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Evaluating Speed Differences Between Passenger Vehicles and Heavy Trucks for Transportation-Related Emissions Modeling (FHWA DTFH61-03-P-00336)

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Role of Passenger Vehicle and Heavy Truck Speed Differences in Emissions Modeling

tech transfer summary

Project Objectives

- Compare the operating speeds of heavy trucks and passenger vehicles on arterials and freeways.
- Evaluate the impact that speed differences have on emissions.
- Recommend appropriate changes in the way the vehicle emissions are modeled.

Problem Statement

Heavy trucks contribute regulated ambient emissions such as particulate matter, carbon monoxide, oxides of nitrogen, and volatile organic compounds at different rates than passenger vehicles. Heavy trucks and passenger vehicles may behave differently on the road as well, such as traveling at different average speeds. However, current emissions models often treat heavy trucks and passenger vehicles similarly, which greatly limits the models' reliability.

Emissions rates from emissions modeling programs such as MOBILE are usually correlated to average speed. Depending on the pollutant, emissions rates are generally higher at lower average speeds, less sensitive for mid-range speeds, and higher as speeds increase. Typically, average speeds are output for a roadway link or facility type from travel-demand forecasting models and a single average speed is input to MOBILE to represent all vehicle types. Since emission rates are correlated to average vehicle speed, systematic differences in operating speeds between heavy trucks and passenger vehicles are not taken into consideration.

Although not frequently considered in calculating emission rates, differences in the operating speeds of passenger vehicles and heavy trucks may significantly influence emissions. Treating different vehicle types alike in emissions modeling adversely affects the ability to accurately estimate emissions rates and effectively reduce pollution levels.

Key Findings

Speed Differences

Average speeds and spot speeds were collected for heavy trucks and passenger vehicles on numerous arterial segments and freeway segments in Des Moines, Iowa, and Minneapolis/St. Paul, Minnesota. Passenger vehicles were found to travel at higher speeds than heavy trucks:

- Average speeds for passenger vehicles were higher than for heavy trucks for all arterial segments in Des Moines, with differences ranging from 0.8 mph to 15.1 mph.

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- Average speeds for passenger vehicles were higher than for heavy trucks for all segments in Minneapolis/St. Paul, with differences ranging from 5.9 mph to 11.4 mph.
- Spot speeds for passenger vehicle were higher than for heavy truck spot speeds for all Des Moines locations except for the I-35 site, with differences ranging from 0.8 mph to 6.1 mph.
- Spot speeds for passenger vehicles were higher than for heavy trucks for all Minneapolis/St. Paul locations, with differences ranging from 0.2 mph to 3.9 mph.

Impact on Emissions

The impact of differences in heavy truck versus passenger vehicle average speeds on emissions was modeled using the emissions modeling software MOBILE, version 6.2. The emission rates of heavy trucks traveling at average heavy truck speed and at average passenger vehicle speed were calculated and compared. The differences in operating speeds between vehicle types were found to significantly affect emission rates (see table).

Comparison of heavy truck emission rates at passenger vehicle average speed versus heavy truck average speed

Location	Average Speed (mph)		Heavy Truck CO Emission Rate (g/m)			Heavy Truck NO_x Emission Rate (g/m)			Heavy Truck Volatile Organic Compounds Emission Rate (g/m)		
	Passenger Vehicles	Heavy Trucks	At Average Passenger Vehicle Speed	At Average Heavy Truck Speed	Difference	At Average Passenger Vehicle Speed	At Average Heavy Truck Speed	Difference	At Average Passenger Vehicle Speed	At Average Heavy Truck Speed	Difference
Location 1 eastbound	26.2	17.3	7.67	11.92	55.3%	8.93	9.97	11.6%	0.98	1.37	40.1%
Location 1 westbound	28.1	23.5	7.17	8.65	20.6%	8.84	9.15	3.5%	0.93	1.07	16%
Location 2 eastbound	38.0	34.2	5.55	5.97	7.5%	8.89	8.75	-1.6%	0.73	0.79	8.3%
Location 2 westbound	38.5	36.9	5.50	5.65	2.7%	8.91	8.84	-0.8%	0.72	0.75	3.1%

Note: Location 1 = Douglas Avenue, Des Moines. Location 2 = Highway 163, Des Moines.

Conclusions

- Different vehicle types have different operating speeds, and operating speeds affect emission rates.
- Emission models should accommodate vehicle type speed differences in order to produce more accurate and reliable emissions forecasts.
- Modeling different categories of vehicles separately could have important consequences in evaluating project-level and regional emissions.

Recommendations

- Different vehicle types should be modeled separately when more accurate modeling is necessary.
- Additional research of vehicle activity modeling should be supported and pursued to better understand the differences between heavy trucks and passenger vehicles.

Implementation Benefits

- Improved vehicle-specific emissions modeling will provide transportation policy makers with better information to make better decisions.
- Modeling heavy truck and passenger vehicle speeds differently in emissions modeling will result in more accurate emissions inventories.