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UT-BATTELLE

Heavy Truck Duty Cycle (HTDC) Project

OVERVIEW

The Heavy Truck Duty Cycle (HTDC) Project is sponsored by the US Department of Energy's (DOE's) Office of FreedomCar and Vehicle Technologies. The project involves efforts to collect, analyze and archive data and information related to class -8 truck operation in real-world environments. Such data and information will be useful for supporting: energy efficiency technology evaluation efforts, the development and evaluation of the Argonne National Laboratory 's Powertrain Systems Analysis Toolkit (PSAT) Class-8 module (C8M), and to provide a means of accounting for real-world driving performance within heavy truck analyses. The Program is being led by Oak Ridge National Laboratory (ORNL), involves Michelin Americas Research and Development Corporation, Schrader Trucking, and one previous partner Dana Corporation. Six instrumented tractors and ten instrumented trailers collected data on their operations for a 15-month period. Sixty channels of data were collected at 5Hz for each of the instrumented tractors. A major product of this effort will be a duty cycle generation tool (to be completed in February 2008) that will allow for the generation of a characteristic duty cycle based on user-specified parameters and real-world data.

BACKGROUND

The HTDC Project was initiated in 2004. At that time, ORNL designed a research program to generate real-world-based duty cycle data from trucks operating in long-haul operations. The research program was designed to be conducted in three phases: a) identification of parameters to be collected, instrumentation and pilot testing, b) identification of a real-world fleet, design of the data collection suite and fleet instrumentation, and c) data collection, analysis, and development of a duty cycle generation tool (DCGT).

TECHNOLOGY

In 2004, more than 100 parameters were identified as candidate measures of performance for data collection. Interactions with ANL identified those of importance for PSAT modeling. Parameter categories included engine performance, location/direction/speed/time-of-day, fuel consumption, real-time weight, precipitation/road condition, wind velocity/direction, road condition, and road grade. For the pilot test, Dana Corporation provided the free-use of a 1999 Peterbilt Tractor and Utility Box trailer. The tractor-trailer was instrumented to collect 104 channels of information at 100Hz. Another industry partner, Michelin Tires, was interested in studying the effects on fuel consumption of their New Generation Single Wide-Based Tires (NGSWBTs) compared to standard dual tires. Two east-west runs were conducted from Kalamazoo, Michigan to Portland, Oregon and back, with each run conducted with different tires. A second set of north-south runs from Kalamazoo, Michigan to Bangor, Maine to Tampa, Florida to Kalamazoo, Michigan was conducted, and again with each run conducted with different tires. Initial analysis of the data indicated a 2.9 % fuel saving when NGSWBTs were utilized, and an 8.0% fuel saving when the data was corrected for congestion effects.

In early FY2006, six data collection suites were developed at ORNL, and a candidate fleet (Schrader Trucking of Jefferson City, TN) was partnered with. Six Schrader tractors and ten Schrader trailers were instrumented, and in October, 2006, they were deployed in a field test. The instrumented tractors are all 2005 Volvo VN class tractors with Cummins engines. Three of the tractors are fitted with NGSWBTs and three are fitted with standard dual tires. The trailers are of various manufacturers and are 53 foot dry-box vans. Five are fitted with NGSWBTs and five are fitted with standard dual tires. A typical Schrader tractor-trailer used in this project is shown in Figure 1 (next page). Nearly 200 gigabytes of compressed data have been collected through December, 2007, and software for cleansing, managing and analyzing the data

Figure 1—Truck 462 with weather station visible on driver's mirror bracket.

were developed by ORNL. Some information generated from the database related to idling time and fuel consumption are presented here as an example of the data that has been collected. To generate idling information, the database was automatically scanned to select data for all time intervals in which a particular instrumented tractor-trailer (Truck#1) had its engine running while the vehicle was not moving. Over a period of one year, the cumulative idling time for this truck amounted to 1,630 hours, with a total number of idling events of 13,300, and for an average idling time of 7.4 minutes. The maximum idling time found was 18.6 hours. The idling statistics are shown in Figure 2 as a histogram with logarithmic values for the event frequency in the Y-axis and one-hour-wide bins in the X-axis.

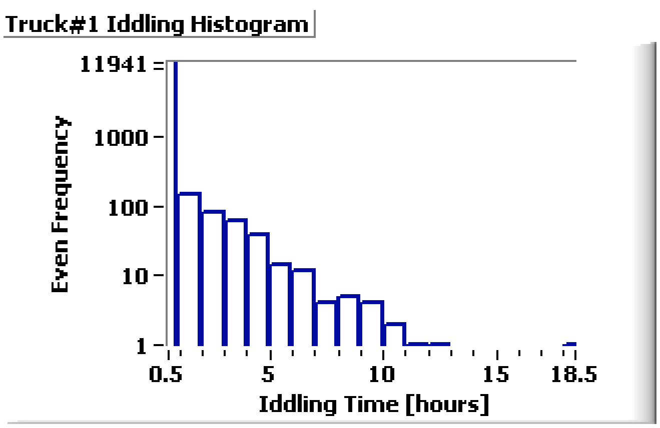

Figure 2—Idling histogram for Truck No. 1.

The means and standard deviations of the fuel consumption rate for each of the idling events are shown in Figure 3 as a function of the mean engine RPM. It appears as if the truck had two main idling speeds, and that the maximum power demand on the engine while the vehicle is not moving can be as high as four times the minimum.

Another major effort that was engaged in during FY2007 was the development of a Duty Cycle Generation Tool (DCGT). This tool allows a user to specify characteristics

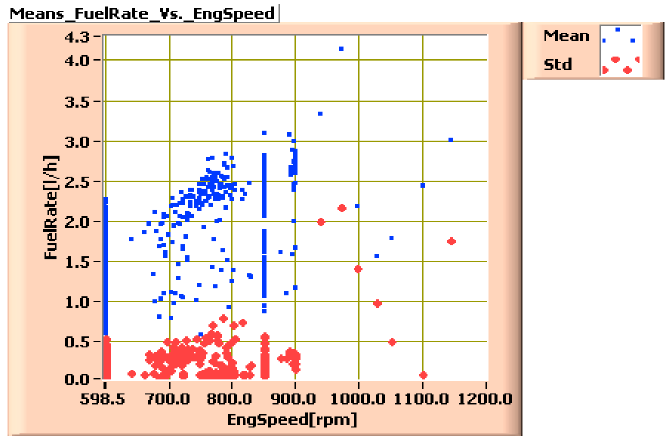

Figure 3—Means and standard deviations of the fuel consumption rate for each of truck No. 1's idling events as a function of the mean engine RPM.

of a duty cycle of interest to the user. For example, the user can specify road grade, weight, weather conditions, type of highway, etc. For the selected parameters, the tool will select all time periods out of the collected data, which match the selected user specifications. Once these multiple segments are compiled, and the user indicates the length of the duty cycle required, the multiple segments are statistically combined to provide a characteristic duty cycle that conforms to the user's specifications, and that is based on real-world performance. Figure 4 shows a characteristic short-duration duty cycle engaged in by Truck#1. Only vehicle speed and road profile are shown for clarity.

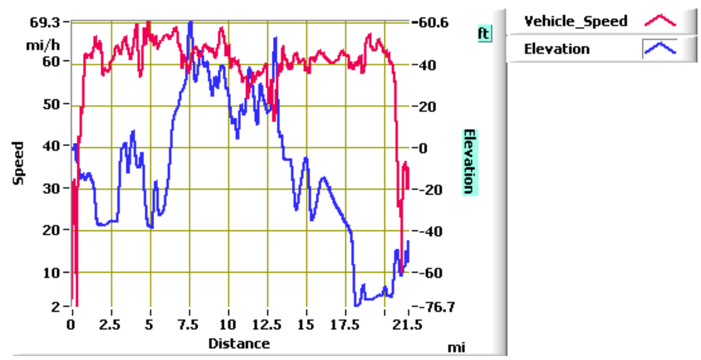

Figure 4—A characteristic short-duration duty cycle for Truck No. 1.

FUTURE DIRECTIONS

Future directions for this work will be to enrich the database with data that provides greater breadth and depth to analysis capabilities. That is, to collect and analyze data on other vehicle types (e.g., Class-6 vocational applications), situational circumstances, operational protocols, etc. Such a capability would be a valuable national asset for heavy truck energy efficiency research. Inclusion of safety data and information might also be a long-term goal that could receive cross-agency attention and support.

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