CAPHE PHAP-RM

7.1 MOBILE SOURCE CONTROLS: DIESEL ENGINE RETROFITS

2016

This work is made possible by National Institute of Health and Environmental Sciences, RO1ES022616, and the Fred A. and Barbara M. Erb Family Foundation. Additional support was provided by the Michigan Center on Lifestage Environmental Exposures and Disease (M-LEEaD), #P30ES017885.

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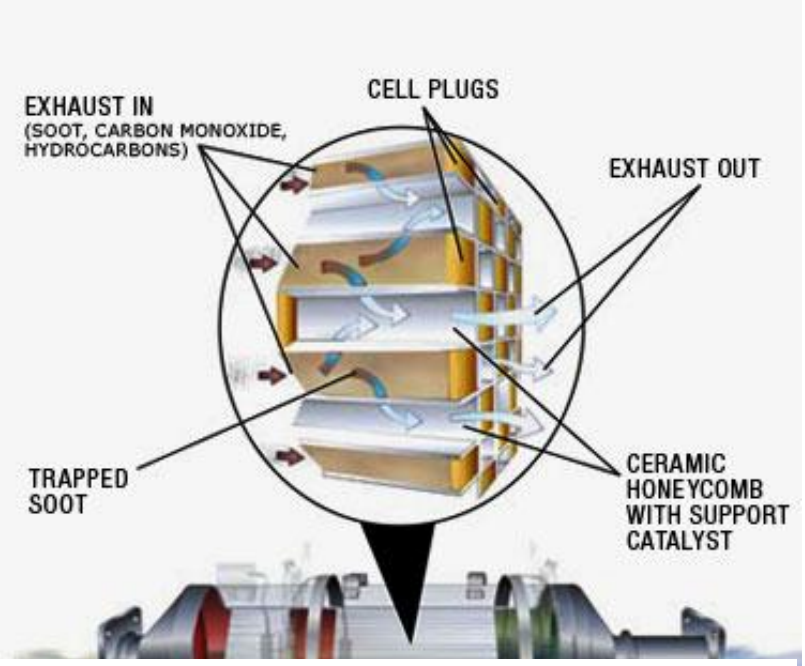
7.1 Mobile Source Control: Diesel Engine Retrofits

7.1.1 What is a diesel retrofit?

Retrofitting diesel engines involves installing more modern and effective emission controls on older diesel engines (especially those built before 2007) to reduce the amount of pollutants emitted. Diesel retrofits can be used on trucks, school buses, off-road construction vehicles (e.g. dump trucks and cranes), diesel-powered equipment (e.g. generators and pumps), ships and trains.



7.1-1: Diesel particulate filter (DPF) with catalyst. Exhaust flows through t hat remove particles. Taken from: https://www.demanddetroit.com/part /parts/emissions.aspx

7.1.2 What types of retrofits can be used?

Several types of retrofits are used. Installing engine and exhaust system emissions control devices is one of the most cost-effective approaches. The most common are diesel particulate filters (DPFs - see Figure 7.1 – 1) or traps installed on exhaust systems, and diesel oxidation catalysts (DOCs). DPFs and DOCs can be combined, as shown in the picture at right. This filter removes over 90% of the particulate matter ($PM_{2.5}$).[1]

Other approaches to reducing diesel exhaust emissions include installing idle reduction devices (Section 7.4), rebuilding or replacing the engine, replacing the vehicle, using cleaner fuels, and replacing diesel engines with electric motors.

7.1.3 Why is this important?

Diesel engines have long lives, and thousands of older vehicles and engines remain in use today. These old engines have few if any emissions controls, and they emit considerable amounts of pollutants like particulate matter ($PM_{2.5}$), nitrogen dioxide (NO_x), and other pollutants. Diesel exhaust accounts for 20% percent of $PM_{2.5}$ concentrations at Detroit monitoring sites, and a larger amount at "hot spots" where there are large numbers of vehicles.[2] Both on- and off-road vehicles are very important in Detroit. About 68% of diesel emissions in

[1] Detroit Demand Performance. 2016. Making It Easy to Stay Compliant. Available: https://www.demanddetroit.com/parts-service/parts/emissions.aspx [accessed 2 February 2016].

[2] MDEQ AQD (Michigan Department of Environmental Quality Air Quality Division). 2008. State Implementation Plan Submittal for Fine Particulate Matter (PM2.5). Available: http://www.michigan.gov/documents/deq/deq-aqd-air-aqe-PM25-SIP-Final-2008_238092_7.pdf [accessed 11 April 2016]. – Appendix G: Overview of Recent Detroit PM Source Apportionment Studies. http://www.michigan.gov/documents/deq/deq-aqd-air-aqe-Appendix-G-Detroit-PM-Source-Apportionment_238078_7.pdf. Accessed Jan. 4, 2015.

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Wayne County come from highway (on-road) traffic[3], and about 22% from non-road vehicles (like construction equipment).[3] Roughly 70,000 – 90,000 trucks travel on major corridors (I-75, I-94, I-96, M10 and M39) in Detroit daily,[4] and the International Bridge crossing has as many as 6900 trucks a day (2.5 million annually).[5]

Retrofitting old vehicles and engines with filters and other modifications can significantly reduce the emissions, and can be more cost-effective than vehicle replacement.[6]

7.1.4 Implications for Health

7.1.4.1 Which pollutants are affected by diesel engine retrofits?

Diesel engine retrofits reduce emissions of several hazardous pollutants, including $PM_{2.5}$, NO_x, and CO.

7.1.4.2 What health effects can be mitigated?

Reduced emissions of diesel exhaust would lead to improvements in respiratory diseases such as asthma; reduced lung diseases such as chronic obstructive pulmonary disease (COPD), bronchitis, emphysema, and lung cancer; fewer heart attacks and cases of hypertension; and reduced irritation of the nose, throat, and lungs.[7]

7.1.5 What is happening in Detroit?

Diesel retrofitting and replacement. Southwest Detroit Environmental Vision (SDEV)'s *Clean Diesel Program* is a successful public-private partnership that has reduced diesel pollution in Southwest Detroit, South Dearborn and surrounding areas. This program is funded by the Michigan Department of Environmental Quality (MDEQ), the Michigan Department of Transportation (MDOT), the Environmental Protection Agency (U.S. EPA) and local business partners. As of late 2014, this program had:

- Replaced 47 old trucks and 8 old school buses with new, cleaner models
- Upgraded 5 old truck engines and 6 old marine engines with new, cleaner engines
- Replaced 7 diesel refrigeration units with electric plug-in units, and
- Installed pollution controls on 140 trucks and idle reduction technology on 40 trucks
- Replaced over 75 old diesel engines with new, low polluting engines.[8]

[3] CAPHE (Community Action to Promote Healthy Environments). 2016. Diesel Pollutant Fact Sheet. Available: http://caphedetroit.sph.umich.edu/project/diesel/ [accessed 11 March 2016].

[4] SDEV (Southwest Detroit Environmental Vision). Truck Traffic and Air Quality in Southwest Detroit Fact Sheet. Available file:///C:/Users/klrice/Downloads/Anti-Idling%20Fact%20Sheet.pdf [accessed 11 March 2016].

[5] PBOA (Public Border Operations Association). 2016. Available: http://publicborderoperators.org/index.php/traffic [accessed 2 February 2016].

[6] EPA (Environmental Protection Agency). 2007. The Cost-Effectiveness of Heavy Duty Diesel Retrofits and Other Mobile Source Emission Reduction Projects and Programs. Available: http://www3.epa.gov/otaq/stateresources/policy/general/420b07006.pdf [accessed 11 March 2016].

[7] Community Action to Promote Healthy Environments, Health Effects of Air Pollutants Chart.

[8] SDEV (Southwest Detroit Environmental Vision, Clean Diesel Program Fact Sheet). Available: http://www.sdevweb.org/wp-content/uploads/2013/02/Clean-Diesel-Program-One-Pager-Revised-11-4-14.pdf [accessed 3 February 2016].

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School bus replacement. In 2015, Detroit Public Schools (DPS) acquired 35 propane gas-fueled buses. These buses are cleaner, and operating costs are about 50 percent less than diesel buses. Roughly 30% of DPS's school bus fleet uses propane autogas.[9]

The City of Detroit and several other City organizations developed and are implementing anti-idling polices, please see CAPHE anti-idling Section 7.4.

7.1.6 What best practices have been used elsewhere?

Diesel retrofit and clean diesel programs have been successfully used elsewhere, and many of these could be used effectively in Michigan.

Require low-pollution construction equipment. Rhode Island created a state-level *Clean Construction Diesel Retrofit Program* in 2010 requiring all heavy-duty vehicles contracted by the state with federal monies to be equipped with modern pollution control devices, adhere to the state anti-idling law, limit idling to 5 minutes, and use clean burning ultra-low sulfur diesel fuel (ULSD).[10] The law imposes relatively low costs to construction companies, and vehicle emissions were lowered by 20-90%.[11]

Force retirement of older trucks**.** To accelerate fleet turnover, California in 2008 and the Ports of Los Angeles and Long Beach in 2006 established regulations that forced the retirement of older diesel trucks. At the Port, the average fleet age decreased from 12.7 years in 2008 to 2.5 years in 2010. The new trucks are equipped with diesel particle filters and other technologies, which significantly reduced emissions of CO (30%), NO_x (48%) and $PM_{2.5}$ (54%).[12]

Fleet replacement. Replacing vehicles is more effective than promoting alternative transport modes or using truck restriction lanes. A 2009 study of the I-710 Freeway in the San Pedro Bay Ports (SPBP) area in California found that fleet replacement with cleaner (especially zero-emission) trucks yielded the most emission reductions compared to alternative modes of transportation and truck restriction lanes.[13]

[9] Crain's Detroit Business. 2015. Detroit students to ride to school on propane-fueled buses. Available: http://www.crainsdetroit.com/article/20150902/NEWS/150909990/detroit-students-to-ride-to-school-on-propane-fueled-buses [accessed 3 February 2016].

[10] RI DEM (Rhode Island Department of Environmental Management). 2014. Mobile Source Pollution Reduction: Clean Construction—Diesel Retrofit Program. Available: http://www.dem.ri.gov/mobile/pdf/story4.pdf [accessed 11 April 2016].

[11] The University of Rhode Island Transportation Center and Outreach Center. (2014). Diesel Emission Reduction in Construction Equipment. Available: http://ntl.bts.gov/lib/51000/51500/51514/S000118.pdf [accessed 3 February 2016].

[12] Bishop, GA, Schuchmann, BG, Stedman, DH. 2012. Emission Changes Resulting from the San Pedro Bay, California Ports Truck Retirement Program. Environmental Science & Technology 46(1): 551-558.

[13] Lee G, Soyoung IY, Ritchie SG, Saphores J, Sangkapaichai M, Jayakrishnan R. 2009. Environmental impacts of a major freight corridor: a study of I-710 in California. Transportation Research Record: Journal of the Transportation Research Board 2123: 119-128.

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7.1.7 How many people could be affected in Detroit by diesel retrofits?

The number of people affected by diesel retrofits depends on how many engines are modified or replaced. Those who would benefit most are those who live, work, and spend time near major freeways, sites with heavy diesel truck traffic, or construction and industrial sites using diesel engines.

Sites in Detroit where people could be affected include:

- Ambassador Bridge and the future site of the Gordie Howe Bridge
- The new Industrial Park and Logistic Center in Eastside
- Truck and rail transfer stations, for example the Container Port on West Fort Street
- Schools where buses are queuing
- Bus terminals
- People living or working near freeways such as I94 and I75 (an estimated 69,000 Detroit residents live within 150 meters of a major highway)
- People living or working on surface streets with considerable truck traffic, such as Fort Street and Michigan Avenue
- People living or working near construction sites and other locations where diesel vehicles or diesel engines operate.

Two groups are particularly important to mention. These include children riding on diesel school buses, especially since about 70% of DPS's bus fleet is diesel,[14] and truck drivers, who frequently have high occupational exposure to diesel exhaust. Both groups are particularly vulnerable to adverse health effects from exposure to diesel exhaust, and would benefit from actions taken to retrofit or replace diesel engines.

7.1.8 Applicable Strategies for Detroit and/or Michigan:

Expand diesel retrofit programs and fleet and engine replacements. Retrofitting and replacement programs are cost-effective ways to reduce diesel emissions,[15] and public-private partnerships can make them financially feasible for many business owners. In addition, incentive programs can be used to promote retrofit programs. Increased federal and state level funding for these types of programs could help organizations, like SDEV, continue and increase their efforts.

Laws and ordinances at State and local levels. Vehicles and equipment using diesel engines, especially larger engines (in heavy-duty vehicles) can be legally required to use pollution control devices.

Require low-emission vehicles and construction equipment in city contracts. City Council can impose stipulations that require the use of pollution control devices in construction, hauling, and other activities.

[14] Crain's Detroit Business. 2015. Detroit students to ride to school on propane-fueled buses. Available: http://www.crainsdetroit.com/article/20150902/NEWS/150909990/detroit-students-to-ride-to-school-on-propane-fueled-buses [accessed 3 February 2016].

[15] EPA (Environmental Protection Agency). 2007. The Cost-Effectiveness of Heavy Duty Diesel Retrofits and Other Mobile Source Emission Reduction Projects and Programs. Available: http://www3.epa.gov/otaq/stateresources/policy/general/420b07006.pdf [accessed 3 February 2016].

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Include low-pollution construction equipment language in Community Benefits Agreements.

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