

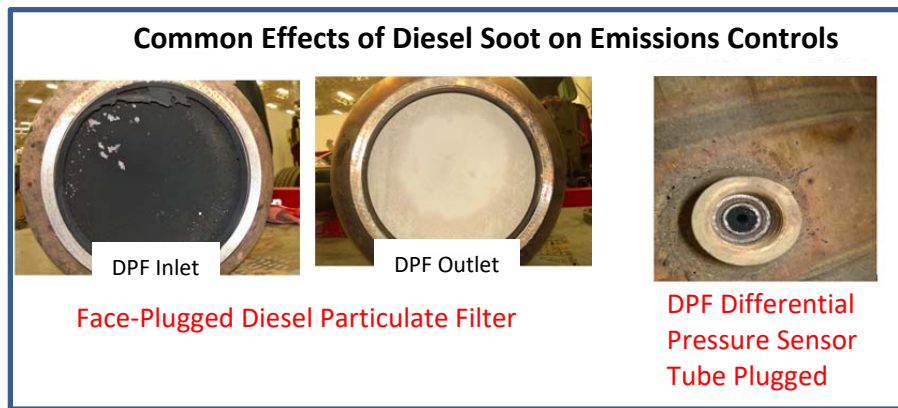
An Economic Study of the Impact of Diesel Engine Soot Loading Upon City Bus Engine Applications

By: Jack Schickler, BSME, MSChE.

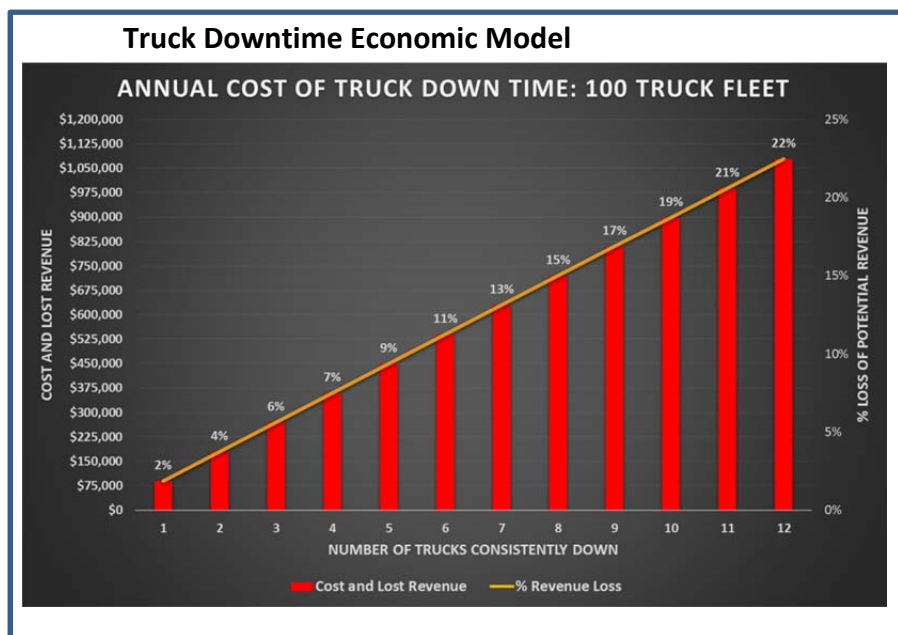
Abstract: Presented here is a summary of the economic impact of diesel engine drive cycles on city buses that lack the means of reducing diesel soot beyond those of current emission controls. The added losses can be in the tens of thousands of dollars per year per bus.

The required investment for a diesel powered city bus is estimated to be \$400,000. The expenses of purchasing and operating a city bus make any causes of downtime a major loss of revenue and an over-budget burden to the city.

Bus Drive Cycles – Among the Worst in the Provision of Diesel Engine Power



Diesel drive cycles requiring frequent stops, accelerations under load and/or long term idling will generate **almost 300% more soot in the exhaust.** Those are typical cycles for a city bus. They can cause 3X more downtime for very expensive repairs.



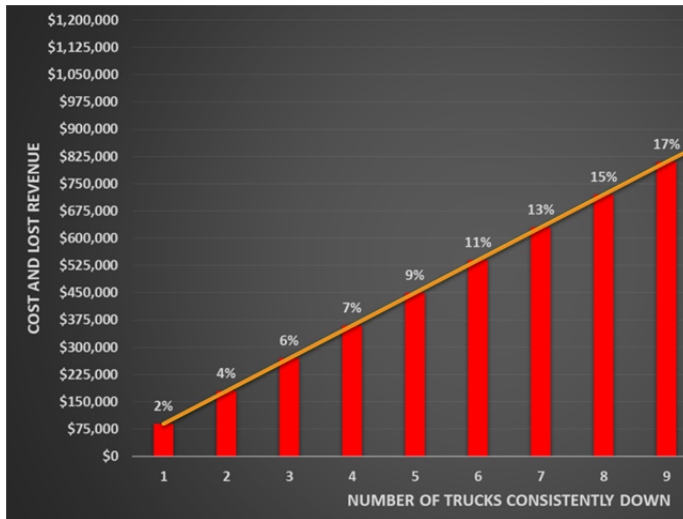
Below are Actual Dynamometer Test Results for Heavy Duty Emissions with Current Technology. PM (Particulate Matter or Soot) Level (10mg/sec.)

- 30 MPH Steady Throttle Highway: 0.2724

- 30 MPH Acceleration, Idle

to 30 MPH City Bus Cycle: 0.7867

Economic Impact of Soot Loading on City Buses



Normal budgeted downtime for heavy duty fleets = 3%

Soot loading penalty for city bus drive cycles = 3X = 9%

Lost revenue and maintenance cost difference = \$6,750/bus/year, plus labor, plus parts

Conclusions:

1. City Buses have some of the worst diesel drive cycles, causing major engine soot loading.
2. City bus fleets would be major beneficiaries of The Paradigm System.
3. The cost of downtime and loss of revenue for city buses is typically 3X that of heavy duty vehicles and with more normal drive cycles.
4. **Therefore, downtime for city buses caused by excess soot loading is:**
 - Over 3 years is estimated at \$20,000
 - Over 5 years is estimated at \$34,000
5. **Amortizing the Paradigm System over those periods would yield paybacks of 2.0 to 3.4X.**



Paradigm Plasma Reactor installed in EGR of a 13.1 L Diesel Engine

The author, Jack Schickler, is a retired General Motors executive with over 50 years of experience in internal combustion engine emission controls. He is currently employed as the Director of Sales Engineering for Paradigm Plasma Systems, LLC.

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