A Study of the Impact of Diesel Buses on Downtown Boulder

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Executive Summary

- Diesel exhaust is a known carcinogen. It is comprised of gases and particulate matter. Two very toxic compounds in diesel exhaust are particulate black carbon and oxides of nitrogen (NOx). Black carbon is a possible carcinogen and NOx is a respiratory irritant associated with cardio-pulmonary disease.
- RTD conducts more than 1,000 diesel bus trips per day in Boulder, CO (counting trips to and from both bus stations in Boulder, the total is approximately 1400).
- Boulder residents commissioned this study of the air quality impact of these bus trips.
- Stationary tests of air quality on downtown Boulder condominium balconies showed elevated levels of NOx that correlate with bus traffic, but did not reveal a serious current threat to health.
- Air quality tests on a bicycle following buses (replicating bicycle commuters and pedestrians, including children) varied widely among buses. Older *Jump* buses created extremely high, bursts of black carbon (possible carcinogen, component of diesel exhaust) and ultrafine particles when traveling directly behind the bus.
- The introduction of electric buses in Boulder would substantially improve air quality and enhance the health and well-being of Boulder residents.

A measurement campaign was conducted during the summer in downtown Boulder, from July 25th to July 31st, 2016. A suitable location next to the Boulder Downtown Bus Station was selected to take measurements, which would capture fresh emissions from transiting buses. Two condo units were employed during the measurements and the bus count was taken to correlate the measured data and bus density. The objective of the study was to characterize the level of emissions from RTD diesel buses and determine the possible risk for the well-being and health of the population.

Several instruments were employed to measure particulate matter, including instruments that measured ultrafine, fine and coarse size particles. Ultrafine and especially fine particulate matter have been connected with respiratory diseases, and they affect lungs, blood vessels, and heart when penetrate deep into the respiratory system. Diesel engines emit particulate matter primarily in the range of ultrafine and fine.

Black carbon measurements were also part of the study and it is a major component of diesel exhaust. Diesel exhaust is a group 1 carcinogen (carcinogenic to humans), from the International Agency for Research on Cancer (IARC). Nitrogen oxides (NOx) were another pollutant measured

during the study, since the emissions of NOx are considerably higher from diesel engines compared to gasoline. NOx increases respiratory diseases, hospital admissions and the risk of suffering asthma.

Traffic-related air pollutant concentrations typically vary between weekends and weekdays, primarily because of the traffic density and vehicle type. This study showed a lower number of buses traveling through downtown Boulder on the weekend (exactly as expected from the RTD schedule); the number of heavy duty trucks was also lower during the weekend. Some differences were found for the car traffic. The early afternoon on Saturday has a higher number of cars compared to weekdays and the density decreases through the afternoon; however, on weekdays the car density is low in the early afternoon and it increases in the late afternoon.

The results from the stationary measurements of particulate matter did not present a direct connection with vehicle density. Atmospheric particulate matter measured during the campaign was a result of regional urban pollution and not local traffic sources. Black carbon and ozone was highly constant and did not vary with vehicle density. Nitrogen oxides were correlated with the bus count, in the morning they went up and in the late afternoon they were even higher. Nitrogen oxides were the only pollutant that had a direct link with diesel bus density.

An additional bicycle ride was carried out on August 4th, 2016. The aim of this test was to chase cars and buses for the purpose of capturing direct emissions behind vehicles. The pollutants measured were particulate matter (ultrafine and fine), black carbon, and ozone. The route was designed to collect measurements in areas without any vehicles, and also in areas with cars and buses. The bicycle ride measurements were highly correlated to the emissions of vehicles, since the bicycle rider was right behind cars and buses. The results showed low concentrations in places without vehicles; elevated concentrations were shown immediately after riding behind buses. When following some buses, the measurements were only slightly elevated. However, certain RTD routes showed an exorbitant rise when riding behind them. This behavior demonstrates that specific buses of the RTD fleet emit different concentration of pollutants depending on their exhaust control system and age of the bus (measurements exhibited higher readings when following the older buses). The average highest concentration of pollutants was found in all the zones surrounding the bus station. Black carbon, which is a main constituent of diesel particulate matter, was highly linked with the concentration level of particulate matter during the bicycle ride. An important finding of the bicycle ride is the fact that the highest reading obtained during the entire campaign was taken when riding right behind an RTD bus.

Pedestrians and bicycle commuters are exposed daily to these air pollutants that represent a threat to health. Minimizing the number of diesel buses would improve the air quality in downtown Boulder, but it would also reduce carbon emission and improve the health of the Boulder population.

The infographic below on health risks of diesel exhaust is courtesy of the Southern CA Environmental Health Centers based at USC.

