Recommendation and Research on School Bus and Automobile Idling
May 9, 2011 - Revised

"The following recommendation is made to the State Health Services Council by the Texas School Health Advisory Committee in order to provide assistance in establishing a leadership role for the Department of State Health Services in the support for and delivery of coordinated school health programs and school health services."

I. Recommendation:

The Texas Department of State Health Services', Texas School Health Advisory Committee (TSHAC) supports the dissemination of the information in this document to school districts for their consideration in the development of a district "no-idling policy."

II. Texas School Bus General Background Information:

Texas has approximately 38,000 yellow school buses which transport an estimated 1.4 million school children to and from school (1). More than 95 percent of school buses are diesel-powered. The majority are owned and operated by school districts. If a child rides a school bus an average of 30 minutes in each direction, he will be exposed to diesel engine exhaust for a minimum of approximately 180 hours each year.

Diesel engine exhaust is a complex mixture of gases and airborne fine particles. Its gaseous constituents include carbon dioxide, carbon monoxide, sulfur dioxide, nitrogen dioxide and gaseous hydrocarbons. Forty of diesel exhaust's chemical components are designated as "toxic air contaminants" by the California Air Resources Board (2). A number of these chemicals, such as benzene, 1, 3-butadiene, and formaldehyde, are classified as "harmful air pollutants" by the Clean Air Act (3).

Diesel engines are one of the largest sources of fine particulate matter (4). Fine particles, known as fine particulate matter (PM 2.5), have a diameter less than 2.5 micrometers in diameter. They are small enough to easily penetrate deep into the lung (5). Collectively, diesel exhaust's particulate matter has a very large surface area, which enables the particles to accumulate inorganic and organic compounds onto their surface and transport them into the lung (6). There is evidence that diesel particles may remain in the lungs for long periods of time (7).

III. Diesel Exhaust Exposure:

Texas school children are exposed to diesel exhaust while riding on a school bus, while boarding or exiting from the school bus, while waiting for parent pick-up in areas adjacent to idling school buses and while indoors at school.

Diesel emissions enter the bus cabin as tailpipe exhaust which enters via windows and other openings and through the door as children get on and off and as engine crankcase emissions, from under the hood, which predominantly enters when children board and exit (8).

Numerous studies have documented that diesel exhaust concentrations inside the bus are much higher than the levels outside the bus. Yale University researchers, in conjunction with Environment and

Human Health, Inc., recorded pollution levels during school bus trips using a monitor attached to a child's backpack. The study revealed that students on school buses were exposed to levels of particulate pollution that were 5-15 times higher than background levels (9). Levels peaked as the child entered and exited the bus and remained high throughout the trip. When school buses queue up one behind another and leave engines running while picking up or dropping students off, or waiting for students to transfer among buses, interior particulate levels rise quickly to their highest levels, often within a minute of arrival. Diesel tailpipe exhaust from adjacent school buses can be drawn into the cabins (9), an indication that the increased exposure is directly related to idling school buses (10).

In a study published in April 2005 in the Environmental Science and Technology Journal, researchers reported that a child riding a school bus is likely to breathe in seven to 70 times more exhaust from the bus in a single day, on average, when compared to the school bus emissions a resident is likely to inhale in an urban area (11).

Behrentz et al. (12) found the concentrations of black carbon, particle surface polycyclic aromatic hydrocarbons, and NO2 to be 2.5-5 times higher (depending on pollutant) at bus stops as compared to school loading/unloading zones where idling was limited.

A recent Environmental Protection Agency (EPA) study of school bus idling in New York concluded that idling for more than three minutes generates 66 percent more fine particle pollution than from buses that are shut off and restarted (13).

The California Air Resources Board found that school bus trips can increase children's daily exposure to black carbon up to 34 percent, compared to regular passenger cars (8, 14).

If buses are left idling while parked in loading and unloading zones near schools, diesel pollution can migrate to adjacent areas and expose students and school staff.

Diesel exhaust can also cause indoor air pollution by entering schools through fresh air intake vents, doors, and open windows (15). Lower outdoor/indoor exchange rates inside school buildings can cause slower ventilation of contaminated air than that detected on moving buses, posing a health risk to children throughout the day (9).

IV. Health Effects of Diesel Exhaust:

A. *Acute effects:*

Acute exposure to diesel exhaust can lead to irritation of the eye, nose, and throat, respiratory symptoms (cough and phlegm), and neurophysiological symptoms such as headache, light headedness, nausea, vomiting, and numbness or tingling of the extremities (6; p9.4.1.1).

B. *Carcinogenic:*

Diesel exhaust was designated as a "probable human carcinogen" by the EPA in 1986 (6; p7-142), the International Agency for Research on Cancer (WHO) in 1989 (16), and the International Programme on Chemical Safety in 1996 (17) and as a known carcinogen by the State of California in 1990 (18). EPA reports state that available evidence indicates that chronic inhalation of diesel exhaust is likely to pose a lung cancer hazard to humans (6; p9-11) and that this hazard applies to environmental exposure conditions (6; p7-143). "More than 100 carcinogenic or potentially carcinogenic components have been specifically identified in diesel emissions." (6; p7-127).

The National Toxicology Program reported an increased risk of lung cancer of 30 percent, with higher risks found among more heavily exposed groups in occupational settings (19).

Air pollution studies estimate, based on lifetime exposure, that diesel exhaust is responsible for 125,000 cancers nationwide (20).

Diesel exhaust imparts a lung cancer risk that is 7.5 times higher than the cancer risk of all other air toxics – combined (21)

The Natural Resources Defense Council estimates that for every one million children riding the school bus to and from school for one or two hours each day during the school year for ten years, 23 to 46 children may eventually develop cancer from the excess diesel exhaust they inhale. This means a child riding a school bus is being exposed to as much as 46 times the cancer risk considered "significant" by EPA and under federal environmental law (22).

C. ***Respiratory/Lung Damage:***

Exposure to diesel exhaust also causes inflammation in the lungs, which may aggravate chronic respiratory conditions such as bronchitis and emphysema (4, 23) and can increase the frequency and intensity of asthma attacks (5).

Asthma is the most common chronic illness in children (24) and the cause of most school absences due to chronic disease (24); children with asthma miss twice as many school days as those without asthma (26).

Numerous studies have linked elevated particulate and carbon monoxide levels in the air to increased hospital admissions, emergency room visits, asthma attacks and premature deaths among those suffering from respiratory problems (27, 28). In 2010, 15,000 hospital admissions, 15,000 emergency room visits, 410,000 asthma attacks, and 14 million restricted activity days were associated with elevated diesel fine particulate levels (21).

Vehicle exhaust measured inside schools has been shown to be significantly associated with chronic respiratory symptoms in children (29).

D. ***Decreased Lung Function and Development:***

Smog-forming oxides of nitrogen, or "NOx," which are emitted from diesel engines in mass quantities, have been linked to decreased lung growth in children (30).

Exposure to fine particles can also reduce lung function in children and is associated with increased frequency of childhood illnesses (5, 30, 31).

Exposure to pollutants that included nitrogen dioxide, fine particulate matter, and elemental carbon have been shown to cause significant chronic adverse effects on lung development in children during the period of rapid lung development that occurs between the ages of 10 and 18 years (32).

E. ***Premature Death:***
Particulate matter, particularly the fine particles such as those in diesel exhaust, cause 21,000 premature deaths nationwide every year (21, 33).

F. ***Cardiovascular Disease:***
Long-term exposure to fine particulate air pollution is associated with an increased incidence of cardiovascular disease (including heart attacks and stroke) and death (27, 33, 34). A study involving postmenopausal women estimated that there was an overall 76 percent increase in risk of death from cardiovascular causes (both coronary and cerebral) with each increase of 10 micrograms per cubic meter increase in particulate matter pollution in long-term exposure (35).

Fine particles aggravate cardiovascular disease and trigger heart attacks by entering the bloodstream and initiating an inflammatory response, disrupting heart rate and increasing blood clotting (21, 36, 37).

G. ***Hormonal effects:***
Animal studies have demonstrated endocrine-disrupting activities of diesel exhaust, such as reduced estrogen receptor expression and decreased sperm production (38, 39).

V. Children are More Susceptible:

Children and the elderly, as well as anyone with existing heart or lung disease, asthma or other respiratory problems are most susceptible to the health effects of fine particles (31, 40). Children are among the most sensitive to the health effects of diesel exhaust exposure due to their developing body and lungs, narrower airways, faster metabolism, and faster breathing rate than adults (22, 31, 41). Children breathe 50 percent more air per pound of body weight than do adults (41). The smaller particles of particulate matter are able to penetrate more deeply within the narrower airways of a child's lungs, where they are more likely to be retained (9).

VI. Factors Influencing Diesel Exhaust Levels Within School Buses:

According to the Yale University/EHHI study, the most important factors influencing diesel exhaust levels within school buses include bus idling behavior, queuing practices, bus ventilation via windows and the outdoor diesel exhaust concentrations on bus routes. Higher concentrations of particulates and carbon were found in idling buses, especially when the idling buses had open windows, with the highest levels found in queued idling buses (9). Higher exhaust levels were also noted when buses moved through heavy traffic.

Other factors influencing pollutant levels and children's exposure include engine model, the age of the engine, number of miles since last overhaul, maintenance cycles, location of bus engine (front, next to driver, or rear), elevation change, passenger load and climate (9).

VII. Legislation:

A number of states have implemented legislation or regulation that limits the time allowed for vehicle idling and/or requires a minimum distance for the parking of buses near school buildings (42). The

American Transportation Research Institute compiles a continually-updated list of state and local anti-idling laws (43). These include:

- California: A statewide regulation to limit school bus idling and other idling at and near schools. California EPA. Air Resources Board. www.arb.ca.gov/toxics/sbidling/sbidling.pdf

- Connecticut: Substitute House Bill No. 5663, Public Act No. 02-56 states that "the operator of any school bus shall not operate the engine of any school bus for more than three consecutive minutes when the school bus is not in motion" with some exceptions. www.cga.ct.gov/2002/act/Pa/2002PA-00056-R00HB-05663-PA.htm

- Maine: An intensive statewide program to reduce school bus idling and to create no idling zones around all school facilities. www.maine.gov/dep/air/school

- Massachusetts: In Massachusetts, state law (M.G.L. Chapter 90, Section 16A) and DEP regulations (See 310 CMR 7.11(1) (b) in the complete Air Pollution Control Regulations) limit vehicle idling to no more than five minutes in most cases. www.mass.gov/dep/air/community/schbusir.htm

- Minnesota: School Bus Idling law 226-237 Sec 2 requires that "all operators of diesel school buses must minimize, to the extent practical, the idling of school bus engines and exposure of children to diesel exhaust fumes." It also requires that "diesel school buses must be parked and loaded at sufficient distance from school air-intake systems to avoid diesel fumes from being drawn into the systems, unless, in the judgment of the school board, alternative locations blocked traffic, impairs student safety or are not cost-effective. http://health.state.mn.us/asthma/documents/FormsR1-R10/r02.pdf

- New Jersey: NJ Department of Environmental Protection Idling Requirements for diesel-powered motor vehicles, N.J.A.C. 7:27-14, 15, includes a three minute limit on idling with some exceptions. www.nj.gov/dep/stopthesoot/sts-idlingsum.htm

- New York: State and city idling laws limit the amount of time vehicles may idle when not in traffic. New York State law provides that trucks and buses with diesel engines may not idle for more than one consecutive minutes, except when powering an auxiliary function (such as loading or unloading cargo or mixing concrete) required for maintenance, or when performing emergency services. www.oag.state.ny.us/press/2004/jan/jan27a_04.html

- Rhode Island: The Anti-Idling Act, 2006, prohibits unnecessary idling of diesel powered equipment both on-road and non-road. Rhode Island legislation also requires that newer buses either be retrofitted with a crankcase ventilation system; a model year 2007 or later engine; or the use of alternative fuels, such as compressed natural gas, which achieve reductions of diesel particulate matter (DPM) emissions.

In the 2007 legislative session, Texas lawmakers introduced legislation that would have prohibited idling a diesel engine of a school bus while the bus is parked at a public school or school event, except to heat or cool a bus before departure or to accommodate those with special needs. This legislation received broad support from many groups, including education groups such as the Texas Federation of Teachers, the Texas Parent Teacher Association, and the Texas Association of School Boards. The Legislature passed the bill, but it was vetoed by the Governor, who stated that "schools should focus on core functions and that school bus idling policies should be decided on at the local level (44)." Therefore, it is important for decision-makers at the school district level to be aware of the health hazards of diesel exhaust and the benefits of a "No Idling" policy for school buses.

The Texas Legislature appropriated funding for fiscal years 2010-2011 to continue cleaning up school buses. The Texas Commission on Environmental Quality (TCEQ) has several incentive programs to clean up school buses. The Clean School Bus Program, which provides grant funding to retrofit school buses with diesel particulate filters and/or crank case ventilation systems, just completed the current school year application period in January 2011. It will award approximately $20 million to potentially thirty school district applicants this year.

Other TCEQ grant programs include the Texas Emissions Reduction Program, which provides funding to replace, retrofit, or repower older vehicles, including school buses, with cleaner vehicles in order to reduce nitrous oxide emissions and the Clean Fleet Program**,** a grant rebate to replace large fleets of diesel vehicles with alternative fuel, hybrid, or electric vehicles. The fleet must contain a minimum of 25 vehicles.

VIII. Anti-Idling and Smart Driving Practices:

The EPA and a number of state agencies have established programs to promote the elimination of unnecessary school bus idling and the use of cleaner school buses to reduce children's exposure to diesel exhaust and the air pollution emitted by diesel school buses. Numerous resources are available to school districts to facilitate the establishment of a "No Idling" policy including the EPA's Clean School Bus Program National Idle Reduction Campaign. www.epa.gov/cleanschoolbus/antiidling.htm This program includes an instructional video/DVD for fleet managers and bus drivers to educate them regarding the hazards of diesel exhaust, smart driving and anti-idling practices.

Among the recommended practices:

- Ensure that both the fleet managers and bus drivers understand the potential risks to the children's and their own health from breathing diesel exhaust and the benefits of not idling or caravanning.
- Train school bus drivers to turn off their buses as soon as they arrive at loading and unloading areas and to refrain from restarting their buses until they are ready to depart.
- Limit idling time during early morning warm-up to what is recommended by the manufacturer (generally 3-5 minutes). Owners of older vehicles can buy electric starting aids such as block heaters which help warm the engine to avoid starting difficulties and reduce idling time during engine warm-up. Newer vehicles are designed to start easily at all temperatures without idling (4).
- Post "No Idling" signs in loading and unloading zones as reminders to bus drivers and passenger cars.
- Revise bus schedules and operational logistics to minimize school bus caravanning. Inform drivers that following other diesel vehicles too closely can contribute to higher concentrations of diesel exhaust inside and outside the bus.
- Assign cleanest buses to the longest trips.

- Institute a program to recognize drivers who successfully reduce idling.
- Consider changing circuit configurations, if necessary, to power flashing lights with the battery.
- Encourage parents to eliminate idling as they wait for their children to be dismissed from school.

Other recommendations include:
- Use ultra-low sulfur diesel fuel.
- Use pollution control equipment such as a diesel particulate filter that substitutes for the original factory muffler. Use diesel particulate filters, installed in the bus exhaust system. A crank case ventilation system, installed under the hood, reroutes pollution to the engine air intake so it doesn't seep into the bus cabin. Together, these technologies cut 90 percent of diesel particle emissions and cost a fraction of a new bus (45).
- Retrofit existing diesel vehicles with pollution controls.
- Purchase vehicles equipped with the most advanced emission control systems available.
- Consider alternative fuel sources such as natural gas, propane, or bio-duel. www.schoolbusfleet.com/Channel/Green-School-Bus/News/2009/04/07/Texas-district-unveils-bio-fuel-school-bus.aspx

Investing in retrofits now makes sense for the long term. The health benefits of installing a retrofit can outweigh the costs by at least 13 to 1. In other words, for every dollar spent on retrofits, the expected savings is $13 in health benefits, such as fewer emergency room visits and hospitalizations. In addition, every dollar invested in replacing old diesel vehicles with 2007 or 2010 engine models will yield in $40 in health benefits, according to the Environmental Protection Agency (45).

IX. Alternatives to School Bus Transportation

Safe Routes to School (SRTS) programs are maintained by the efforts of parents, schools, community leaders and local, state, and federal governments to enable and encourage children to walk and bicycle to school thereby improving their health and well-being. SRTS programs review conditions in the vicinity of schools and conduct projects and activities designed to improve safety and accessibility, reduce traffic congestion, and improve air quality. SRTS programs address parents' safety concerns by educating children and the public, partnering with traffic law enforcement, and developing plans to create safer streets. As a result, these programs help to ensure that bicycling and walking to school are safer and more appealing transportation choices, thus encouraging a healthy and active lifestyle from an early age. www.saferoutesinfo.org/index.cfm (46)

The Safe Routes to School National Partnership is a network of more than 500 nonprofit organizations, government agencies, schools, and professionals working together to advance the SRTS movement in the United States. This network strives to set goals, share best practices, secure funding, and provide educational materials to agencies that implement SRTS programs. www.saferoutespartnership.org/home (47)

Many communities have coordinated a "Walking School Bus" program in which a group of children walk to school with one or more adults. The involvement of school officials, law enforcement officers, and other community leaders can increase the likelihood of the program's success (48).

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Texas Department of State Health Services
School Health Program MC 1923
P. O. Box 149347
Austin, Texas 78714-9347
www.dshs.state.tx.us

TEXAS
Department of
State Health Services