

# ITS RADAR Intelligence Report – Environmental Issues Relating to ITS

## TRB Annual Meeting

### Washington D.C. (22<sup>nd</sup> – 26<sup>th</sup> January 2006)

**Relevant Topics:** *Environment, Emissions, Tolling, Modelling, Freight and Fleet Management, Standards & Policy, High Occupancy Vehicle Lanes.*

**Background:** This Intelligence Report has been produced as part of the ITS RADAR project. The aim of the project is to summarise key information for Highways Agency decision makers and practitioners alike regarding innovative pilot projects worldwide, emerging technologies and issues associated with ITS deployment and operation.

This particular report concerns the environmental issues relating to transport, including the role of ITS, raised at the TRB Annual Meeting 2006 held in Washington D.C.

**Summary:** This document summarises some of the papers presented at the 85<sup>th</sup> TRB Annual Meeting (held in Washington D.C. between 22<sup>nd</sup> and 26<sup>th</sup> January 2006). It particularly focuses on papers that refer to new advances in transport policy and decision making plus example uses of ITS technologies in relation to environmental issues. A summary of each of the chosen papers is provided including a copy of the complete abstract and contact details for the lead author of the paper.

The objective has been to provide intelligence to the Highways Agency and some background information to assist in the consideration of the role of ITS in both monitoring and, thereafter, implementing strategies to minimise the impact of transport on the environment.

There is a continuing evolution of technology types and the way technologies are applied. This reflects advances in transport policy, with an increasing focus on environmental issues, the increasing range of impacts to be considered, Research and Development of tools to monitor the environment and manage transport to minimise emissions.

**Environmental Issues Raised:** The environmental issues addressed in the papers in this document are:

- Truck idling emissions;
- Using environmental impact assessments as a decision-making process;
- Combining emissions models and transportation models to improve emissions estimations;
- Traffic and emission impacts of single lane roundabouts in urban corridors;
- Impacts of toll collection on heavy-duty vehicle emissions;
- The difference in vehicle emissions between general purpose lane facilities, buffer separated and barrier separated high occupancy vehicle lanes;
- The potential applications of combining hydrogen powered vehicles and ITS technologies;
- The development of an improved Traffic Air Quality Simulation Model (TRAQSIM); and,
- The operational effect of allowing single-occupant hybrid vehicles into high occupancy vehicle lanes.

## Context

The papers chosen for this document were presented at the TRB Annual Meeting 2006; they focus on emissions monitoring, emissions modelling, transportation planning policy or integrating advanced technologies. All of the papers make some use of ITS applications in their methods or have some consideration of them in their conclusions.

These papers were chosen so that decision makers might gain a better understanding of recent developments in ITS applications in relation to environmental issues.

## Technology Types

The following table summarises major application areas of the papers summarised in this document.

Paper Reference	Subject	County of Origin	Relevant Topic Areas					
			Emissions	Tolling	Modelling	Freight and Fleet Management	Standards and Policy	High Occupancy Vehicle Lanes
<a href="#">06-0192</a>	Characteristics of Truck Idling Emissions Under Real-World Conditions	USA	✓			✓		
<a href="#">06-0540</a>	Environmental Impact Assessment as Decision-Making Process: Case Study of Transportation System in Tourist Area in the Italian Alps	Italy					✓	
<a href="#">06-1096</a>	Speed- and Facility-Specific Emission Estimates for On-Road Light-Duty Vehicles based on Real-World Speed Profiles	USA	✓		✓			
<a href="#">06-1343</a>	Effect of Roundabout Operations on Pollutant Emissions	Portugal	✓					
<a href="#">06-2141</a>	Impact of Electronic Toll Collection and E-Screening on Heavy-Duty Vehicle Emissions	USA	✓	✓	✓			
<a href="#">06-2241</a>	Measuring Impacts of High-Occupancy-Vehicle Lane Operations on Light-Duty Vehicle Emissions: Experimental Study with Instrumented Vehicles	USA	✓					✓
<a href="#">06-2404</a>	Opportunities for Integrating Hydrogen-Powered Vehicles and Intelligent Transportation Systems	USA	✓			✓		
<a href="#">06-2619</a>	Development of the Traffic Air Quality Simulation Model (TRAQSIM)	USA	✓		✓			
<a href="#">06-2813</a>	Operational Effect of Allowing Single-Occupant Hybrid Vehicles into High-Occupancy Vehicle Lanes	USA			✓			✓

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## The Papers

The following paragraphs summarise the key details of the papers selected for this document; these include the paper title, the paper number from the TRB Annual Meeting 2006, the name and available contact details for the lead author and a verbatim reproduction of each papers abstract.

### **Characteristics of Truck Idling Emissions Under Real-World Conditions ([06-0192](#))**

*Lei Yu, PhD.*

*Professor of Texas Southern University and Changjiang Scholar of Beijing Jiaotong University, USA*

*yu\_lx@tsu.edu*

This paper is intended to identify the characteristics of truck idling emissions by collecting data using an advanced portable emission measurement system, in which the attempt is made to measure actual idling emissions from truck tailpipes and to relate measured emissions to altered pre-testing driving conditions. The On-Board Emission Monitoring system (OEM-2100TM) is employed for the testing. This equipment can determine the second-by-second emissions of HC, CO, CO<sub>2</sub>, O<sub>2</sub>, and NO<sub>x</sub> in the exhaust gas by a functional equivalent of a repair-grade dual five-gas analyzer subsystem. Altered driving circumstances considered during truck idling tests include cold starts and hot starts, different distances and durations of driving before the tests, different roadway facility types used while driving, different durations of idling tests, etc. Measured emissions under all the different pre-testing driving conditions are then analyzed and compared.

### **Environmental Impact Assessment as Decision-Making Process: Case Study of Transportation System in Tourist Area in the Italian Alps ([06-0540](#))**

*Rossella Cerioli*

*Poliedra, Politecnico di Milano, Italy*

*cerioli@poliedra.polimi.it*

The paper presents a case study of an environmental impact assessment for the choice of the transportation system in a tourist village on the Italian Alps with problems of traffic congestion. Alternative multimodal transportation systems, including demand-responsive and conventional transit systems, and measures of travel demand management, are studied and compared using a multicriteria analysis. The effects of such alternatives on mobility, environment, land use, and economy, and their psychological acceptability are evaluated. The problem is characterized by the presence of different criteria and conflicting actors [*sic*], with different interests and values and with different decision power. An aggregated viewpoint is generated through a mediation of the different actors' viewpoints to find a compromise solution. The stability of the alternative rankings is evaluated with a sensitivity analysis, and a conflict analysis is performed to examine the level of agreement associated with the compromise solution.

### **Speed- and Facility-Specific Emission Estimates for On-Road Light-Duty Vehicles based on Real-World Speed Profiles ([06-1096](#))**

*H. Christopher Frey, PhD.*

*Professor, Department of Civil, Construction and Environmental Engineering, USA*

*frey@eos.ncsu.edu*

This research represents an attempt to bridge the gap in transportation and emission models, through the use of real-world distributions of Vehicle Specific Power (VSP) bins that are associated with average link speeds for various road classes. A successful effort in this direction would extend the use of transportation models to improve emissions estimation using the limited output produced by such models. In addition, the variability of emissions and emission rates over average speeds for a given facility type is explored and recommendations are made to extend the methodology to additional facility types.

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## **Effect of Roundabout Operations on Pollutant Emissions (06-1343)**

*Margarida C. Coelho, Ing*

*Invited Assistant Lecturer, Mechanical Engineering, Portugal*

*margarida@mec.ua.pt*

The main objective of this research is to quantify traffic and emission impacts for single lane roundabouts in urban corridors. Based on experimental measurements of traffic and using the “Vehicle Specific Power” methodology, the impact of traffic and emission performance of roundabouts is presented. The approach attempts to explain the interaction between roundabout system operational variables (entry volume, conflicting volume and roundabout geometry) and the resulting traffic performance and vehicle emissions.

The experimental data for calibrating the numerical traffic model were gathered from two single lane roundabouts located in Lisbon (Portugal) and Raleigh (North Carolina, USA). Using the congestion-appropriate speed profiles of vehicles on roundabout approaches, the emissions calculation methodology is used to quantify the relationships between vehicle dynamics and emissions.

The main findings of the present work are: the characterization of three synthetic speed profiles that occur at a roundabout approach, the distribution of these profiles based on congestion levels, and the correlation between queue length and the number of stop and go cycles. Two different types of stop and go driving cycles for vehicles joining the queue at a roundabout were identified: short and long. The length of each cycle depends on the expected queue length at the roundabout and the frequency of each cycle directly impacts the level of vehicle emissions.

## **Impact of Electronic Toll Collection and E-Screening on Heavy-Duty Vehicle Emissions (06-2141)**

*Mohan M. Venigalla*

*Civil, Environmental and Infrastructure Engineering Department, George Mason University, USA*

*mvenigal@gmu.edu*

In this paper a speed profile discretization technique (SPD) to model emissions at ETC/E-Screening facilities is presented. The SPD technique is based on MOBILE 6 method of representing vehicle miles of travel in various speed-bins. The technique defines an emissions influence zone (EIZ) within which the speed profiles are altered which further determine vehicle emissions. Using this technique, emission impacts of heavy duty trucks at the toll collection plaza on George Washington bridge, New York, are estimated. Current mix of cash and EZ-pass transactions on GW Bridge are shown to reduce emissions of VOC, HC and NO<sub>x</sub> within the emission influence zone. The degree of reduction is dependent on the speed with which EZ-Pass vehicles are processed. If the EZ-pass were to be processed only at 10 mph, reductions in VOC, CO and NO<sub>x</sub>, are estimated to be 30.8%, 23.5% and 5.8%, respectively. The results indicate that if the EZ-pass allows the vehicles to be processed at 20 mph, the reductions in VOC due to truck traffic alone could be as high as 50%. The SPD technique and the study methodology presented in this research may be used for modeling heavy duty vehicle emissions attributable to any traffic flow improvement project.

## **Measuring Impacts of High-Occupancy-Vehicle Lane Operations on Light-Duty Vehicle Emissions: Experimental Study with Instrumented Vehicles (06-2241)**

*Michael Krimmer*

*Science and Tech II, George Mason University USA*

In this research differences in vehicle emissions between High occupancy vehicle (HOV) and general purpose (GP) facilities were measured using portable emissions sensors. Several hundred miles of on-road emissions data were collected with vehicles instrumented with portable emissions monitoring systems (PEMS) by driving in HOV and GP lanes during peak hours in the metropolitan Washington, D.C. area. Data were collected at HOV facilities with buffer separation and at HOV facilities with barrier separation (limited access). Experimental runs were conducted with pairs of nearly identical instrumented vehicles which began trips in parallel HOV and GP lanes simultaneously, and terminated at a common location. The experimental design controlled for vehicle type and driver characteristics. Analysis identified emission profiles of vehicles operating in barrier-separated HOV lanes (I-95) and vehicles

operated in buffer-separated HOV lanes (I-66). Experiences related to experimental design using PEMS, field deployment of PEMS, data collection and analysis are discussed in detail. Included in the discussion is the application of a geographic information system (GIS) for data collection and analysis. Viability of using PEMS for field verification of emissions impacts of transportation improvement projects and transportation control measures is addressed.

## **Opportunities for Integrating Hydrogen-Powered Vehicles and Intelligent Transportation Systems (06-2404)**

*Dr Timothy E. Lipman*  
*Institute of Transport Studies, University of California, USA*  
*telipman@berkeley.edu*

The project reviewed state hydrogen activities suggested potential applications of combined hydrogen and intelligent transportation system (ITS) technologies that warrant further study and field-testing. The main concept underlying this study is the potential for synergies between two rapidly evolving areas of advanced transportation and energy technology: hydrogen energy systems and ITS. Schemes that combine these two sets of technologies can help to improve convenience and optimize the operation of hydrogen infrastructure by allowing communication and mapping/navigation technologies to facilitate the access to and operation of initially sparse hydrogen refuelling networks. This could initially be in fleet and motor pool settings where hydrogen vehicles are first introduced, but then could spread to the broader consumer market should it evolve. Additional benefits include helping to mitigate the limited driving range of early hydrogen-powered vehicles and exposing consumers to new technologies in ways that do not require purchasing them, such as through fleet/motor pool, transit, and car sharing organization operations. Finally, additional opportunities for integration of hydrogen energy and ITS can be found through linkages with stationary power generation, where a new paradigm of “distributed power generation” is emerging.

## **Development of the Traffic Air Quality Simulation Model (TRAQSIM) (06-2619)**

*Brian Y. Kim*  
*Environmental Measurement and Modeling Division, Volpe National Transportation Systems Center, USA*  
*kim@volpe.dot.gov*

The Traffic Air Quality Simulation Model (TRAQSIM) was developed to create a theoretically more realistic (more natural), easier to understand, and more flexible modeling environment than CAL3QHC. Instead of steady-state plume equations used in CAL3QHC, TRAQSIM models dispersion through the use of Gaussian puffs emitted from discrete moving sources in a traffic simulation environment. Although most of the components incorporated in TRAQSIM are not new, the combination of these components within a fully integrated environment is new and provides the potential for more direct (more logical) expansion of modeling capabilities. As part of an initial validation assessment, a relative comparison of CAL3QHC and TRAQSIM results showed that TRAQSIM produced more intuitively correct spatial allocation of concentrations. The validation assessment also showed good agreement by both models when compared to measured data with overall  $R^2$  values of 0.721 for CAL3QHC and 0.605 for TRAQSIM. This paper describes the data and methodologies used to develop TRAQSIM and the initial validation work.

## **Operational Effect of Allowing Single-Occupant Hybrid Vehicles into High-Occupancy Vehicle Lanes (06-2813)**

*Christopher Breiland*  
*Fehr and Peers Associates Inc., USA*  
*c.breiland@fehrandpeers.com*

This paper presents a microscopic simulation method to examine the possible effects of a proposed California state hybrid-HOV law that would allow single occupant hybrid vehicles into the state's HOV network. The results from simulating a 12-mile by 16-mile freeway network around Irvine, California under several travel demand scenarios show that the policy would not have a significant impact on HOV lane operations in the study area. While the addition of single occupant hybrids might only have a

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modest impact on short-run HOV lane operations, policy implementation opens the door to more difficult long-term policy questions.

## Concluding Remarks

As further evidence emerges on developments in ITS for monitoring the environment and implementing strategies to manage transport networks to the benefit of the environment, this will be highlighted within future ITS RADAR 'Newswires'. To seek registration for the Newswire service, please go to the ITS RADAR website [www.itsradar.co.uk](http://www.itsradar.co.uk) where you can apply online.