

Understanding the Results of an Emissions Control School Bus Study and Health Risk Assessment

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Why did the NJDEP conduct an emissions control study of diesel school buses?

The Diesel Retrofit Law, signed in September 2005, establishes the framework for reducing diesel exhaust fine particles ($PM_{2.5}$) from certain diesel powered vehicles including school buses. The law requires that all school bus owners install technologies to reduce fine particle emissions from the engine crankcase (where the major engine components of a vehicle are housed), with a closed crankcase ventilation system or C CVS. The C CVS is designed to capture and filter diesel engine compartment vent emissions and redirect them into the combustion process.

The Diesel Retrofit Law required the New Jersey Department of Environmental Protection (NJDEP) to undertake a study and do a health risk assessment to determine whether in-cabin exposure could be further reduced by tailpipe controls, such as a diesel particulate filter or a flow through filter. If so, the Department could require that tailpipe controls be installed on school buses in addition to the already required C CVS.

Why was a C CVS required on diesel school buses?

On existing school buses and many other diesel vehicles, gases and fine particles that escape from the crankcase during the combustion process (often called blow-by gases) are directed to the outside by a vent that runs under the bus and comes out near the front door. It is believed that these emissions enter the cabin of the school bus each time the front doors are opened and closed, and possibly when bus windows were open, thus increasing exposure to potentially dangerous toxins. A C CVS prevents emissions from the engine compartment from entering the cabin.

What studies were conducted?

There were two studies done by Rowan University. The results of the first study which was conducted in 2007 could not be used because upon review, it was learned that the bus used in the study was damaged and would not have passed the required NJ Motor Vehicle Commission's school bus inspection. In particular, the seals around the doors were faulty allowing particulates from the outside diesel exhaust to enter the bus. A second study using an undamaged bus was conducted in 2008, and its data have been accepted.

What were the results of the second study?

The second study concluded that equipping school buses with C CVS's and ensuring that all school buses meet New Jersey Motor Vehicle Commission's school bus inspection requirements, including a properly sealed school bus cabin, substantially reduces the levels of fine particles to below health standards used by the Department in evaluating air pollution exposure risks. In addition, the NJDEP concluded from the second study that equipping diesel school buses with tailpipe control devices such as a diesel particulate filter would not provide a significant further reduction in health risks associated with exposure to fine particles in the cabin of a school bus.

How do NJ's school bus laws help reduce emissions from entering the cabin of school buses?

New Jersey's school bus inspection system and mandatory bus retirement law (12 years for most school buses) are important for ensuring that the school bus fleet is in good condition. Compliance with the New Jersey Motor Vehicle Commission's Inspection Standards, particularly with regard to properly sealed front/back doors, engine compartment and exhaust system, and proper installation of a C CVS substantially reduces in-cabin fine particles

and ultra fine particles levels. For information on the New Jersey Motor Vehicle Commission program, visit: state.nj.us/mvc/inspections/schoolbus.htm

What is particulate matter?

Particulate matter is a complex mixture of tiny particles that consist of dry solid fragments, solid cores with liquid coatings, and small droplets of liquid. These particles vary greatly in shape, size and chemical composition, and can be made up of many different materials such as metals and other toxics, soot, soil and dust. Particulate matter can be coarse, fine, or ultra fine.

Fine particles are about 2.5 microns or less in diameter. You would need about 40 fine particles measuring about 2.5 microns in diameter to equal the average width of a human hair.

Ultra fine particles are a subset of fine particles. This is any particle that is less than 0.1 microns in diameter. Often these particles are so small that thousands of them could fit in the period at the end of this sentence. Because these particles are so small, they can easily penetrate deep into the lungs causing respiratory illnesses.

What are the health effects associated with Particulate Matter?

Diesel exhaust is a likely human carcinogen. Both short and long-term exposures to particulate matter have been shown to cause harmful health effects. Scientists have observed higher rates of hospitalizations, emergency room visits and doctor's visits for respiratory illnesses and heart disease as particulate matter concentrations rise. Scientists have also observed the worsening of both asthma symptoms and acute and chronic bronchitis and a reduction in lung function from exposure to particulate matter. Particulate matter has many sources including diesel exhaust.

In addition, ultra fine particles can penetrate deep into the alveolar portion of the lungs and can enter the bloodstream and be transported to other parts of the body because they are so small. There is evidence linking both moderate and long-term exposure to ultra fine particles to an increased risk of premature mortality and risk of stroke. Ultra fine particles have not been directly linked with asthma, but have been implicated in respiratory effects in asthmatics.

Why are children at risk from health effects of PM?

Children are especially vulnerable to the effects of PM because their lungs are still developing and they breathe more air per pound of body weight than adults. Children who already have asthma are particularly sensitive to PM. PM might increase their incidence of an asthma attack. In New Jersey, between 10 to 13 percent of all children in grades K-12 have asthma.

How will installation of a CCVS on a school bus affect my child's health?

The results of this study demonstrate that the installation of a CCVS reduces fine and ultra fine particles entering the school bus cabin. This will result in a considerable reduction in asthma attacks and other adverse respiratory effects such as bronchitis and upper/lower respiratory symptoms. CCVSs may also slightly reduce the risk of developing cancer.

What are the results of the health risk assessment?

There were two risk assessments conducted. One for non cancer health effects and the other for cancer risk. The overall conclusion of these risk assessments is that for fine particles, installing a CCVS will result in a considerable reduction in asthma attacks and to a lesser extent, other adverse respiratory effects such as bronchitis and upper/lower respiratory symptoms in addition to a reduction in cancer risk. Installation of a tailpipe retrofit would only provide marginal additional health benefits.

The cancer risk assessment concluded that the risk of cancer from inhalation of fine particles from diesel emissions in school buses that just meet inspection requirements is five in a million. The risk assessment also concluded that the risk of developing cancer from diesel emissions from school buses with a CCVS retrofit was less than one in a million.

A five in a million cancer risk means that in a population of one million there would be five additional cancers resulting from this exposure over a lifetime. A one in a million risk means that in a population of one million you would see one additional cancer resulting from this exposure over a lifetime. It should be noted that both numbers fall within the risk range of one-in-a-million to one-in-ten thousand, which is the public health risk range often applied nationally to the setting of standards and guidelines for exposure to carcinogens for the protection of human health. The NJDEP considers a less than one in a million risk as negligible when evaluating permit applications for individual air pollution emission sources.

What did the risk assessment conclude regarding ultra fine particles?

There are currently no exposure guidelines for ultra fine particles, which are needed in order to develop a risk assessment. However, the significant reduction in ultra fine particles achieved with a CCVS or a CCVS with a diesel particle filter, would suggest that health risks are reduced because ultra fine particles are removed from the in-cabin air of school buses by these devices.

What is a risk assessment?

A risk assessment is a tool that is used to evaluate the potential for a chemical to cause adverse health effects including, but not limited to, cancer or other illnesses. In certain applications, risk assessments can be used to estimate the extent of adverse effects that will result from a specific level of exposure to toxic chemicals, including substances in the air such as diesel exhaust particulates.

Risk assessments rely on data from both human and animal studies to estimate the relationship between exposure to a contaminant and health effects. Conclusions from these studies are then combined with assumptions about the conditions of exposure, including how long and how often a person is exposed.

There are several risk assessment tools for assessing the risk of different adverse health effects from diesel fine particles. Most are based on the assumption of lifetime exposure (70 years) at the levels that were measured in the cabin. As a result, some of these tools do not apply to the short term daily exposure a child would experience riding on a school bus. Therefore, the risk calculations used to evaluate health effects in this risk assessment may overestimate the actual risk.

What actions will the NJDEP take as a result of the two studies and the risk assessment?

As a result of the second study, the NJDEP concluded that tailpipe emission control technologies do NOT significantly reduce in-cabin particulate levels and therefore do not provide significant health benefits. Therefore, the NJDEP will NOT require tailpipe emission control technologies and will recommend that the NJMVC school bus inspection process continue.

The existing requirement for all regulated school buses to install CCVSs by July 2010 will remain.