ABSTRACT

Thomas, Salimol. Ph.D., Purdue University, December, 2007. Modeling of Freeway Air Quality during Recurring and Nonrecurring Congestion Events. Major Professors: Robert Jacko, Joseph Sinfield.

Freeway emissions pose significant risk to human health and the environment. The ability to manage freeway air pollution depends on our ability to model and predict the pollutant emissions. This research has developed applied models to predict air pollutants under normal and congested traffic conditions. Regression and neural network models were developed for forecasting hourly $PM_{2.5}$ and CO concentrations. The availability of real time $PM_{2.5}$ and CO forecasts will help highway managers to identify air pollution episodic events beforehand and to determine mitigation strategies.

Deterministic models were developed for predicting air pollutants under non-recurring conditions such as incidents and work zone; and recurring congestion condition such as oversaturation. Similar to the traffic delays caused by incidents, excess emissions resulting from an incident were found to be a second order function of the incident clearance time. Excess emission resulting from oversaturation condition was found to be a second order function of the degree of oversaturation. Work zone length, speed limit, duration and the traffic demand during the work zone activity determine the impact of work zone on air pollutants and the traffic delay.

Stochastic models were developed to estimate the average excess emissions and the traffic delay due to recurring and non-recurring conditions. For non-recurring incident conditions, it was found that estimated excess CO and traffic delay could be modeled as lognormal distributions; $PM_{2.5}$ as a gamma distribution; excess VOC and NO_X as 3-parameter lognormal distributions. Based on the results of the Monte Carlo simulation, it was estimated that an incident on an average would result in 138% increase in CO emissions, 500% increase in VOC emissions, 26% increase in NO_X emissions and 43% increase in $PM_{2.5}$ emissions compared to the normal traffic emissions. On an average an oversaturation condition would result in an increase of 218% in CO emissions; VOC, NO_X and $PM_{2.5}$ emission will increase by 900%, 8% and 45% respectively. These models provide a framework for the highway managers to model emissions under recurring and non-recurring congestion conditions and can be used to refine the annual emission inventory.