

UPDATING INSPECTION PROCEDURES FOR BHARAT STAGE VI COMMERCIAL DIESEL VEHICLES

A GUIDE FOR RTOS AND TESTING CENTERS

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)	—

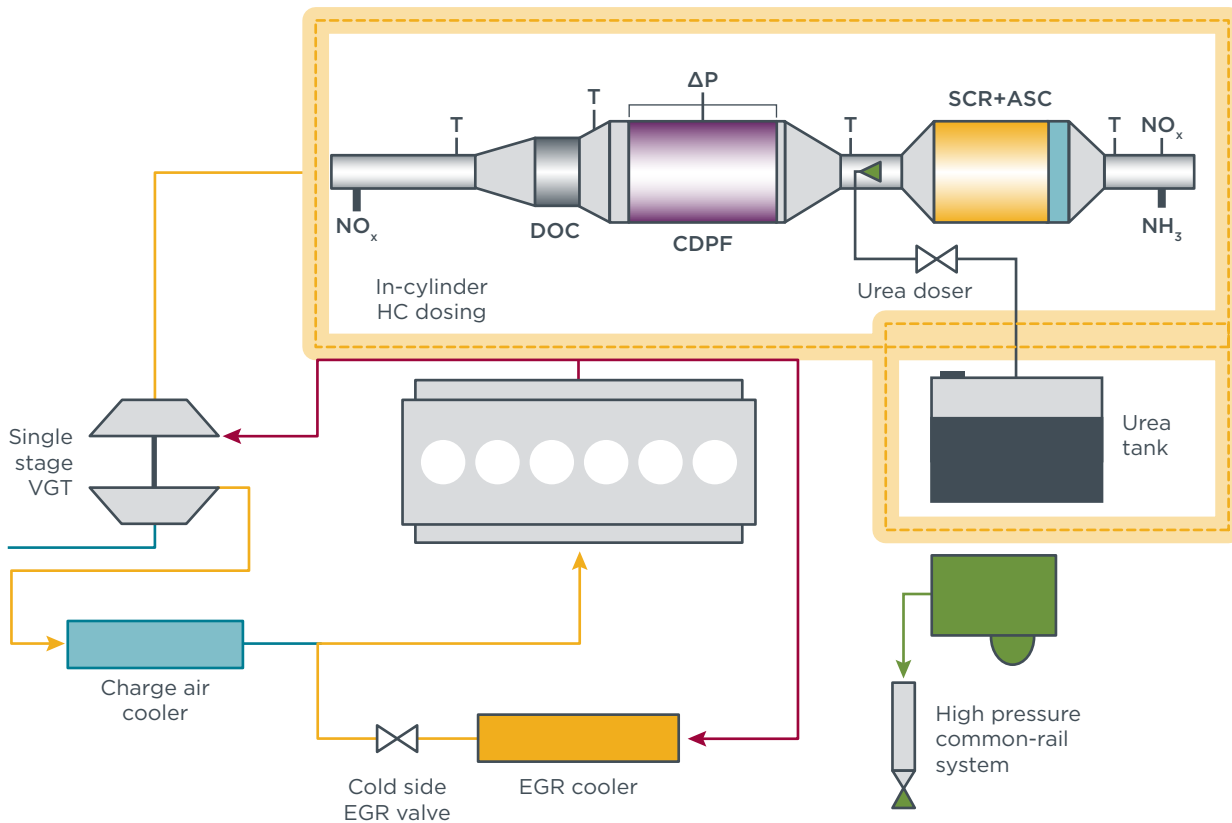


Figure 1. Schematic (not to scale) of Euro VI and expected BS VI aftertreatment systems. In the above figure T, NH₃, NO_x and ΔP refer to temperature, ammonia, nitrogen oxide and differential pressure sensors, respectively.









Picture Courtesy: Dieselnets

PROPOSED CHANGES TO VEHICLE FITNESS TEST:

Apart from the existing checklist used by the Regional Transport Offices (RTOs) for conducting an evaluation prior to issuing a fitness certificate, the following items should be added to the evaluation procedure.

1. All BS VI diesel vehicles will be equipped with *DPFs*, which trap soot in the exhaust and reduce harmful, regulated pollutants such as PM and hydrocarbons (HC). A visual check of the following should be conducted:
 - a. The DPF housing: Check if there is any damage—e.g., holes or cracks—or indication of structural compromise to the housing.
 - b. Sensors: Using the DPF schematic from the manufacturer's manual, ensure that the pressure and temperature sensors are still in the appropriate ports and that there has been 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 no tampering devices have been introduced to modify exhaust
2. All BS VI diesel vehicles will be equipped with *DOCs*, which reduce harmful, regulated pollutants such as HC and carbon monoxide (CO), and aid in the process of reducing PM. A visual check of the following should be conducted:
 - a. The DOC housing: Check if there is any damage—e.g., holes or cracks—or indication of structural compromise to the housing.
 - b. Sensors: Using the DOC schematic from the manufacturer's manual, ensure that the pressure and temperature sensors are still in the appropriate ports and that there has been no damage to the wiring harness.
 - c. DOC tampering: Compare the pictures from the schematic of the DOC in the manufacturer's manual with the vehicle itself to confirm that no tampering devices have been introduced to modify exhaust flow to or from the DPF. Verify that the DPF part number matches the manufacturer-specified part number.

- d. HC doser: If the DPF regeneration strategy is based on post-injection (check the manufacturer’s manual), verify the presence of a HC doser and that there has been no damage to the wiring harness.
3. Some BS VI diesel vehicles will be equipped with *exhaust gas recirculation (EGR)* for reducing harmful NO_x emissions from the engine. 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.
 4. All BS VI diesel vehicles will be equipped with SCR systems. This reduces harmful, regulated NO_x emissions. A visual check of the following should be conducted:
 - a. SCR housing: Check if there is any damage—e.g., holes or cracks—or indication of structural compromise to the housing.
 - b. Sensors: Using the SCR schematic from the manufacturer’s manual, ensure that the temperature sensors and the NO_x sensors are still in the appropriate ports and that there has been no damage to the wiring harness.
 - c. 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. Additionally, make sure that there has been no damage to the wiring harness.
- d. AUS tank: Verify the presence of an AUS tank and confirm that there has been no damage to it.
 - e. SCR tampering: Compare the pictures from the schematic of the SCR in the manufacturer’s manual with the vehicle itself to confirm that no tampering devices have been introduced to modify exhaust flow to or from the SCR. Verify that the SCR part number matches the manufacturer-specified part number.
5. Driver display and OBD: All centers conducting fitness certification should own a diagnostic tool and adapter to connect to the SAE J1939 standard OBD port on BS VI vehicles.
 - a. BS VI vehicles are OBD enabled and have been programmed with sophisticated diagnostics to detect critical anomalies. This is to prevent tampering with the engine and aftertreatment system and any component failure.
 - b. The inspector should turn the ignition key to the ON position and ensure that the driver display is operating per manufacturer specification, that all of the LEDs are functioning, and that there are no broken indicators.
 - c. The engine should then be cranked and left in the RUN position for a minimum of 5 minutes, or for the manufacturer-recommended minimum time for the OBD to start monitoring. The inspector should ensure that no pending maintenance requests are coming from the OBD system.

Possible OBD dashboard indicators	Standard SAE/ISO description
	<ul style="list-style-type: none"> • Warning light for <i>exhaust gas temperature (EGT) sensor</i>-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 <i>tampering</i>-relevant activity like DPF removal, and for <i>operator negligence</i> in response to malfunctions and OBD requests (e.g., DPF regeneration and AUS refill).
  	<ul style="list-style-type: none"> • Warning light for DPF half-full status. • Warning light for <i>DPF full and ready for regeneration</i>, which requires the driver to complete regeneration pre-requisites.
	<ul style="list-style-type: none"> • Indicates <i>AUS level low</i> or critically low and refill required, or <i>incorrect AUS refill</i>.

CHANGES PROPOSED TO THE POLLUTION UNDER CONTROL (PUC) TEST:

All centers 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.

1. Once the tool is connected, with the ignition key in the ON position, the inspector should verify that no pending maintenance requests or active fault codes are present.
2. Turn the ignition key to the RUN position and crank the engine. Then take the engine to high idle revolutions per minute (RPM), or to recommended idle RPM for 5 minutes; this is to allow readings to stabilize and the OBD to start monitoring engine operation.
 - a. Check DPF backpressure values and confirm that the recorded value is greater than the nominal value at set RPM, per manufacturer specification. This confirms the existence of a filter inside the DPF housing.
 - b. Check the EGR throttle position and the EGR rate. Confirm that the recorded value is the same as the nominal value at set RPM, per manufacturer specification. This confirms the existence of EGR and that there has been no tampering with EGR valves.
 - c. The Hartridge Smoke Unit reading from the opacity meter should be lower than the nominal value at set RPM. This confirms an intact filter inside the DPF housing and that it has not cracked or failed.

REQUIRED UPGRADES TO INSTRUMENTATION AND SKILL AT TESTING CENTERS:

All test equipment used at testing centers must be standardized to avoid any significant variations in results from center to center.

1. Existing smoke meters and opacity meters should be standardized and calibrated.
2. All testing centers must possess a standardized OBD reader or diagnostic tool and software capable of reading SAE J1939 or ISO 15765 standard messages.
 - a. The diagnostic tool must include a standard display which shows the values of requested channels like EGR throttle position, DPF backpressure, and other measurements required for the inspection.
 - b. The center should also possess connectors or adapters for the tool to connect to the OBD ports of different vehicles. All SAE J1939 and ISO 15765 connectors are standardized.
3. All personnel must be trained to perform a visual inspection and OBD test:
 - a. They should be familiar with the schematics of the BS VI vehicle and exhaust system.
 - b. Personnel must train with different failed components—e.g., EGR, DPF, SCR, and other inspection components—and different types of failures to recognize them visually during inspection.
 - c. They must know to use the appropriate OBD connector, depending on the port on the vehicle.
 - d. Personnel must use the software to retrieve all measurement values from a vehicle's OBD.
 - e. They must know how to interpret the malfunction indicator light and OBD indicators on the dashboard of the vehicle using the manufacturer's manual.