 April 2023, and medium and light motor vehicles by 1 June 2024 for mandatory testing at ATS.[9] The deadline for mandatory testing has now been extended to 1 October 2024.[10]

The objective is not only to monitor fitness and roadworthiness of vehicles but also identify the unfit vehicles or end-of-life (ELV) vehicles. ELVs are those that are no longer registered, declared unfit, or cancelled due to various reasons, including court orders or owner declaration. ELVs are categorized into Natural ELVs (wear and tear) and Premature ELVs (unnatural reasons like accidents, fire, or vandalism).

Specifically with respect to the government-owned vehicle 15 year age bar has been imposed. Thus, the certificate of registration for motor vehicle owned by the Central Government, the State Government or Union Territory administrations; any Municipal Corporation or Municipality or Panchayat; a State Transport Undertaking established under the Road Transport Corporation Act, 1950 (64 of 1950) and the Companies Act, 2013 (18 of 2013); a Public Sector Undertaking; an autonomous body owned or controlled by the Central Government or the State Government, will expire after the lapse of 15 years from the initial date of registration of vehicles. Such vehicles must be disposed of through an RVSF after 15 years from initial registration, as per the Motor Vehicles (Registration and Functions of Vehicle Scrapping Facility) Rules, 2021.[11]

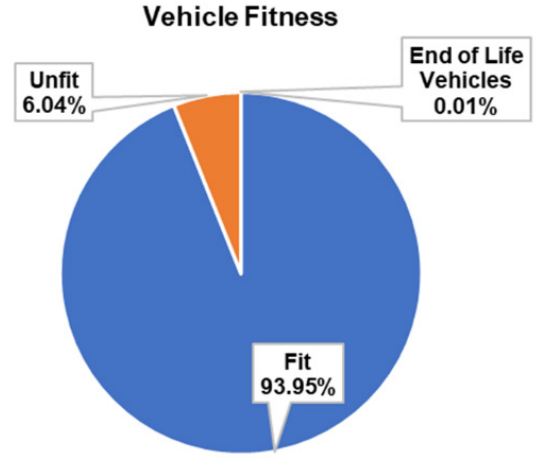
How effective is the system to identify unit and end-of-life vehicles?

Based on the VAHAN database, about 74 Automated Testing Stations (ATS) have been established. But the scale of test is still very limited.

The Vahan database shows that as of August 2024, the ATS centres have conducted fitness tests on 1.6 lakh vehicles, with only 14 being declared as ELVs. As of August 7, 2024, 6.04 per cent of vehicles have been deemed unfit, while 93.95 percent have been declared fit.

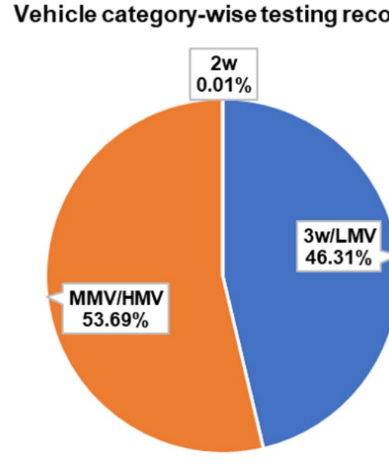
Notably, over 50 per cent of the tested vehicles are heavy-duty vehicles. *(See Graph 7: Number of Vehicles declared fit and unfit at Automated Testing Centres across India* and *Graph 8: Category-wise breakdown of vehicles tested at Automated Testing Centres across India)*

Graph 7: Number of Vehicles declared fit and unfit at Automated Testing Centres across India



Source: Based on the data available on VAHAN database, data for 2024 is until 7 August 2024

Graph 8: Category-wise breakdown of vehicles tested at Automated Testing Centres across India



Source: Based on the data available on VAHAN database, data for 2024 is until 7 August 2024

State-wise fitness results across India, based on ATS, reveal varying trends. Gujarat, Bihar, and Chhattisgarh are leading the way in setting up ATS, closely followed by Rajasthan, Uttarakhand, Assam, and Madhya Pradesh. Notably, Chhattisgarh has a higher percentage of vehicles undergoing fitness tests despite having fewer ATS than Bihar. *(see Table 1: Status of fitness tests).*

Meanwhile, Bihar, Rajasthan, and Assam have achieved nearly 100 per cent pass rate, with almost all vehicles declared fit.

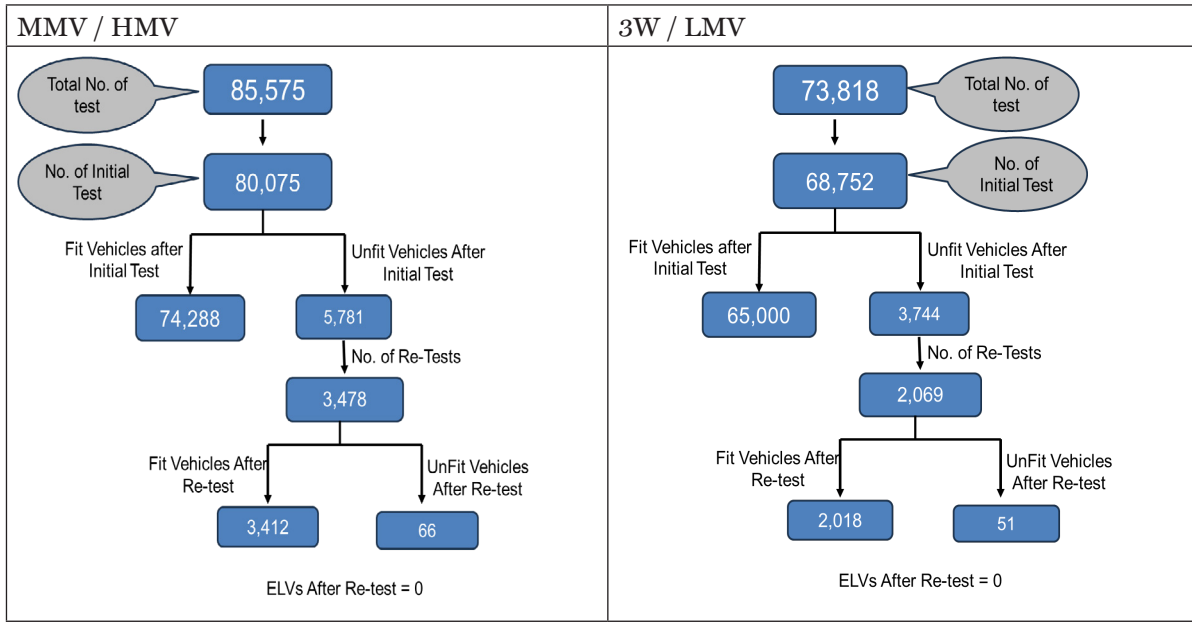
Table 1: Status of fitness tests

Sr. No.	State Name	No. of ATS Centre	Form 69 (Fitness Result)			
			Form 69 (Total)	Fit	Unfit	% of fit vehicles
1	Gujarat	38	75653	68081	7562	90%
2	Bihar	9	7676	7671	5	100%
3	Chhattisgarh	8	64428	62606	1818	97%
4	Uttarakhand	4	4168	3983	185	96%
5	Kerala	4	-	-	-	-
5	Madhya Pradesh	3	273	196	77	72%
6	Rajasthan	2	7302	7301	1	100%
7	Assam	2	105	104	1	99%
8	Delhi	1	0	0	0	0
9	Jharkhand	1	0	0	0	0
10	Uttar Pradesh	1	0	0	0	0

Source: Based on the data available on VAHAN database, data for 2024 is until 7 August 2024

The vehicle fitness testing results reveal notable differences between heavy-motor vehicles (HMVs) and light-motor vehicles (LMVs), with approximately 7 per cent of HMVs and 5 per cent of LMVs declared unfit after the initial test, and subsequent re-testing showing that 60 per cent of HMVs and 55 per cent of LMVs pass, while 1.9 per cent of HMVs and 2.5 per cent of LMVs remain unfit. Even if the vehicles which are declared unfit, none of the vehicles have been declared as an ELV. *(see Figure 1: Vehicle fitness testing results of heavy-motor vehicles (HMVs) and light-motor vehicles (LMVs).*

Figure 1: Vehicle fitness testing results of heavy-motor vehicles (HMVs) and light-motor vehicles (LMVs)



Source: Based on the data available on VAHAN database, data for 2024 is until 7 August 2024

It is still not clear, how the MoRTH deadline of October will be met as the number of ATS are still very small compared to the scale of national vehicle fleet.

Moreover, some reality check from the current ATS reveal that some of these are quite underutilized. However, the probability of failing a test is higher in ATS than in manual testing centre. Therefore, there is some merit in the MoRTH notification mandating tests in the ATS.

However, it is important that the emissions testing in the ATS is also automated which reportedly is not the case and can still fall victim to manipulation.

Formal scrappage centres without adequate end-of-life vehicles

The Ministry of Road Transport and Highways (MoRTH) has formulated a comprehensive Vehicle Scrappage Policy that includes a system of incentives/ disincentives for creation of an ecosystem to phase out older, unfit polluting vehicles. To enforce provisions of the policy, rules have been notified under the framework of the Motor Vehicles Act, 1988 and Central Motor Vehicle Rules, 1989.

The key elements and related notifications are as follows:

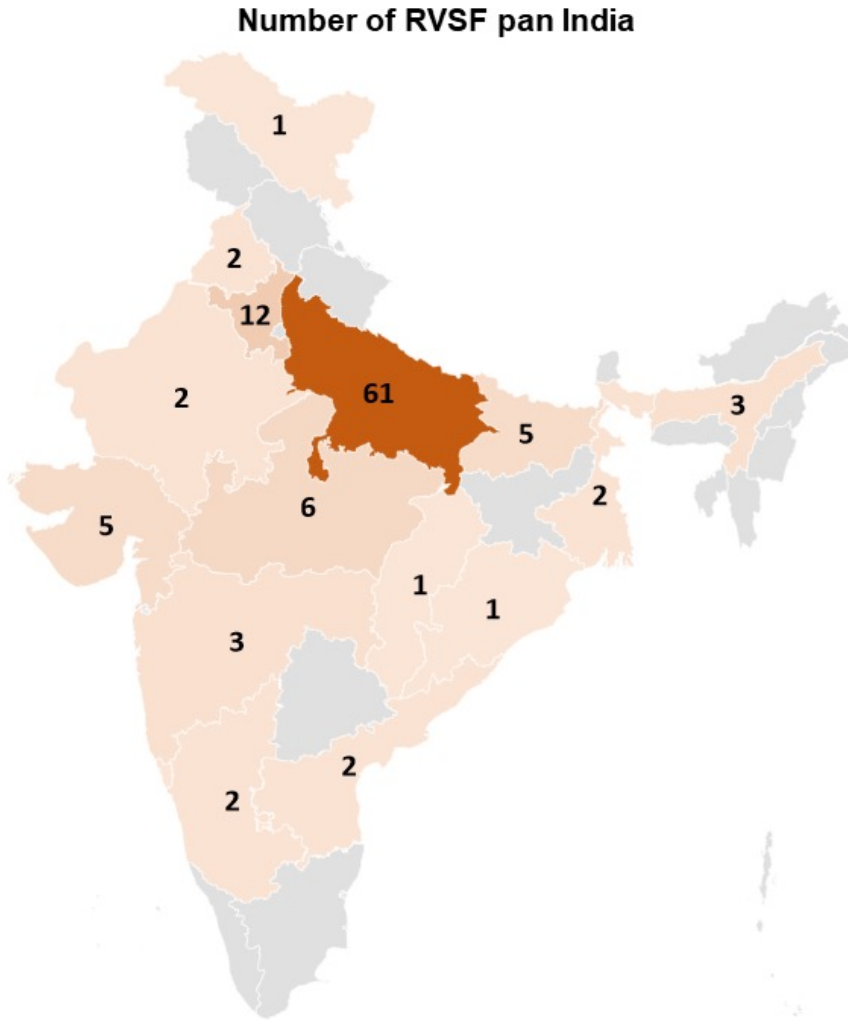
- **Setting of the Registered Vehicle Scrapping Facility (RVSF):** GSR 653(E) dated 23 September 2021 establishes the rules for setting up RVSFs. These rules apply to all vehicle categories, their last registered owners, and associated facilities, including collection centres, dismantling, scrapping, and recycling facilities. The rules also apply to guidelines for Environmentally Sound Management of End-of-life Vehicles (ELVs) and Automotive Industry Standard (AIS) 129. These facilities must ensure that scrapping is conducted according to environmental guidelines set by the Central Pollution Control Board (CPCB).

- **Criteria for scrapping of vehicles**: Vehicles eligible for scrapping include those with: expired or non-renewed registration, no certificate of fitness, damage from fire, natural disasters, accidents, or calamities, declared obsolete or surplus by government organizations, purchased for scrapping at an auction, outlived their utility or application, manufacturing rejects, test vehicles, or unsold/unregistered vehicles, impounded or abandoned by enforcement agencies and voluntarily offered for scrapping by the owner.

- **Incentives for Scrapping:** MoRTH provides tax concessions to encourage scrapping: GSR Notification 714 (E) dated 04.10.2021 provides for upward revision of registration fee, fitness testing fee and fitness certification fee of vehicles. The notification has come into force with effect from 1st April 2022. It waives off registration fees for vehicles registered using the Certificate of Deposit. GSR Notification 720 (E) dated 05.10.2021 provides for concession in the motor vehicle tax for the vehicle registered against submission of a "Certificate of Deposit". It grants a motor vehicle tax concession of up to 25 per cent for non-transport vehicles and up to 15 per cent for transport vehicles when a new vehicle is purchased against a "Certificate of Deposit" from an RVSF. This concession lasts up to eight years for transport vehicles and up to 15 years for non-transport vehicles, starting from the date of first registration. However, there's no tax concession for transport vehicles after eight years and for non-transport vehicles after 15 years, both calculated from the date of first registration.

- **Environmental and Regulatory Compliance:** RVSFs must handle hazardous components in line with CPCB guidelines. The framework aligns with the End-of-Life Vehicles (Management) Rules, 2024, notified through S.O. 367(E) dated 30 January 2024, which introduce Extended Producer Responsibility (EPR) for vehicle manufacturers.

Map 2: Number of Registered Vehicle Scrapping Facility across India



Source: Based on the data available on VAHAN database, data for 2024 is until 7 August 2024

India's efforts to tackle unfit vehicles and gross polluters under the current system, struggles to effectively address the issue. Many vehicles are still not being directed to RVSF at the desired scale. Currently, only government-owned vehicles older than 15 years are required to be scrapped, highlighting a gap in broader enforcement. According to the Vehicle Scrapping Policy 2021, India has 51 lakh light motor vehicles (LMVs) older than 20 years and 34 lakh LMVs older than 15 years. Additionally, around 17 lakh medium and heavy commercial vehicles (M&HCVs) older than 15 years are operating without valid fitness certificates. These older vehicles emit 10 to 12 times more pollutants than fit vehicles, while also posing serious road safety risks.

The 2023 year-end review of MoRTH, reveals that around 49,700 vehicles have been scrapped at RVSFs, with approximately 39,200 of these being scrapped in 2023 alone. Among government vehicles, around 30,400 have been scrapped so far, with 26,600 scrapped in 2023. Around 44 RVSFs are operational across 15 states and 37 automated testing stations (ATSs) are active across 8 states. As of 8 August 2024, 62 RVSFs have been established, with 22 of them set up by former informal scrappers, indicating a shift towards formalization of the scrapping ecosystem.[12]

The VAHAN database shows a different number of RVSFs compared to the figures in the government's PIB release, with gaps and caveats due to ongoing updates. Based on the VAHAN database, as of 7 August 2024, India has made significant progress in setting up RVSF with 114 facilities across 11 states. The majority of RVSF are located in Uttar Pradesh (61), followed by Haryana (12), Madhya Pradesh (6), Gujarat (5), and Bihar (5). This expansion has led to a notable increase in private vehicle scrappage applications by 31per cent in 2024 compared to 2023. Furthermore, Certificates of Deposit (CD) and Certificates of Vehicle Scrapping (CVS) has seen a substantial increase by 54 per cent and 72 per cent, respectively, in 2024 (until August 7) compared to 2023. However, for government-owned vehicles, while CDs have more than doubled in 2024, CVS has surprisingly decreased until 7 August 2024.

This essentially shows that even though the MORTH rules have defined ways of identifying the unfit vehicles and ELVs the monitoring and inspection system is not effective enough to apply those criteria.

This overview of the status of PUC, fitness testing and scrappage programme – that are all designed to address emissions from on-road vehicles - only reconfirms the need for upgrading the emissions surveillance system to make all these pieces of the system work.

10. WHAT IS THE AUTOMOTIVE INDIAN STANDARD–170 COVERING REMOTE SENSING ACTIVITIES IN INDIA?

A pilot study to measure vehicle emissions using remote sensing was carried out in Delhi with funding from Department of Heavy Industries in 2018. The result of the study emphasized that remote sensing was an effective tool in understanding the on-road emission profile of vehicles. In view of this Honourable Supreme Court of India has directed Ministry of Road Transport and Highways (MoRTH)

to constitute a committee and develop guidelines for implementing remote sensing in India. The implementation of on-road vehicle emission monitoring was discussed in Standing Committee on Implementation of Emission Legislation (SCOE). On direction of SCOE meeting, AIS panel was constituted to draft a technical requirement for remote sensing implementation in India. SCOE also directed to consider polluter thresholds based on prevalent emission norms and in the absence of authentic data for these thresholds, the committee had agreed to consider the first year as monitoring phase to arrive at threshold values.

The output of the AIS panel was the formation of AIS 170 document which focuses on technical guidance on remote sensing equipment, remote sensing data reporting which specifies design, construction, networking, and data sharing of motor vehicle and recommend polluter thresholds for different vehicle and different fuel types.

What are the salient points of AIS 170? The Ministry of Road Transport and Highways (MoRTH) is developing AIS 170 technical regulations for Remote Sensing Device (RSD) implementation. While these guidelines are a step forward, they require further strengthening. In addition, amendments to the Central Motor Vehicles Rules (CMVR) are necessary to define the mandate, rules, and scope for RSD implementation and enforcement.

The AIS 170 document, currently being refined, provides technical guidance on RSD equipment, data reporting, analytics, and polluter thresholds for different vehicle and fuel types. However, key gaps remain, such as CO_2 absorption measurement, NO and NO_2 measurement for diesel vehicles, and comprehensive procedures for site selection, data analysis, and integration with the VAHAN database. Addressing these issues is essential for robust implementation.

Notably, the 60th and 61st SCOE meetings highlighted the need to refine thresholds and set a monitoring phase to gather authentic data. Further efforts should focus on ensuring that AIS 170 thoroughly addresses these regulatory and technical aspects for successful RSD deployment in India.

- AIS 170 defines the RSD equipment device specifications such as equipment range and accuracy for emission pollutants. The specifications define device's emission measurement capabilities to be followed while implementing RSD programmes.
- It also defines different standards such as IS/IEC 60529 (for ingress protection), IEC 61000 (Electromagnetic compatibility) that device must comply.

- AIS 170 defines the list of parameters such as emission measurements, vehicle registration details, operating conditions, time and date of measurement, RSD device details etc. that shall be recorded in RSD programme evaluation studies.
- It gives a list of IT hardware and infrastructure required to set up the device at the monitoring station.
- It gives the requirement on how and at what frequency the RSD device should be calibrated, a failure of which may affect the device accuracy to measure pollutants.
- It gives the steps required to properly set up the devices at the site.
- It gives an indication on how valid and invalid vehicle records are classified.

What are the gaps in AIS 170?

- The procedure does not elaborate on consideration to be followed while choosing remote sensing sites. The document also does not define what data analysis needs to be carried out for effective monitoring of remote sensing programme.
- The procedure fails to classify different remote sensing technologies that are available in the market and what technologies will be best suited for India. For some of the current RSD technologies equipment calibration is not required as they are based on different measurement principle. However, the document has generically covered all equipment as having the requirement of periodic calibration.
- It does not give any details on how emissions cut points, above which a vehicle is considered high emitters, are defined.
- The document lacks in providing clear guidelines on how PUC and remote sensing can co-exists and if the vehicle needs to pass both to remain road worthy.
- AIS 170 document is not clear on regulatory action to be taken in case if the vehicle is identified as high emitter. The lack of clear legal framework will slow the technology adoption and causes legal dispute between vehicle owners who think that their vehicle has valid PUC certificate and authorities who had identified vehicle as high emitter through remote sensing device.
- AIS 170 document does not provide details on how the computer system at monitoring site should communicate with VAHAN database. Nor it gives any details on technology requirements from NIC (National Informatics Centre) to be followed if some entity wants to access VAHAN data for implementing remote sensing program.

Consultation with ICCT shows that it is crucial that the draft makes it mandatory to measure CO_2 absorption. Remote Sensing (RS) does not measure tailpipe concentration directly. It is recalculated from the pollutant/CO_2 absorptions ratio (and only done correctly for stochiometric engines, therefore not for diesels). Without CO_2 absorption, pollutant absorptions alone are hardly useful. ICCT also recommends making NO measurement mandatory, as well as primary NO_2. Modern diesel can emit up to 50 per cent of NOx as NO_2. There can be a risk that RS with NO, but without NO_2, will underestimate real-world NOx emissions of diesel vehicles.

AIS 170 document should comprehensively address the challenges posed by model engine technology. In view of this national regulations for vehicle emission monitoring using remote sensing should be prepared that provide guidelines on how to implement remote sensing program in India. Cities that want to carry out remote-sensing programs will refer to the national regulation to screen for and take actions against non-compliant high-emitting diesel vehicles. The standardized remote sensing data can also be used for purposes that are not covered in the regulation, such as fleet screening, evaluating the in-use vehicle emission level, and identifying high-emitting models that may have manufacturing defects.

11. CO-EXISTENCE OF PUC WITH RSD

It is not very clear how the PUC and RSD tests can coexist. It is necessary to provide clear guidelines on how PUC and remote sensing can co-exists and if the vehicle needs to pass both to remain road worthy.

In fact, it has been noted in Kolkata, that when vehicle owners are intimated by the department about their polluting vehicles, they often challenge on the grounds that they have a valid PUC certificate and should not be penalized. This requires MORTH to clarify how remote sensing monitoring will co-exist with the PUC program.

This highlights the challenge of corelating PUC and RSD to identify high emitters. To make the PUC and RSD program compatible more data is needed to analyse statistically significant correlation between RSD and PUC.

An effort was also made to correlate the RSD and PUC result in the ICCT pilot story of 2024. According to the ICCT analysis, to compare with PUC limits for BS IV and BS VI petrol and CNG vehicles, ICCT used the combustion equation for

carbon balance to convert the emission ratios from the remote sensing device to estimate concentrations of CO (per cent) and HC (parts per million, ppm).

A similar comparison for diesel vehicles was not possible because remote sensing measures pollutants-to-CO_2 ratios in the diluted plume and the PUC test measures only tailpipe opacity (proxy for PM) for diesel vehicles. The unknown tailpipe CO_2 concentration for diesel prevents estimating tailpipe pollutant concentration.

The ICCT notes, - though, that these test procedures are quite different and high average real-world emissions do not mean that the vehicles are not complying with PUC limits, which are designed for idle-testing conditions. This comparison is for representative purposes only.

This requires clear guidelines on how PUC and remote sensing can co-exist and how the threshold values and cut points need to be developed.

Other countries are framing rules to set threshold limits for RSD. Hong Kong Environmental Protection Department (HKEPD) has set up a system in which all the data are transmitted to a remote data storage and then post processed by the HKEPD to identify the vehicle manufacture year, model, fuel type and emission certification levels.

For a vehicle to be identified as a high emitter, there must be two measurements above the cut points, and the driving characteristics must be within the speed/acceleration ranges of the laboratory testing cycle. They have developed limit values for RSD. The regulation in Hong Kong apply to petrol and liquified petroleum gas (LPG) vehicles. Emission limits are set for NO, CO, and HC, in the units of concentration. However, they also have a system for an additional confirmatory tests in the established inspection and maintenance centres.

12. THE NEXT STEPS

Roadmap for implementation of RSD in the NCR region: To implement the July, 2024 directive of the Supreme Court, MoRTH, Commission for Air Quality Management in NCR and the four state governments in NCR – Delhi, Uttar Pradesh, Haryana and Rajasthan need to develop the roadmap and timeline for implementation of RSD urgently.

Strengthen technical regulations AIS 170 and notify the rules for implementation under the Central Motor Vehicles Act and Rules to create a mandate for nation-wide implementation: Even though Automotive

Industry Standard (AIS) 170 have been developed, the MoRTH has not notified the rules and threshold values for identification of gross polluters yet. Moreover, the AIS 170 itself requires further strengthening to address gaps including process for site selection, data analysis requirements, criteria for selection of suitable remote sensing technologies, improve certain aspects of measurements methods, state the interface with the VAHAN database, provide technology requirements for accessing VAHAN data among others.

The MoRTH has already proposed a measurement and monitoring phase to generate vehicle emissions data using remote sensing to help define the accurate polluter thresholds. The timeline for this may be fixed and rolled out quickly. Clear guidelines are needed for setting emissions cut points, integrating remote sensing with PUC checks, and specifying regulatory actions for high emitters.

Develop certification system for RSD machines to enable procurement and deployment: AIS 170 needs to set the required technical parameters for testing and certification of remote sensing devices that the state governments require for procurement and deployment. Automotive Research Association of India (ARAI) and (ICAT) need to upscale facilities for testing and certification.

Develop national guidance framework for implementation of RSD

National-level enforcement framework needs to be defined under the Central Motor Vehicles Act and Rules to enable implementation of RSD program across the country. Ministry of Road Transport and Highways needs to amend the Motor vehicle Rules to incorporate the provision of remote sensing monitoring for enforcement and to provide legal back up to its implementation and enforcement in cities.

Support roll out of lighthouse projects on RSD in selected cities

As this is a very new area of intervention and cities do not have experience, it is necessary to support the first set of programs in selected cities including those that have already taken steps in this direction including Delhi and Kolkata to implement the RSD program. These can be the lighthouse projects to demonstrate the pathways and systems for implementation and enforcement in Indian cities.

Upscaled programme can help to establish the markets for RSD devices and reduce costs: Legally enforceable can help to establish the market and

bring adequate numbers of technology providers for matured technologies and improve cost effectiveness of the programme. This will help to build local market for RSD technologies in India. This is needed to build confidence and capacity of the implementing agencies in cities. State governments with support from the central government can plan the time bound phase-in and designing of the program.

Provide technical knowledge support to implementation of RSD program and build awareness: Vehicle testing agencies and the appropriate technical bodies need to provide technical knowledge support to the state governments related to instrumentation, data analytics, network and system design, adoption of gross polluter threshold, clean and dirty screening approaches, among others. Such application can open several opportunities for regulatory interventions for pollution control. These include enforcement of low emissions zones.

Need quicker transition to Bharat State VII emissions standards along with stronger real world emissions regulations: It is necessary to align with the latest real world emissions regulations enforced in Europe (Euro VI-e/E standard with tighter real-world emissions regulations). Also enable quicker adoption of BS VII standards with tighter real-world emissions requirements and on-board emissions monitoring.

Align RSD programme with the identification of unfit and end-of-life vehicles for scrappage and fleet renewal: The current efforts of the government to reform the PUC programme, or augment automated testing centre and push state governments to set up scrappage infrastructure are not adding up to effectively screen all vehicles and identify unfit vehicles, ELVs and vehicles with non-functional emissions control systems. RSD system is needed to enable this effectively. Otherwise, the investments in testing facilities and scrappage centres will remain sub-optimal.

Need ambitious implementation plan and target for zero emissions vehicles: It is evident from the pilot programme in Delhi that even though CNG programme has helped to curb toxic diesel particulate emissions, NOx emissions from CNG vehicles can be a matter of concern. This builds the case for a quicker uptake of battery operated vehicles with zero tailpipe emissions to curb vehicular pollution.

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