POLICY BRIEF

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NEW CHALLENGES

Centre for Science and Environment

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Authors: Anumita Roychowdhury and Vivek Chattopadhyaya

Contributors: Swagata Dey and Shambhavi Shukla

Editor: Archana Shankar

Design: Ajit Bajaj

Production: Rakesh Shrivastava and Gundhar Das

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41, Tughlakabad Institutional Area
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Phones: 91-11-40616000
Fax: 91-11-29955879
E-mail: cse@cseindia.org
Website: www.cseindia.org

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INTRODUCTION

India adopted nationwide Bharat Stage VI (BS-VI) emissions standards on 1 April 2020. This direct leapfrog from BS-IV to BS-VI emissions standards has led to a paradigm shift in emission-control systems, especially in diesel vehicles. As a result, compared to BS-IV emissions standards, particulate emissions limits for BS-VI diesel cars have dropped by at least 82–93 per cent and nitrogen oxides by at least 68 per cent. Similarly, the particulate emissions limit from diesel trucks and buses is lower by at least 50–67 per cent. Also, the emissions gap between petrol and diesel cars has narrowed down.

While this transition has substantially improved emissions from the new fleet, there is the added concern of upgrades in the current on-road emissions surveillance system to keep these vehicles low emitting throughout their useful life on road. This is particularly important as substantial tightening of emissions standards has led to a paradigm shift in the systems and approaches of emissions control, especially in diesel vehicles. While they have the potential to reduce emissions substantially, their optimum and effective functioning during their useful life on road is critical for maintaining the emissions gains.

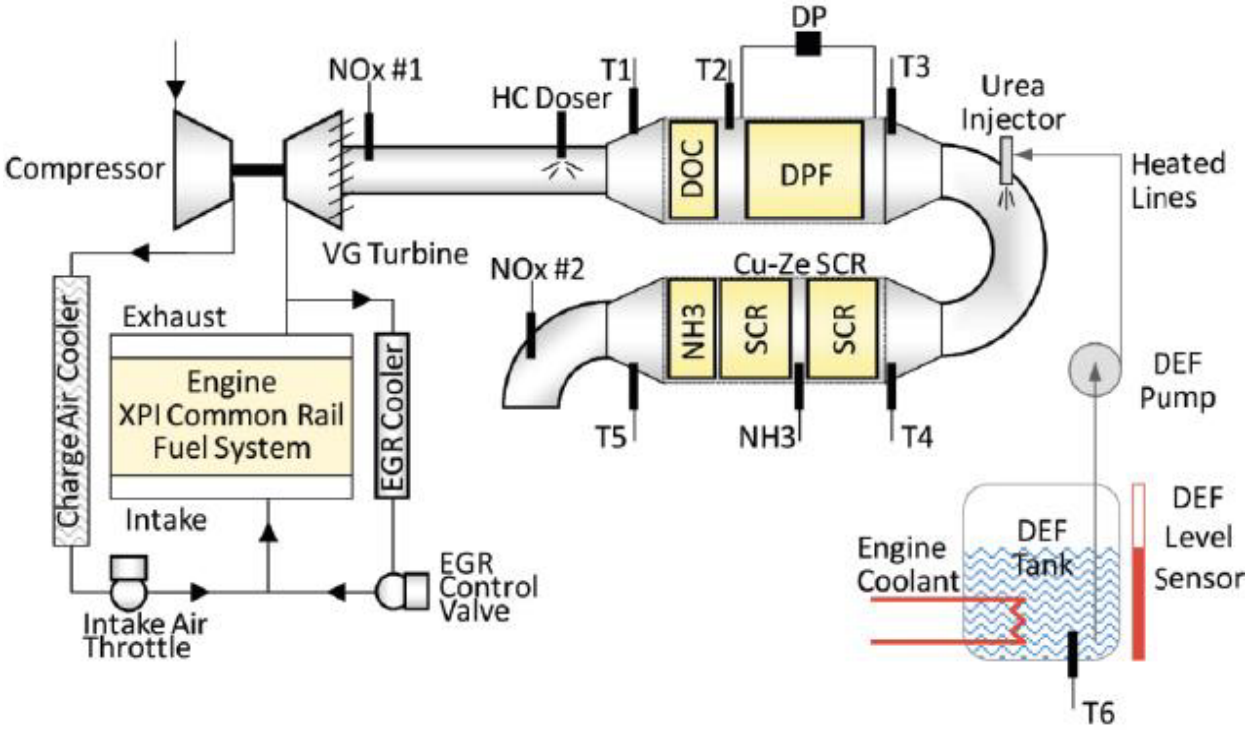
Most dramatic is the change in the controls for the pollutants of concern from diesel vehicles particulate matter (PM) and nitrogen oxides (NOx). Tightening of the limit for PM mass emissions combined with the first-ever norms for particle numbers have led to the introduction of advanced diesel particulate filters (DPFs) that can filter out up to 99 per cent of particles. DPFs have an inbuilt capability to trap and purge or burn off the particles for self-regeneration. Similarly, selective catalytic reducing (SCR) in the exhaust system uses auto-grade urea solution to neutralize NOx emissions. The exhaust gas recirculation (EGR) system has been further developed to reduce NOx by lowering the combustion temperature inside the engine. This is a dramatic shift from the dominant conventional approach of using only diesel oxidation catalysts.

The entire exhaust treatment ecosystem has become far more complex to maintain (see *Figure 1: BS-VI and advancement in systems of diesel emission control*). This poses a serious challenge to management of emissions of on-road vehicles.

There are concerns, based on global experiences, that without adequate surveillance and safeguards these systems may get compromised and disabled, affecting the overall emissions from in-use vehicles. This is why new strategies are coming up for surveillance and control of real-world emissions, strengthening of vehicle inspection and maintenance programmes, upgradation of on-road fleet screening with the help of remote sensing methods, and assigning manufacturers' responsibility for emissions performance. The new strategies have drawn considerable policy attention globally.

India has also stepped up action in this direction. As part of the BS-VI regulations it has adopted real-world emissions measurement requirement for type approval process or vehicle certification. Further, reforms in these rules as well as the new requirement of in-service conformity are expected to be introduced in 2023. Accordingly, the Automotive Indian Standards (AIS) related to technical parameters of vehicle testing procedures for certification are being modified. AIS rules are also being crafted for application of remote

Figure 1: BS-VI and advancement in systems of diesel emission control



Source: National Academic Press

sensing monitoring of the on-road fleet. These are expected to substantially transform the real-world emissions surveillance system.

While all these strategies need to evolve and scale up quickly across all regions, there is a specific aspect of on-road emissions surveillance that has not yet drawn attention in India. This is the problem of tampering with advanced emission-control systems or use of cheat devices to tamper with advanced emission -control systems in in-use vehicles. If not checked and controlled, this can lead to uncontrolled emissions negating the emissions gains from investment in new emissions-control systems.

Global review of this challenge has shown that such emissions frauds can be quite widespread and if not addressed early can seriously compromise performance of the advanced emissions-control systems in BS-VI vehicles and undermine air-quality gains.

Emissions frauds have been reported at two levels—during manufacturing and at the time of vehicle operations. Instances of emissions frauds during manufacturing are well captured in the infamous Dieselgate, which started with the Volkswagen scandal. Vehicles were fitted with 'defeat devices' in the form of a computer software designed to cheat on the US federal emissions tests. This software could detect when the vehicle was undergoing an emissions test and turned on full emissions controls during the testing period. But during normal on-road driving, the effectiveness of these devices was reduced, leading to very high emissions. Subsequently, several vehicle brands in Europe were found to be emitting several times higher than their certified levels.

Emissions frauds at the time of vehicle operations involve vehicle owners and/or users—especially commercial vehicle owners—resorting to the use of defeat devices or tampering to avoid high cost of maintenance and operations of the advanced emissions-control systems in BS-VI vehicles. This requires yet another filter of check during emissions inspection of on-road vehicles to ensure such tampering has not been resorted to. If not addressed, it can have serious consequences in terms of high and uncontrolled emissions from new vehicles.

Centre for Science and Environment (CSE) outlines in this policy brief the challenges associated with tampering and emission frauds as well as lessons from the global learning curve to explain why the missing link in the overall in-use emissions management needs to be addressed in India. While introduction of in-service compliance requirements and real-world emissions testing are expected to come into force in 2023 and be an effective check on compromises at the manufacturing level, remote sensing measurements are also being planned in a few cities to improve on-road fleet screening to catch grossly polluting vehicles. But it will take time before these options become fully scalable across all regions in India.

Until then there is an urgent need for simpler upgrades in the existing on-road emissions inspection regime, including in vehicle inspection centres for fitness and roadworthiness tests and Pollution under Control (PUC) centres. Physical verification and checks to detect tampering need to be introduced. Two immediate upgrades are required. One, a checklist for physical verification of key emissions-control systems to detect any kind of damage and tampering needs to be introduced. Two, a system inbuilt in vehicles of on-board diagnostics (OBD) to monitor and record anomalies, including emissions performance of the vehicle with the PUC system, needs to be integrated. The Ministry of Road Transport and Highways (MoRTH) has already notified the need to check the malfunctioning light linked with the OBD on the dashboard of vehicles. If this light is on at the time of PUC testing it is not allowed to be tested but returned for further checking to workshops and necessary remedy. OBD is a self-policing system in vehicles that can detect and self-record any problem, including emissions, as fault codes. Globally, basic screening of vehicles requires checking of the malfunctioning light. But to prevent the risk of even the OBD system getting disabled, inspection centres are equipped with an OBD scanner to check and ensure that the OBD system is working and has not been disabled. India needs similar strategies immediately. In fact the new centralized vehicle-inspection centres for commercial vehicles have started to acquire OBD scanners. This needs to be scaled up to integrate with upgraded PUC systems.

These strategies are quickly scalable nationwide for basic screening against tampering and fraud and any kind of malfunction that compromises emissions performance of vehicles.

Next steps

India cannot risk emission frauds and cheating and worsen its public health risk after making big investments to improve vehicle technologies to meet tighter emissions standards. While steps have already been taken to adopt real-world emissions regulations and in-service compliance requirements for more fundamental control of real-world emissions—and this reform must stay on course and align with the global best practice—more is needed to prevent cheating and tampering during the operational phase.

In fact, some of the clean air action plans of cities under the National Clean Air Programme (NCAP) have included provision of advancement in on-road emissions surveillance, including remote sensing measurements among others. These plans have also asked for further upgradation of the PUC centres to be BS-VI ready.

It is therefore recommended that MoRTH immediately takes steps to initiate the following measures to address the additional concern related to use of the defeat device and tampering of emissions control systems. State governments also need to chart a roadmap for implementation.

Implement checklist of physical tests to detect tampering and damages to emission control systems: The commercial vehicle inspection centres for annual roadworthiness and fitness tests and PUC centres need to be upgraded to adopt a checklist of physical verification of diesel particulate filters (DPRs) and selective catalytic reducing (SCRs) systems among others fitted in BS-VI vehicles. This can be introduced quickly nationwide while more advanced systems, including remote sensing for on-road fleet screening and real-world testing as part of in-service conformity, can follow. There is a need for a strong inspection regime to prevent the use of defeat devices by vehicle users. India needs to align with this emerging global trend.

Adopt cheat device regulations: There is still a critical gap that needs to be addressed to prevent the use of cheat or defeat devices. India needs cheat-device regulations to enable surveillance systems and penal action as well as monitoring. The regulations are needed to prevent promotion of products that unethically claim to disable emission-control systems. Giving such devices in the hands of the people for en masse disabling of emission-control systems will have serious consequences.

Link on-board diagnostics (OBD) with emissions inspection: MoRTH has already issued a notification for checking of malfunctioning light on vehicle dashboards linked with the OBD alerting anomalies, including emissions anomalies in vehicles. If a malfunctioning light is detected during a PUC test, vehicles are asked to go back for a more thorough checking in workshops. But to align with global good practices it is also necessary to have a simple testing system in PUC centres that can detect if the OBD itself is functioning or if it has been disabled. This additional reform is necessary. All PUC centres and commercial-vehicle inspection centres conducting fitness tests should be equipped with a diagnostic tool and adapter to connect to the SAE J1939 standard OBD port on BS-VI vehicles for checking of maintenance status of vehicles and other faults.

It is encouraging to see that centralized vehicle inspection centres for commercial vehicles in different parts of the country are already required to procure a scanning tool for OBD and record fault codes for vehicles.[1] In fact, available evidence shows that the tendering process for procurement has started. This may be scaled up for selected workshops and PUC centres in cities.

Need consumer outreach programme: A strong consumer outreach programme is needed to sensitize consumers about the dangers of tampering and how the cost of compliance is more affordable than non-compliance. If these advanced after-treatment systems get damaged the cost of replacing them can be prohibitive.

Post-2023 BS-VI reform agenda needs to stay on course: MoRTH is already revising the AIS parameters to strengthen real-world emissions testing and introduce an in-service compliance strategy. These reforms along with the adoption of improved WLTC (worldwide harmonized light vehicles test cycles) for vehicle testing need to stay on course. Similarly, the AIS reform for introduction of remote-sensing measurements for on-road fleet screening should be expedited. This must not slow down the face of the pandemic crisis.

SECTION 1: Vulnerability of emission-control systems

The fact that advancement in emissions control systems in itself is not sufficient to ensure emissions performance of vehicles during their useful life on road has drawn considerable regulatory attention globally. It has led to vehicle-emissions inspection programmes as well as emissions-warranty and vehicle-recall programmes for manufacturers—with varying scope and details—across the world.

India has adopted the pollution under control (PUC) certificate programme for all vehicles and vehicle fitness and roadworthiness tests for commercial vehicles for basic screening. PUC norms have been upgraded from time to time to match the improvement in mass emissions standards for new vehicles through the successive stages of Bharat Stage mass emissions standards.

However, the current PUC system—as several audits of the programme have shown—requires significant upgrade and reforms for it to be an effective programme. But there is also the larger concern that the only PUC tests available for diesel vehicles—the basic smoke density test—is not even relevant for the new generation BS-VI diesel vehicles. These vehicles barely have any visible smoke; but they can be high emitters of tiny particles if their particulate filters are damaged or are not performing. But PUC systems cannot capture this. It cannot also capture high real-world NOx emissions, as NOx measurement is not possible within the PUC framework.

India is therefore at a crossroads and needs to overhaul its existing system for emissions surveillance. This therefore makes the matter of detecting emissions fraud more serious. The current PUC system or the annual fitness and roadworthiness tests are not even designed for prevention for emissions frauds.

Vulnerability at the manufacturing level: The problem of emissions fraud first caught public attention globally when Dieselgate hit the US, Europe and some other markets. It started with the 2015 Dieselgate scandal when the US Environmental Protection Agency (EPA) investigation following the tests carried out by the International Council on Clean Transportation (ICCT) found Volkswagen had used rigged software to pass the federal certification tests but reduce the effectiveness and performance of the Selective Catalytic Reduction (SCR) system during normal driving on road, leading to high emissions. The inbuilt software could sense the test bed at the time of the vehicle certification to perform optimally to meet the emissions standards. But this reduced the effectiveness of SCR, requiring lower dosage of urea solution once the vehicle was on the road, leading to higher NOx emissions in the real world.

Once this was discovered, regulators globally went into overdrive to reform the testing and certification parameters to bring in more exacting real-world emissions monitoring requirements and in-service compliance regulations to prevent such manipulation at the manufacturing level. This led to the introduction of the Real World Driving Emission (RDE) testing with a portable emission-monitoring system (PEMS), more rigorous vehicle testing based on WLTP test procedures, and in-service compliance requirements. This required higher level of performance and integrity of the on-board diagnostic system (OBD) to detect emission exceedance.

While crafting the BS-VI regulations, India also took note of the requirements related to real-world emissions surveillance and in-service compliance and is introducing and ratcheting them up in phases. This is expected to be completed with the 2023 reforms.

SECTION 2: Fooling the system on road

Tampering at the manufacturing level is not the whole story. Instances of tampering by vehicle users during the operation phase is yet another serious challenge. Vehicle users themselves have reported substantial emissions frauds and tampering of advanced emission-control systems. The additional costs of operating and maintaining these systems have added to the perverse incentive for tampering with these systems. India has to take note of these widespread reports of vehicle users tampering with the emissions control systems, especially of trucks and commercial vehicles.[2]

These instances are varied. For instance, the SCR unit that is meant to control exhaust NOx contains an aqueous urea storage tank, urea injector, NOx sensor and exhaust temperature sensor at the inlet.[3] This system requires periodic refilling of autograde urea solution that neutralizes NOx in the exhaust emissions. But this creates a perverse interest to tamper and disable the system to avoid the additional costs of urea refill. Similarly, DPFs are fitted with inlet and outlet temperature sensors, fuel injectors, OBD indicators and warning lights. It is also believed that sometimes the DPFs can create back pressure and affect performance. Tampering may also include removal of catalytic converters, air pump or EGR valve. Further, installation of any part of a vehicle's emission-control system with a non-certified part that does not have the identical design and function or adding parts such as turbochargers may count as tampering and is an additional concern[4] (see *Box: Possible means of tampering*).

Vehicle owners want to remove emission-control devices from their engines to eliminate repair costs, reduce operational costs or even have the misplaced notion of increased performance. This results in uncontrolled emissions. Tampering with these instruments is not a complicated process and in several instances can go unchecked. For instance, the exhaust gas recirculation (EGR) system can easily be disabled by deleting its functionality from the engine control unit (ECU) via a remapping (reflash). Another option is to mechanically block the EGR gas tube or by sealing the hose to the vacuum actuator. The same method can be used to remove or disable the SCR systems as well[5] (see *Figure 2: At a glance—Type of tampering with the emission-control systems*).

It may be noted that globally as well as in India, regulations require vehicle manufactures to install inbuilt automatic checks in the vehicle itself that can sense if the urea solution in the SCR system has depleted and stop the vehicle automatically. But defeat devices are designed to disable even this in-built check. These devices modify the system to allow the vehicles to run even if the solution is not refilled and also not let the on-board diagnostic system flash red to alert the user. This brings out the importance of integrating OBD with the vehicle inspection programme. The inspection centres should be equipped with the basic scanner to check if the OBD is working.

Further, there exists a grey market for the end user. The benefits of tampering are often much higher than operational costs and hence serve as a perverse interest.

Unethical marketing of cheating devices: It is ironic how with the advent of advanced emissions control systems in the global market, internet retail of

Box: Possible means of tampering

Diesel particulate filter (DPF)

The diesel particulate filter must be routinely cleaned. It may, however, be removed altogether or minor defects covered by welding. The presence of soldered or welded spots thus needs to be investigated. Additionally, deposition of soot in the exhaust of Euro 5 or Euro 6 vehicles is indicative or tampering of DPF. A hole may be drilled through the filter to improve the air flow. This is also a clear case of tampering.[6]

Selective catalytic reducing (SCR) systems

One of the reasons for SCR tampering is that it requires periodic refilling with autograde urea, which is expensive. Consumption and frequency of autograde urea varies across vehicle models. For instance, a heavy duty vehicle with a mileage of 5 km per litre requires 12 litres of AdBlue per 1000 km. A large truck, on the other hand, plies for 3,500 km with 40 litres of autograde urea. Hence tampering is seen as a way out to circumvent the trouble and expense of filling with autograde urea. Further, there may be the possibility of misfuelling if strict quality control checks for urea are not undertaken.[7]

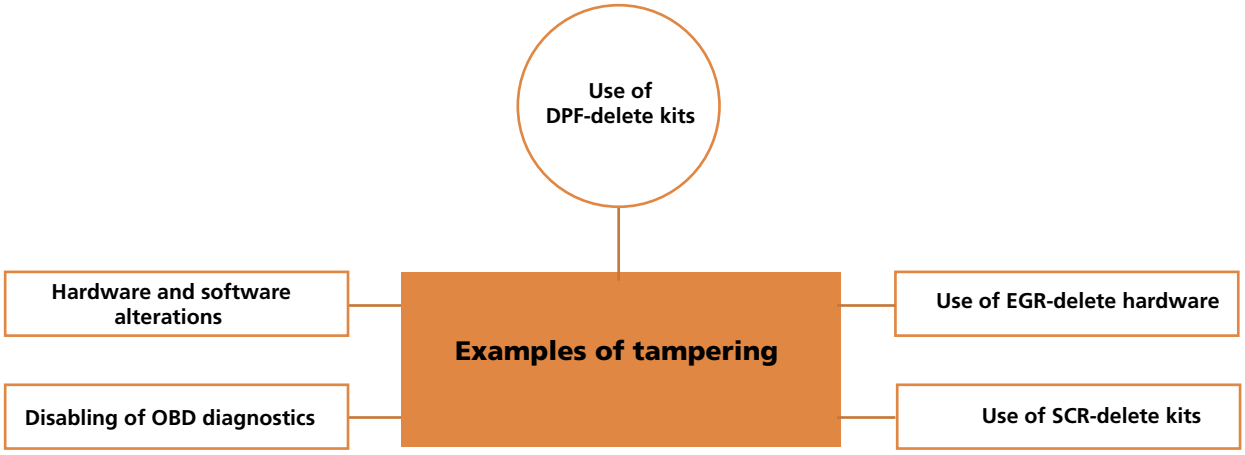
Modification of SCR control codes amounts to tampering. Further, visible crystallization or rust formation around the autograde urea tank cover and pipe is an indication of tampering as these are due to inferior quality of urea. Other examples of SCR 'emulators' include modified and soldered wires in the harness, retrofitting of any electronic device to the OBD-port and presence of splices wires within the SCR system.

Exhaust gas recirculation (EGR)

EGR delete hardware kits usually include various pipes such as straight pipes and turbo-back pipes, which are used to replace the exhaust system, including all the filters and catalysts. The system is then recalibrated after disabling of OBD diagnostics. This involves the following steps; a 'tuner' that is installed through the data link connector is used to hack into and modify the vehicle's software and calibration files. Tuning helps make an engine operational after removal of EGR and prevents the OBD from activating. Even if the filters and catalysts are not altered, tuning can increase the tailpipe emissions.[8] From the end user's perspective, tuning is beneficial as it increases the horsepower and torque of the engine, which leads to greater acceleration.

Other mechanical alterations inside the engine compartment such as blocking of gas tube and sealing of the hose to the vacuum actuator are examples of tampering of EGR systems.

Figure 2: At a glance—Type of tampering with the emission-control systems



Source: Compiled from different sources

defeat devices to disable diesel emissions control systems has taken off. Leading internet-based retailers have periodically advertised products such as Adblue OBD2 Emulator for Trucks Plug Drive Ready Device by OBD2. These defeat devices disable the SCR system, enabling the consumer to avoid or lower the cost of regular refill. In 2016 it was noted that internet marketing even provided an installation manual for customized use in major truck brands. Graphic descriptions were given to truck users on how to use these devices. Companies even inform that use of AdBlue Emulator device is illegal in some countries, especially in the European Union, which has higher emissions standards.[9]

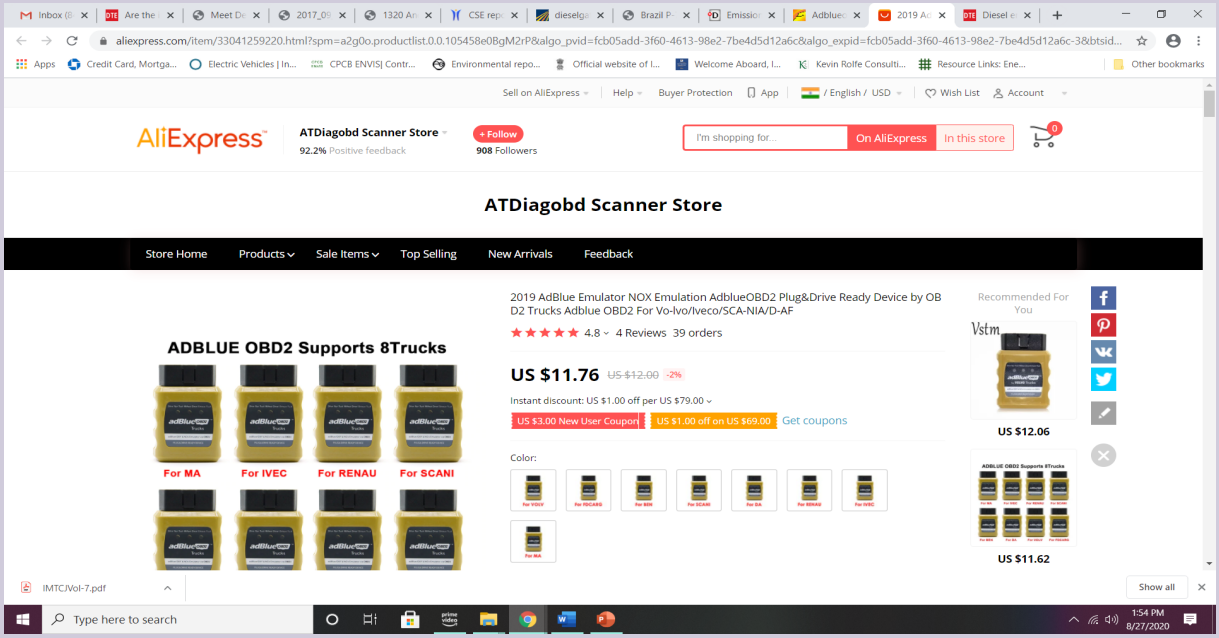
The fact that such devices exist for open sale to disable emissions control systems requires rules against cheating devices. Evidence shows nearly all major markets are vulnerable to emissions frauds. For global evidence see *Box: Global evidence on tampering*.

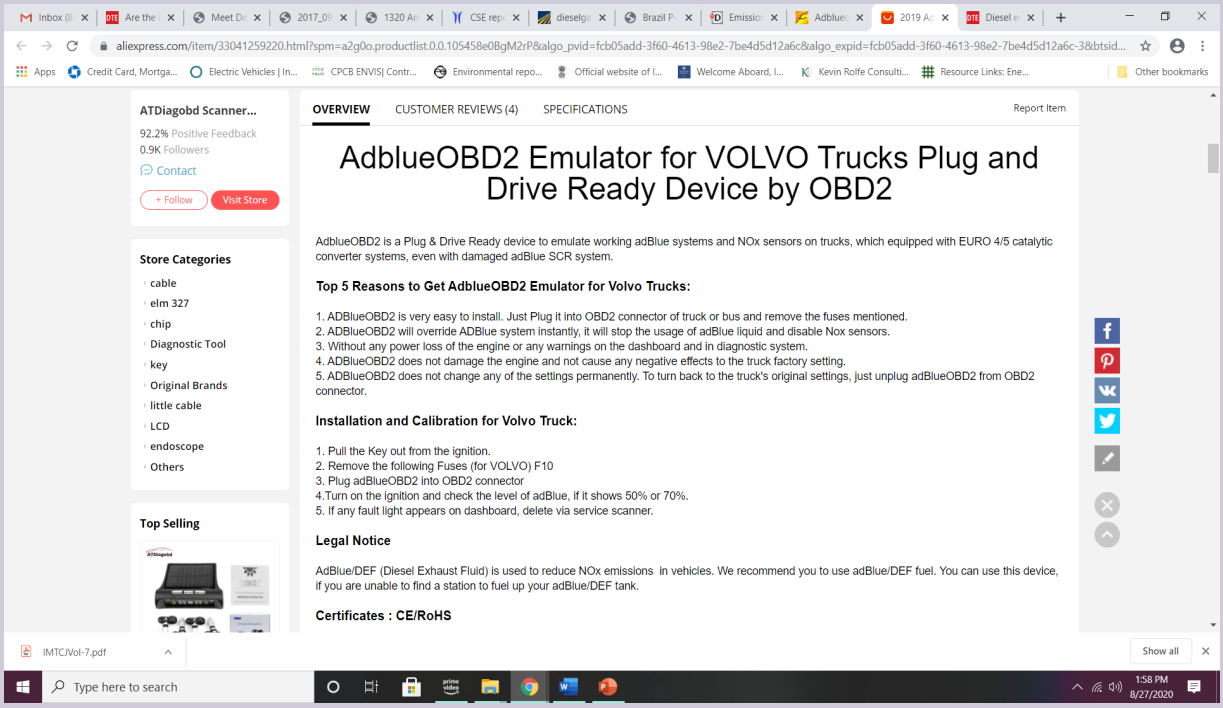
There might also be other genuine problems such as malfunctioning of exhaust sensors and clogging of DPF, all of which will lead to higher and uncontrolled emissions from the vehicles. But this requires detection on time for remedial action. To control this menace, governments around the world have begun to frame a series of visual and qualitative checks during vehicle inspection.

Box: Global evidence on tampering

China: The vehicle market in China has faced its own challenges in manufacturing defeat devices and retailing them through e-commerce websites. The product comes with detailed instructions on installation and usage and with only a legal disclaimer stating 'AdBlue/DEF (Diesel Exhaust Fluid) is used to reduce NOx emissions in vehicles. We recommend you use adBlue/DEF fuel. You can use this device, if you are unable to find a station to fuel up your adBlue/DEF tank'[10] (see *Image 1: Website selling AdBlue emulator*).

Image 1: Website selling AdBlue emulator





Brazil: The Sao Paulo State Environmental Agency has had to create enforcement measures to check for AdBlue adulteration and detection of defeat devices in trucks.[11] For instance, police officers use portable refractometers to check for the quality of urea. A syringe and pipe are used to collect 50 ml of liquid from the tank, which is then subjected to the refractometer. Since the regulatory limits are 31.8–33.2 per cent urea, acceptable values are taken as 30–35 per cent during inspection. Additionally, the quality of deionized water is checked in the spot with a few drops of Eriochrome Black T indicator.[12] A blue colouration is expected, while a red colouration is indicative of ionization due to impurities. Further, all officers are trained by the Brazilian Automotive Engineering Association to detect defeat devices in the vehicles. There are reports of quite extensive disabling of SCR systems in buses.

European Union: In a weeklong study,[13] NOx emissions from 222 trucks on a Czech motorway were measured using a portable FTIR gas analyser. Of these, nearly 66 per cent were Euro VI, 25 per cent were Euro V and the remaining 9 per cent were older-category The study was found that 10–15 per cent of Euro V and 10–25 per cent of Euro VI were excess emitters and there was no SCR functionality in about 10–15 per cent of Euro VI trucks. It must be noted that detection of higher NOx levels in trucks during a measurement in a relatively short time period is evidence of non-compliance and tampering.[14]

United States: The US EPA is said to have resolved more than 30 cases involving more than 10 lakh defeat devices, which also includes criminal charges of tampering by owners of heavy-duty fleets.[15] Corporations such as Abbyland Trucking (Wisconsin) and Freerksen Trucking (Minesotta) were found to be selling and installing tuning products that bypass or render inoperative emission controls, including DPFs, EGRs and SCRs in heavy-duty diesel trucks.[16]

SECTION 3: Global course correction

India needs to wise up to the global learning curve on the use of cheat devices and tampering for necessary action to improve our system of vehicle inspection *by* taking cognizance of global learning and measures by regulatory bodies.

Many countries are reforming their vehicle-inspection programme by taking into consideration the challenges to control emissions during in-use conditions where a vehicle's emission performance depends on the service, maintenance, usage and testing regime. Several governments have designed inspection programmes to counter and prevent tampering and fraud and detect simple technical faults that often go undetected during operation.

In addition, complementary rules are being adopted to identify and eliminate the use of defeat devices and systems. Systems are being put in place to check their usages. Inspection protocols are being adopted for visual inspection of after-treatment systems to identify damage or tampering, check on malfunctioning light, integrate OBD testing etc. An important learning curve is emerging from the global experience.

Action in the US

The US has adopted defeat-device laws. The US regulation (40 CFR §86.1803-01) defines a defeat device as 'an auxiliary emission control device that reduces the effectiveness of the emission control system'. Any element of design that senses temperature, vehicle speed, transmission gear, or any other parameter for the purpose of activating, delaying or deactivating the operation of any part of the emission control system is liable for severe penal action. The law prohibits the use of defeat devices. Defeat devices and such methods were included in the 1975 Clean Air Act in the US.

The US laws are reported to have slapped civil penalties as well. The US Environmental Protection Agency (EPA) can levy civil penalties of up to $37,500 per vehicle and $3,750 per sale of defeat device. Such penalties have been imposed periodically in the US.

Further tampering or removal of emission-control devices is prohibited by the Clean Air Act's civil and criminal provisions. For instance, vehicle on-board diagnostics (OBD) is considered a 'monitoring device or method' required by the CAA and it is a crime to knowingly falsify, tamper with, render it inaccurate, or fail to install it. Post Dieselgate such reforms are being strengthened because availability of defeat devices or tampering is increasing. Specifically, the National Compliance Initiative 2020–2023 is meant to stop the sale and installation of defeat devices.[17]

UK MOT test

In the UK, MOT (Ministry of Transport) testing centres to test annual roadworthiness are now required to issue advisories apart from pass and fail. Additionally, defects in vehicles are categorized as dangerous, major and minor faults, which need to be mentioned as part of the advisory to be given after the MOT test.

As per the test reform implemented in 2018, a vehicle is failed if a MOT tester finds visible smoke of any colour from the exhaust; evidence that the emission control devices such as DPF has been tampered with; or the engine malfunction indicator lamp (MIL) inoperative or indicating malfunction[18] (see *Box: UK MOT test*).

Europe

The European Union (EU) framework regulation empowers the European Commission to adopt 'requirements for the implementation'. It is evident from the review carried out by the International Council on Clean Transportation (ICCT) that the EU Vehicle Emissions Regulation (EC 715/2007, Article 13) directs the Member States to 'lay down the provisions on penalties applicable for infringement by manufacturers of the provisions of this Regulation and [to] take all measures necessary to ensure that they are implemented'. In January 2016, the Commission received reports on penalties from only 18 of the 28 member states. These range from fines to withdrawal of type approval, recall and repair obligations, and prison. However, these rules are more directed at the manufacturer of vehicles.

China

The Beijing Environment Protection Bureau (EPB) has also instituted a requirement that during the initial inspection of new vehicles—that is in-use inspection at zero mileage—a careful check of the key components be carried out to assure that the vehicles include the same equipment as did the vehicle or engine during the type approval. Other environmental protection authorities in the Jing-Jin-Ji region (Beijing, Tianjin and Hebei) are planning to carry out such inspections.

China also faces the problem of 'smart tampering' when devices are used only to pass a scheduled test. To prevent this, China has amended the standards and introduced harsh penalties. The amended air pollution law specifically prohibits vehicle owners and service stations from tampering with emissions-control devices or systems.[19]

Box: UK MOT test

More stringent emissions tests have been introduced in the UK for all diesel cars, resulting in more vehicles failing their MOT test.[20]

As per the norms introduced in 2018, all cars being tested are classified in three categories; Dangerous, Major and Minor. Cars classed as Major or Dangerous automatically fail. Cars that have faults falling into the Minor category will pass, but the faults will be recorded.

Further MOT testing centres are now required to issue an advisory apart from pass and fail. As per the test reform implemented in 2018, a vehicle fails if a MOT tester observes visible smoke of any colour from the exhaust.

All vehicles fitted with a diesel particulate filter (DPF) that appears to have been either removed or tampered with will be an automatic fail unless there is evidence that it was done in the process of cleaning the filters.

If the engine malfunction indicator lamp (MIL) is found to be inoperative or indicating malfunctions, it is considered a major fault.[21]

Thus, globally, governments are waking up to address these concerns. Rules and inspection protocols are being improved to screen compromises and cheating. ICCT has also reviewed some global experiences and a prepared a factsheet on a key test protocol that RTOs in India can follow during vehicle inspection (see *Box: ICCT checklist—Updating inspection procedures for Bharat Stage VI commercial diesel vehicles).* This has detailed specific test requirements for each exhaust emission control system such as devices to control PM and NOx emissions.

Build consumer awareness

A common motivation for tampering is the perceived monetary gain from savings on maintenance and operations of the emissions-control equipment. Owners need to be aware of the dangers of such tampering. Use of contaminated and off-spec urea can lead to deposit formation in urea supply and dosing system, blockage of injector nozzles, catalyst poisoning leading to permanent damage or reduction in efficiency, loss of warranty for the SCR system, fitness approval issue, and serious environmental penalty.

While some operators claim—falsely—that removing the particulate filter can lead to better performance, others claim that removing the filter would lead to greater savings than replacing an older blocked filter with a new one.

It is important to build consumer awareness regarding the importance of good maintenance that can reduce the cost of repair and replacement. If such malpractices are caught with more stringent surveillance, the replacement cost of the advanced emissions control systems can be prohibitive and unaffordable for many. It is important to organize outreach for sensitization of consumers.

In view of the substantial cost of replacing these components, there is need for continuous, appropriate inspection and maintenance systems for vehicle components in BS-VI vehicles.

Box: ICCT checklist—Updating inspection procedures for Bharat Stage VI commercial diesel vehicles

The non-profit agency International Council on Clean Transportation (ICCT) has outlined the key test protocols that Regional Transport Offices (RTOs) in India can follow during vehicle inspection.[22] It has detailed specific test requirements for each exhaust emission control system for PM and NOx emissions. The protocol has been developed for the vehicle fitness test, and changes proposed for the PUC test.

Apart from the existing checklist that RTOs use for conducting an evaluation prior to issuing a fitness certificate, the following can be added to the evaluation procedure.[23]

i. Diesel particulate filters (DPFs)

A visual check of the following should be conducted:

a) DPF housing
b) Sensors: Check the pressure and temperature and see that sensors are still in the appropriate ports and that there is no damage to the wiring harness
c) DPF tampering: Compare the pictures from the schematic of the DPF in the manufacturer's manual with the vehicle itself to confirm that there has been no tampering of devices to modify exhaust flow to or from the DPF. Verify that the DPF part number matches the manufacturer specified part number.

ii. Selective catalytic reduction (SCR)

The following should be checked:

a) SCR housing
b) Sensors
c) Aqueous urea solution (AUS) injector. Using the SCR schematic from the manufacturer's manual, ensure that the AUS injector is in the appropriate port and verify the presence of an injector. Ensure that there is no damage to the wiring harness. Also, check the AUS tank and look for SCR tampering.

iii. Diesel oxidation catalysts (DOCs): Visually check the parameters such as DOC housing, sensors, DOC tampering and HC doser.

iv. Exhaust gas recirculation (EGR): Check the manufacturer's schematic for the presence of EGR and if present inspect to make sure that all connections from the EGR are intact. Additionally, ensure that no tampering devices have been introduced to affect EGR operation.

v. Onboard diagnostic system (OBD): All centres conducting fitness certification should own a diagnostic tool and adapter to connect to the SAE J1939 standard OBD port on BS-VI vehicles for checking of maintenance status of vehicles as well as faults.

a) All centres conducting the PUC test must have a diagnostic tool and adapter capable of connecting to the SAE J1939 standard OBD port on the vehicle and reading controller area network messages.[24] This helps check the monitoring of engine operation, DPF back pressure and EGR performance.

All personnel must be trained to perform a visual inspection and OBD test. Be familiar with schematics of the BS-VI vehicles and exhaust systems. Personnel must be trained with different failed components—e.g. EGR, DPF, SCR and other inspection components—and different types of failures to recognize them visually during inspection. They must know—by using the manufacturer's manual—how to interpret the malfunction indicator light (MIL) and OBD indicators on the dashboard of the vehicle.

SECTION 4: Way forward

After making big investments to improve vehicle technologies to meet tighter emissions standards, India cannot risk emission frauds and cheating and increase its public-health risk. The country has already moved forward to frame and adopt real-world emissions regulations and is taking further steps to adopt in-service compliance requirements. It has to stay on course as planned and must align with the global best practices. This is needed to prevent diesel vehicle manufacturers from cheating emissions regulations.

The next big challenge is to improve and upgrade on-road emissions inspection systems to prevent tampering with emissions-control systems during the operation phase and identify gross polluters on roads. Some of the clean air action plans in cities that have been identified as not meeting the national ambient air quality standards under the National Clean Air Programme (NCAP) have begun to include provisions on advancement in on-road emissions surveillance, including remote sensing measurements among others. These plans have also asked for further upgradation of the PUC centres to be BS-VI ready.

However, the focus on the problem of tampering and cheating devices is still very weak.
It is therefore recommended that the MoRTH immediately initiates the following measures to address the additional concern related to use of defeat device and tampering. State governments also need to chart a roadmap for implementation.

Implement checklist of physical tests to detect tampering and damages to emission control systems: Commercial vehicle inspection centres for annual roadworthiness and fitness tests and PUC centres need to be upgraded to adopt a checklist of physical verification of diesel particulate filters (DPFs), selective catalytic reduction (SCR) and other emission-control devices such as DOCs and EGR fitted in BS-VI vehicles. This can be introduced quickly nationwide while more advanced systems including remote sensing for on-road fleet screening and real-world testing as part of in-service conformity can follow. There is a need for a strong inspection regime to prevent the use of defeat devices by vehicle users. India needs to align with this emerging global trend.

Adopt cheat-device regulations: There is still a critical gap that needs to be addressed to prevent the use of cheat or defeat devices. India needs cheat-device regulations to enable surveillance systems and penal action and monitoring. This is needed to prevent promotion of any product that unethically claims to disable emission-control systems. Giving such devices in the hands of the people for en masse disabling of emissions control systems will lead to serious consequences.

Link OBD with emissions inspection: MoRTH has already issued a notification for checking of malfunctioning light on the vehicle dashboard linked with the OBD alerting anomalies, including emissions anomalies in vehicles. If a malfunctioning light is detected during a PUC test, the vehicle is asked to go back to the workshop for a more thorough check-up.

But to align with global good practice it is also necessary to have a simple testing system in the PUC centres that can detect if the OBD itself is functioning or if it has been disabled. This additional reform is necessary. All PUC centres and commercial vehicle inspection centres conducting fitness tests should be equipped with a diagnostic tool and adapter to connect to the SAE J1939 standard OBD port on BS-VI vehicles for checking of maintenance status of vehicles as well as other faults.

It is in fact encouraging to see that already the centralized vehicle inspection centres for commercial vehicles in different parts of the country are required to procure a scanning tool for OBD and record fault codes for vehicles.[23] In fact, available evidence shows that the tendering process for procurement has started. This may be scaled up for selected workshops and PUC centres in cities.

Need consumer outreach programme: A strong consumer outreach programme is needed to sensitize consumers about the dangers of tampering and how the cost of compliance is more affordable than of non-compliance. If these advanced after-treatment systems get damaged, the cost of replacing them can be prohibitive.

The post 2023 BS-VI reform agenda needs to stay on course. MoRTH is already revising the AIS parameters for further strengthening of real-world emissions testing and for introducing in-service compliance strategy. These reforms along with the adoption of improved WLTC (worldwide harmonized light-duty vehicles test cycles) for vehicle testing etc. need to be kept on course. Similarly, the AIS reform for introduction of remote sensing measurements for on-road fleet screening should be expedited. It must not slow down the face of the pandemic crisis.

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Centre for Science and Environment
41, Tughlakabad Institutional Area,
New Delhi 110 062 Phones: 91-11-40616000
Fax: 91-11-29955879 E-mail: cse@cseindia.org
Website: www.cseindia.org