



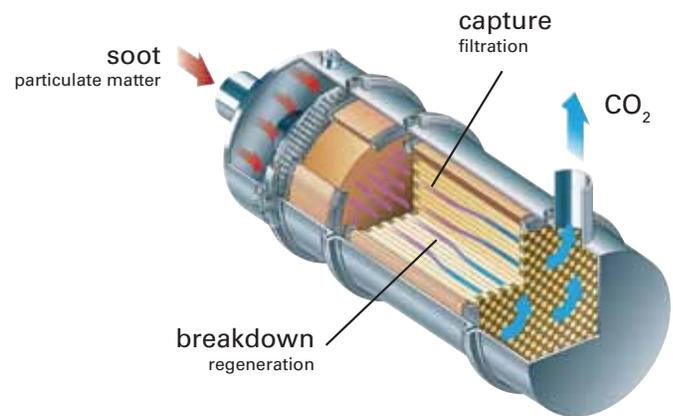
## Advanced Technologies Reduce Diesel Pollution

### The Issue

Diesel trucks are essential to our modern economy and form the backbone of our goods transportation system. However, the exhaust from the diesel engines in these trucks has serious health effects. Particulate matter (PM) emitted from diesel engines is a known carcinogen and emitted gases such as oxides of nitrogen ( $\text{NO}_x$ ) form health-damaging ozone and  $\text{PM}_{2.5}$ . In 2000, the Air Resources Board (ARB) adopted the Diesel Risk Reduction Plan, intended to result in an 85 percent reduction in particle emissions from diesel equipment by 2020 (compared to 2000 levels). Diesel engines are very durable and without additional actions, turnover of the current fleet could take 20 years or longer. Therefore, the Plan calls for the use of cleaner-burning diesel fuel, retrofits of existing engines with particle-trapping filters, and transition to “new technology” diesel engines or alternative fuel technologies that produce 90 percent fewer emissions of diesel PM and  $\text{NO}_x$ .

### Research Goals

The initial research evaluated technological options for reducing diesel emissions such as diesel particulate filters (DPFs shown in Figure 1), and selective catalytic reduction and lean  $\text{NO}_x$  catalysts for  $\text{NO}_x$  control. Additional research examined the emission rates from various low-emitting diesel trucks while operating on California roadways in order to understand reductions achieved in real-world operations, and to evaluate whether these reductions met expectations. Further research is examining the emissions from very large samples of the on-road fleet in order to assess the rate of fleet turnover and the long-term effectiveness of the new technologies.



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Figure 1. Diagram of a diesel particulate filter (DPF).

### Results

Research conducted and funded by ARB has played a major role in guiding the regulatory efforts that have led to the introduction of the emission control technologies now installed on new and retrofitted diesel engines. ARB research is also playing a major role in understanding how the reduction in emissions from trucks has lowered human exposure to harmful air contaminants.

Thus far, ARB researchers have:

- Identified the best technologies to reduce emissions.
- Identified and enabled limiting of certain undesirable and previously unknown side effects from some of the new technologies.
- Demonstrated a 70 percent reduction in diesel black carbon emissions (and 40 percent for  $\text{NO}_x$ ) on diesel-dominated freeways in Southern California between 2009 and 2011 (see Figure 2), with similar reductions in West Oakland.
- Identified areas needing improvement in the implementation of some of the emissions control technologies.

## Conclusions and Impact

ARB's research program to understand the emissions from diesel trucks has addressed several critical knowledge gaps and provided a clearer foundation for adoption of significant regulatory actions to reduce the harmful effect of diesel exhaust. The control technologies now found on every new and retrofitted diesel engine are working to provide significant reductions in diesel particle and smog-forming emissions, especially those operating near major ports. The research program also has identified several areas needing new research, such as the emissions of very small particles from newer trucks, and how well the emission control technologies operate during certain duty cycles.

## Related Research

Advanced technologies and aftermarket treatments are still relatively new technologies and research is continuing to:

- Understand in-use diesel emissions and evaluate the current engine certification protocol.
- Characterize the durability of emissions reductions from new technology diesel vehicles as they age.
- Identify technologies that may allow for even further reductions of diesel emissions.
- Understand the emissions of very small particles, called ultrafines, especially their chemical composition and potential toxicity.

Various institutions and organizations in addition to ARB, including the U.S. Environmental Protection Agency, the Manufacturers of Emissions Controls Association, and the U.S. Department of Energy, have conducted studies on the use of such technologies to evaluate the processes and the effectiveness, as well as the costs and benefits, of the various devices and control programs.

## More Information

For more information on ARB's Vehicle Emissions Research, visit [www.arb.ca.gov/research/veh-emissions/veh-emissions.htm](http://www.arb.ca.gov/research/veh-emissions/veh-emissions.htm).

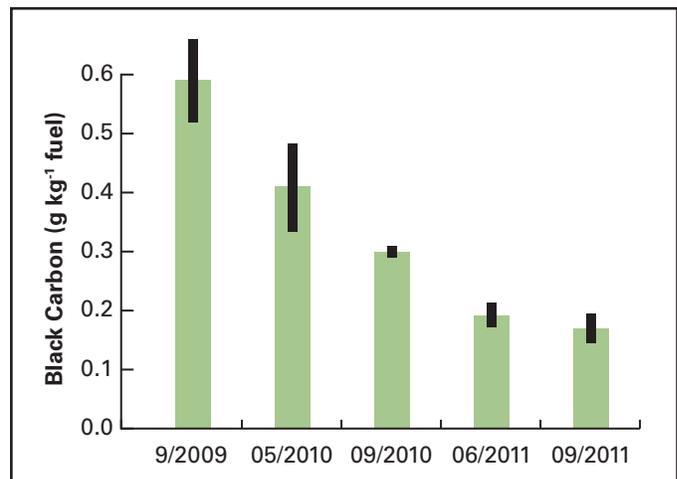


Figure 2. Reductions in black carbon (soot) emission rates in heavy-duty diesel trucks operating on Southern California freeways (Kozawa et al., 2014, *Environmental Science & Technology*, Volume 4, pages 1475–1483)

## About the Air Resources Board's Research Program

California's progress on addressing environmental problems is guided by a strong scientific knowledge base. The Air Resources Board sponsors a comprehensive program of research into the causes, effects, and solutions of the air pollution problem, supporting its regulations on cars, trucks, fuels, power plants, and other sources. The research is done under the guidance of ARB's Research Screening Committee and in partnership with the University of California system and other research institutions.

Learn more about these projects including their final reports, public seminars, articles in scientific journals, and other products by visiting [www.arb.ca.gov/research](http://www.arb.ca.gov/research).