Measuring Heavy-Duty Vehicle Emissions at the Caldecott Tunnel

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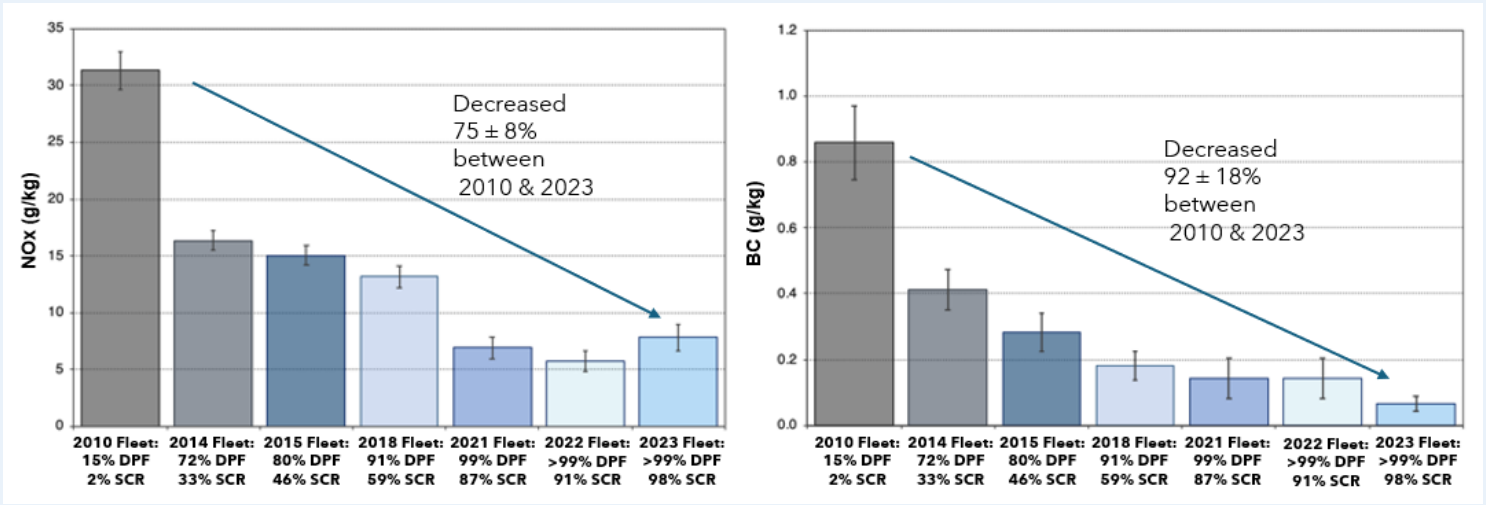
THE ISSUE

Heavy-duty (HD) diesel vehicles emit pollutants like oxides of nitrogen (NO_X) and black carbon (BC), which degrade air quality and pose health risks. Starting January 2023, California's Truck and Bus Rule mandates that most trucks and buses must be equipped with engines from the year 2010 or newer that comply with more stringent emission standards. To meet these requirements, most HD trucks in California are outfitted with emission control technologies like Diesel Particulate Filters (DPF) and Selective Catalytic Reduction (SCR) systems. Monitoring truck emissions helps examine the emission reductions achieved by having more stringent standards. Monitoring at the same site every year can show how emission control systems deteriorate over time, meaning that as a truck ages, it tends to emit more.

THE METHOD

Researchers at the University of California, Berkeley (UCB) measured emissions from HD trucks using a plume capture system at the Caldecott Tunnel in Oakland, California (Figure 1). This system collects part of the

Figure 1. A van using monitoring equipment on an overpass at the Caldecott Tunnel Caltrans facility. Exhaust from a heavy-duty truck is sampled as it travels eastbound on Highway 24 and enters the tunnel. (a) The Van; (b) the roadside camera placed at the entrance to the tunnel.



exhaust gas as trucks pass by and analyzes the emissions for pollutants such as NO_X, BC, nitrous oxides (N_2O), and ammonia (NH_3). It also reads trucks' license plates to identify their engine model year and emissions control technologies. The research team collected samples from 1,000 trucks every year over three months between 2021 to 2023.

KEY FINDINGS

- By 2023, 98-99% of HD trucks were using emission control systems to reduce emissions (Figure 2). These systems have successfully reduced average NO_X by 75% and BC emissions by 92% since 2010.
- Increased NO_X was observed in 2023, possibly due to deteriorating and aging systems. Although these emissions still meet the 2010 standards, they need to be carefully monitored.

Figure 2. The near-universal adoption of DPFs & SCR between 2010-2022 reduced fleet-average NO_X and BC by ~75% and ~92 %, respectively.

THE CONCLUSIONS

Results showed that a small group of trucks were responsible for the most emissions. Specifically, 75% of the NO_X emissions and 85% of BC emissions were associated with just 10% of trucks that were studied. Additionally, elevated NH_3 emission rates were observed in a small number of trucks when NO_X emissions were low, due to NH_3 slip or overdosing by SCR systems. This project stresses the importance of policy requiring onboard diagnostics and the HD Inspection Program. Proper operation and maintenance of HD control technology will ensure further emissions reductions and the proper functioning of HD emissions control systems.

MORE INFORMATION

Summary of contract 20RD004. This project was conducted independently and not in connection with any regulatory proposal or other action considered by CARB. For more information, visit CARB Research or contact the Research Division.