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FLEET AND MAINTENANCE MANAGERS WHAT TO EXPECT FROM BHARAT STAGE VI DIESEL VEHICLES?

India will transition to Bharat Stage (BS) VI emissions standards across all on-road vehicle platforms starting on April 1, 2020. BS VI is comparable with the Euro 6/VI emission standards that went into effect in the European Union in 2014. Most significantly, the BS VI standards require reductions in tailpipe emissions of nitrogen oxides (NO_x) and particulate matter (PM), which will require nearly all diesel engine manufacturers to use both a diesel particulate filter (DPF) and a selective catalytic reduction (SCR) system. These are integrated with the rest of the exhaust assembly into what is commonly referred to as the ‘aftertreatment system.’ In some

cases, a third component, an ammonia slip catalyst (ASC), may also be added, depending on the manufacturer. These components are added to the aftertreatment system so that it can operate efficiently, and they add complexity to the overall exhaust system. Such technologies are carefully calibrated by manufacturers for optimized emissions reduction without affecting performance. Owing to the substantial cost of replacing failed parts, the continuous, appropriate inspection and maintenance of vehicle components has become more critical than ever with the introduction of BS VI standards.

Component addition for BS VI compliance	Associated critical components
diesel particulate filter (DPF)	differential pressure sensor (inlet)
	exhaust temperature sensor (inlet)
	exhaust temperature sensor (outlet)
	fuel injector (inlet)/hydrocarbon doser (usually placed at the pre-diesel oxidation catalyst [DOC] to aid soot oxidation through active regeneration)
	on-board diagnostics (OBD) indicators and warning lights
selective catalytic reduction (SCR)	urea storage tank or aqueous urea solution (AUS) storage tank
	urea injector
	NO _x sensor
	exhaust temperature sensor (inlet)
	on-board diagnostic indicators and warning lights
ammonia slip catalyst (ASC)	—

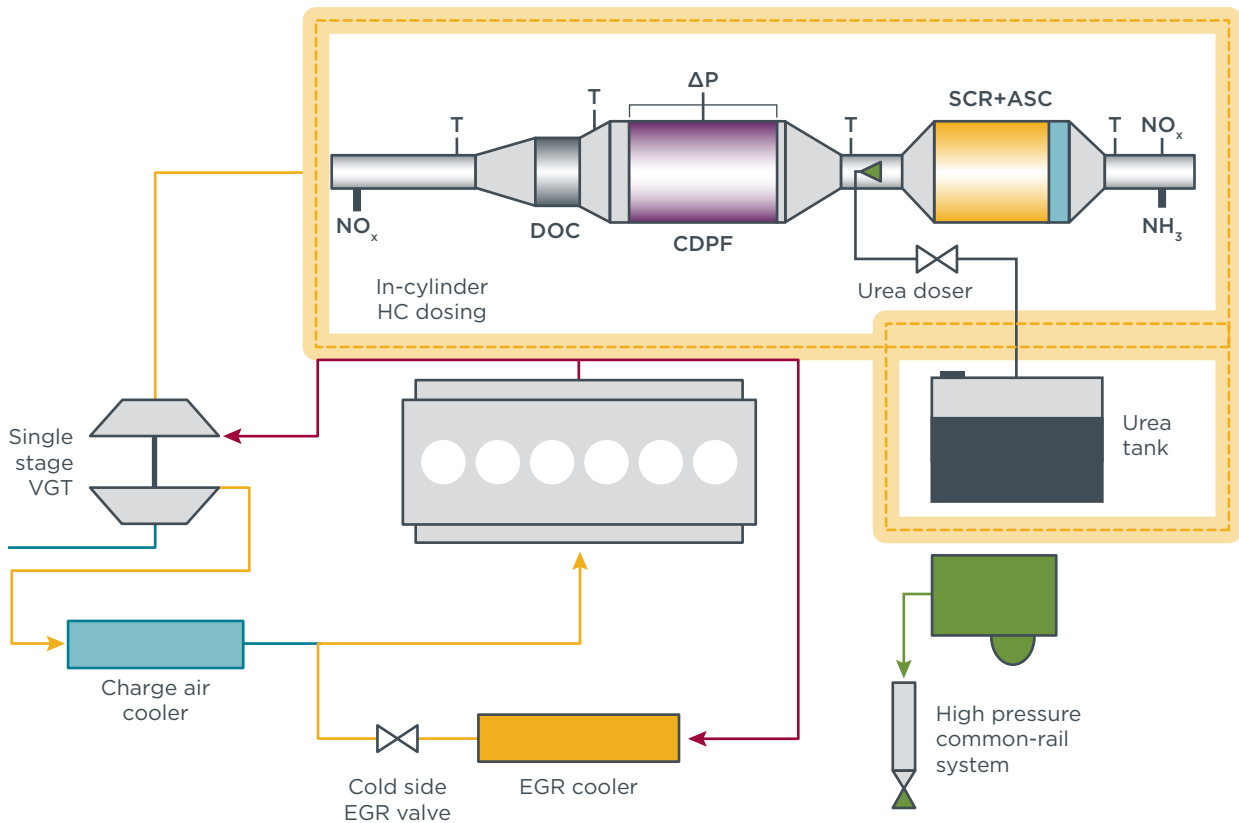

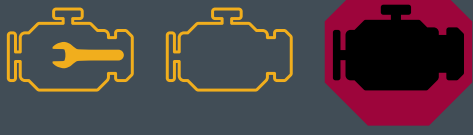




Figure 1. Schematic (not to scale) of Euro VI and expected BS VI aftertreatment systems. In the above figure T, NH₃, NO_x and ΔP refer to temperature, ammonia, nitrogen oxide and differential pressure sensors, respectively. Picture Courtesy: Dieselnets

CHANGES AND THINGS TO KEEP IN MIND FROM A VEHICLE STANDPOINT:

1. BS VI buses and trucks will be equipped with DPFs, which trap soot in the exhaust. DPFs perform soot oxidation through passive regeneration without any operator input. However, active regeneration (thermally), which requires operator input, is periodically required to oxidize the soot and prevent excessive engine backpressure from the DPF. Significantly elevated tailpipe temperatures (>600°C) should be expected during active DPF regeneration events. The regeneration frequency can range between zero and three times per day, depending on the DPF and the operating conditions.
2. The fuel economy of BS VI vehicles is sensitive and dependent on proper operation of the SCR and DPF. This makes regular and proper maintenance of these systems critical. Increased frequency of DPF regeneration
3. The fuel at pumps should be only BS VI fuel (10 parts per million sulfur diesel) starting on April 1, 2020. Still, drivers and operators should make a conscious effort to verify that it is BS VI fuel before filling up tanks. It is illegal to adulterate fuel. Doing so is detrimental to the vehicle and will increase maintenance costs.
4. Expect changes in the driver display console with additional LEDs/incandescent bulbs and buttons and switches:

Possible OBD dashboard indicators	Possible description
	<ul style="list-style-type: none"> Warning light for EGR malfunction Warning light for EGT sensor (exhaust gas temperature)-relevant malfunctions. Warning light for high EGT due to active DPF regeneration without enough air flow.
	<ul style="list-style-type: none"> Warning light for tampering-relevant activity like DPF removal, operator negligence in response to malfunctions and OBD requests (e.g., DPF regeneration or AUS refill).
	<ul style="list-style-type: none"> Warning light for DPF half full status. Warning light for DPF full and ready for regeneration. This prompts the driver to complete regeneration prerequisites.
	<ul style="list-style-type: none"> AUS level low or critically low and requires refill, or incorrect AUS refilled.

A DPF regeneration-inhibit switch or button will be available to drivers. Note that the malfunction indicator lights, OBD indicators, and other warning lamps can trigger individually or in combination, and they can produce either a constant light or a flashing light. Each indicates a specific condition, status, or malfunction, and it is critical that all drivers and operators are fully familiar with the **manufacturer manual and guidance brochures**.

- Drivers may experience loss of power, loss of torque, and even vehicle shutdown while driving if maintenance requests are not completed on time and/or they are not appropriately fulfilled. Inducement strategies are included by the engine manufacturer to protect the engine and aftertreatment system from irrecoverable failures.

CHANGES IN VEHICLE MAINTENANCE PRACTICES AND OBD TESTS:

- Only **oil meeting IS 13656 : 2014** specifications or better should be used. The use of high sulphated ash phosphorous and sulfur oil will be detrimental to the vehicle and will increase maintenance costs.
- Fleet managers should prepare cheat sheets using manufacturer guidance documents and manuals and provide easy, simplified action tables for drivers regarding how to read and
- react to OBD requests, including warning lights.
- Fleet managers should maintain records of all **parked regeneration** events for all the vehicles in the fleet. This will help identify if there is an increase in frequency, which indicates poor in-use maintenance or, potentially, DPF failure.
- Fleet managers should maintain logs of AUS refills.
- Fleet owners could consider taking additional security measures because aftertreatment system components are expensive and easy to remove. Such measures could include:
 - Installing surveillance cameras in fleet parking lots and employing security guards during non-shift hours.
 - Creating a critical-components checklist and conducting periodic (weekly or monthly) fleet-wide inspections.
- In cases of component failure, fleet managers should directly contact the manufacturer and/or authorized dealers for guidance and should not resort to alternative solutions that are not certified. Doing the latter will not only void the warranty on the failed component, but may also void the warranty on other, associated powertrain components.
- The OBD systems in BS VI vehicles monitor several operating parameters and store values in memory for various reasons.

Fleet owners and maintenance managers should familiarize themselves with critical component parameters, as these will help them with a variety of things including filing warranty claims, monitoring tampering activity, diagnosing potential failures, and even addressing driver negligence. The manufacturer's user manuals and training materials should detail these items.

- a. Depending on the manufacturer, the distance between DPF-regeneration events and inhibit-regeneration events may be stored. This helps track DPF performance and driver negligence.
- b. Depending on the vehicle manufacturer and the driver, the distance between SCR refills may be stored and retrieved. This will help in evaluating expenses and forecasting maintenance costs over time.
- c. Fleet managers should make topping off AUS tanks on a weekly or bi-weekly basis a part of the periodic maintenance routine. The frequency can depend on the distance traveled between AUS refills.
- d. Depending on the manufacturer, tampering activities like removing a DPF, SCR, or associated components will be detected and stored.
- e. Depending on the manufacturer, the vehicle's OBD may recommend and allow

diagnostic tests to be performed for troubleshooting diagnostic trouble codes or fault codes on the vehicle.

8. If any engine or aftertreatment-associated critical component is replaced, maintenance managers should follow the manufacturer-recommended post-replacement steps for the component exactly. This will help the component to efficiently integrate in the system and perform well.
 - a. These post-replacement steps include an on-board test to validate the replaced component and update the engine control unit (ECU) and associated controllers of the new component.
 - b. Some components may have a learning or break-in period and may need to be recognized as a new component by the system (ECU, vehicle control unit, etc.) to allow appropriate calibrations and avoid triggering premature fault codes.
9. Fleet managers should ensure that all drivers and operators have received the complete training required to operate the vehicle and BS VI aftertreatment system. Managers could also engage drivers/operators in training workshops that detail manufacturer-recommended maintenance activities and provide a list of dos and don'ts.