

An assessment of the real-world emissions performance of a Bharat Stage VI truck and bus in India

Washington, DC, 20 December 2021 — A new study carried out by researchers from the International Council on Clean Transportation (ICCT) with testing partner HORIBA India is among the first to quantify the real-world emissions from Bharat Stage (BS) VI diesel vehicles. One truck and one bus were evaluated via in-use portable emissions measurement system (PEMS) testing and the study is released as standards and provisions for India's in-service conformity (ISC) tests for heavy-duty vehicles are being introduced for the first time with the BS VI regulation.

In addition to evaluating emissions based on Part IV of India's AIS 137 and the Euro VI-D and E provisions, researchers conducted a comprehensive, no-exclusions-based assessment at different engine loads and speeds. Both the truck and the bus were well under the limits for nitrogen oxide (NO_x) emissions using the AIS provisions. When the Euro provisions were applied, however, the NO_x emissions increased for both vehicles and more so for the bus, which showed emissions 1.75 to 2.2 times higher than the WHTC limit, depending on the test parameters.

"These results illustrate how the current AIS provisions could be improved, and it's important because a significant chunk of the NO_x emissions are being generated under conditions that are not currently included when evaluating for compliance," said Bharadwaj Sathiamoorthy, an ICCT consultant researcher and the lead author of the study. "The more effective the testing is at capturing these, the better."

While the NO_x emissions from the truck were consistently lower than from the bus, the opposite was found for particle number (PN) emissions, and this is reflective of manufacturer calibration strategy. India's AIS requirements, which are not being phased in until April 2023, do not currently include a conformity factor for PN. "These results reinforce the importance of carefully monitoring and regulating both NO_x and PN emissions in order to fully capitalize on the newly introduced emission control systems for BS VI vehicles," said Tim Dallmann, compliance and enforcement program lead at the ICCT.

Additionally, while the latest Euro provisions are found to be better overall than the AIS provisions in terms of real-world emissions accountability, the Euro provisions still do not effectively capture performance during cold start and urban operations. "For India's ISC testing to capture all emissions from real-world driving, they could be amended by lowering the power

threshold to 5%, including all cold-start emissions, and increasing the percentile for data evaluations to 100%,” said Sathiamoorthy.

A window-based analysis based on raw data without any weighting factors and where each window was equal to 1xWHTC work also showed substantial differences in performance between the truck and bus. The cold NO_x from the bus was, on average, twice as much as the cold NO_x from the truck. However, average cold NO_x emissions from the truck were nearly five times higher than average NO_x from the rest of the cycle. Average cold PN emissions from the bus were roughly three to ten times higher than average PN compared to the rest of the cycle. Another important factor that influenced NO_x and PN emissions was engine load. Elevated PN emissions were observed as engine load on the truck remained low, below 20%, and elevated NO_x emissions were observed from the bus when engine load was below 10%.

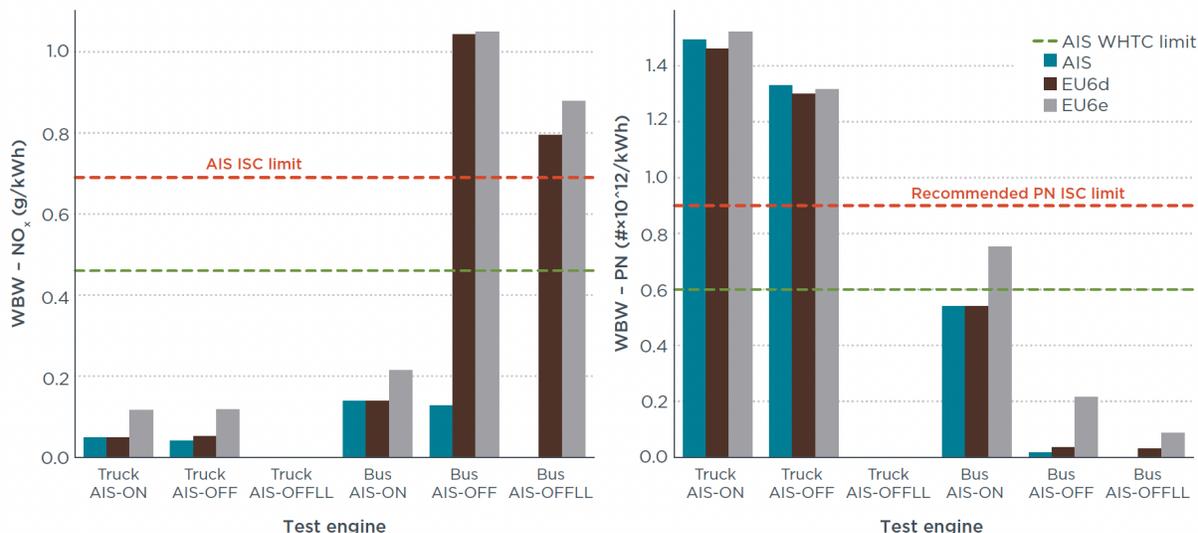


Figure. NO_x (left) and PN (right) emissions of the selected BS VI truck and bus using AIS and Euro provisions.

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Publication details

“Real-world emissions performance of a Bharat Stage VI truck and bus”

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Download: <https://theicct.org/publications/india-hdv-pems-testing-dec21>

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