UNIVERSITY OF CALIFORNIA

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Motor Vehicle Episodic Emissions: High Loads, Accelerations and Grades.

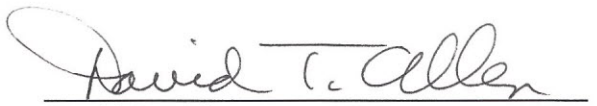
A dissertation submitted in partial fulfillment of the requirements for the degree Doctor of Environmental Science and Engineering.

by

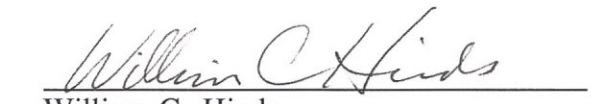
Pablo Cicero-Fernández

1995

The dissertation of Pablo Cicero-Fernández is approved.



David T. Allen



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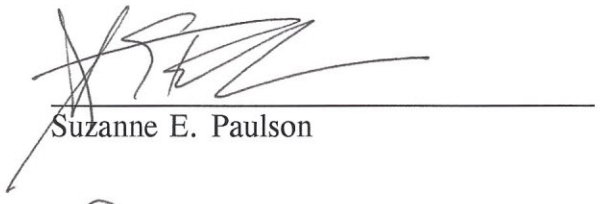

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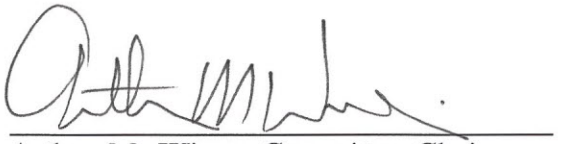

Arthur M. Winer, Committee Chair

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1995

"How much better to get wisdom than gold,

to choose understanding rather than silver."

Proverbs 16:16

To Ivonne, my wife,

Raul and Martha, my parents,

my siblings in the Flesh,

my siblings in the Law,

my siblings in the Faith,

my siblings in the Guild,

and

my siblings in Academia.

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ABSTRACT OF THE DISSERTATION

Motor Vehicle Episodic Emissions: High Loads, Accelerations and Grades

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Pablo Cicero-Fernández

Doctor of Environmental Science and Engineering

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Professor Arthur M. Winer, Chair

Cars that are clean under certification conditions have the potential to output large amounts of pollutants in short periods of time under high engine load conditions such as hard accelerations or grades. Such events are not included in the current Federal Test Procedure. This project was developed to assess driving patterns likely to promote emission excursions. Hard acceleration events were analyzed from existing data collected on-dynamometer. Additionally an instrumented vehicle was used to assess grade effects on the road. The vehicle was equipped with an on-board data-logger and analyzers for hydrocarbons and carbon monoxide, along with sensors for basic driving parameters such as speed, manifold pressure, throttle position, and grade. The validation of the on-board emission instrumentation was performed by parallel

sampling on a dynamometer with second-by-second emissions capability. Controlled runs with predetermined cruises and accelerations were conducted on flat terrain and hills on grades ranging from 0% to 7%. The hills were located in metropolitan Los Angeles, both on freeways and arterials. For hydrocarbons, the effects were on the order of 0.04 g/mile per 1% grade increment. The case of CO was more dramatic with a predicted increase for a 1% grade increment of 3.0 g/mile. The results have significant uncertainties (R^2=0.40 for hydrocarbons and R^2=0.36 for CO) since there is evidence of a synergistic effect of grade and speed, and a potential load threshold for emission excursions. Effects on engine total load, such as passengers or air conditioning, were also important. Emission effects are enhanced (0.07 g/mile for hydrocarbons and 10.2 g/mile for CO) with a fully occupied vehicle (4 passengers) while driving on a hill (4.5% grade). In a similar way, air conditioning operation enhances emission rates (0.08 g/mile for hydrocarbons and 32.9 g/mile for CO). The air conditioning test was performed on two hills (4.5 and 6.7%). Uncertainties were also important (R^2s ranged from 0.32 to 0.83) for these additional loads tests. The results highlight the importance of including emissions caused by grades in the emission inventory. This study has also significant implications for assessing the effectiveness of some transportation control measures.