

Truck Duty Cycle and Performance Data Collection and Analysis Program

(the Medium Truck Duty Cycle – MTDC and Large Scale Duty Cycle – LSDC Projects)



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KNOXVILLE
AREA TRANSIT



**FOUNTAIN CITY
WRECKER
SERVICE**



Oak Ridge National Laboratory

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**Project ID #
VSS002**



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Overview



Timeline

- Project start date: March, 2008
- Project end date: September, 2012 (+)
- Percent complete: 50%

Budget

- Total project funding
 - MTDC
 - DOE share: \$1.76M (\$0.86M received to date)
 - Partner share: \$1.40M (\$0.93M received to date)
 - LSDC
 - DOE share: \$4.8M (\$0.09M received to date)
 - Partner share: \$1.2M (\$0.00M received to date)
- Funding received in FY09
 - MTDC (\$0.32M)
 - LSDC (\$0.00M)
- Funding Expected in FY10
 - MTDC (\$0.52M)(\$0.33M received to date)
 - LSDC (\$0.15M) (\$0.09M received to date)

Barriers

- **Barriers addressed**
 - Obtaining Voluntary Fleets for Data Collection
 - Obtaining Inter-Agency Cooperation for Leveraged Funding
 - Getting Data Into Industry

Partners

- H. T. Hackney (Class-7 Combination Trucks)
- Knoxville Area Transit (Class-7 Transit Busses)
- Federal Motor Carrier Safety Administration (FMCSA) (wireless technologies for data download, brake and tire performance data on Hackney vehicles)
- Dillard Construction Company (Class-7 Utility Truck – for PTO data)
- Fountain City Wrecker Service (Class-7 Towing and Wrecker)
- Project lead: ORNL

Objectives: Collect and Analyze Real-world Heavy- and Medium-truck Duty Cycle and Performance Data to Support: PSAT/Autonomie Modeling, DOE Technology Investment Decisions, Heavy and Medium Truck Fuel Efficiency Research, and Outreach to Other Federal and Private Stakeholders.

Relevance:

Modeling Efforts:

- ✓ Support PSAT/Autonomie modeling and validation with data from real-world operations. Sufficiently ground modeling efforts with commercial vehicle operations and experience.

Decision Making:

- ✓ Provide a sound basis for future DOE research and technology investment decisions for heavy- and medium-trucks. Decisions can be made based on real-world operations and performance.
- ✓ Provide baseline data for 21CTP technologies & SuperTruck evaluation.

Relevance (continued) :

Research:

- ✓ Provide realistic duty cycles to evaluate energy efficiency benefits of new and emerging energy efficiency technologies. Energy efficiency (EE) is highly dependent on duty cycles (velocity vs. time), and operational characteristics (weight, grade, congestion, idling, weather, highway-type, etc.).
- ✓ Conduct special real-world-based energy efficiency studies for DOE (e.g., EE and weight, speed, type of highway, etc.). For a particular vocation, what is the within-vocation variance of the associated duty-cycles?
- ✓ Provide a significant database of heavy- and medium-truck real-world operations experience to support research and development. The database for long-haul operations, and now for class-7 combination tractor-trailers and transit busses (and next year for utility trucks and towing & wrecker services is the largest in the world (currently 490 Gbytes of data).

Relevance (continued) :

Outreach:

- ✓ **Develop tools capable of demonstrating the EE benefits of new and emerging technologies based on collected duty cycle data. For example: For a particular duty cycle, technology “T” can provide a fuel savings of “S.” What EE technologies would be good for a particular carrier to invest in given a particular duty cycle – supports earlier adoption of such technologies.**
- ✓ **Seek leveraged funding from other federal agencies (DOT, EPA), other major Programs (VIUS, FAF), and private industry. FMCSA collected 20 channels of data at 5Hz for 12 months on brake and tire performance from the H.T. Hackney vehicles.**

Technical Objectives

- Primary Technical Objectives (past year)
 - Signed MOUs with H. T. Hackney & KAT.
 - Partnership with FMCSA. (wireless technologies, brake & tire performance).
 - Collected data on class-7 combination and transit vehicles (200 Gbytes).
 - Support PSAT/Autonomie development efforts with HTDC data.
 - Complete class-8 special study on fuel efficiency (paper presented at TRB in January 2010).
 - Seek to establish energy efficiency technology assessment corridor.
 - Seek to establish a Large Scale Duty Cycle (LSDC) Project (duty cycle and selected performance data from 5,000+ vehicles – inexpensively).



Commercial Motor Vehicle Roadside Technology Corridor

A series of fixed and mobile state-of-the-art facilities for testing and evaluating CMV enforcement technologies in a real-world setting

"The goal of this long-term collaborative effort among FMCSA, TDOS, TDOT, ORNL and UT is to develop and promote advanced truck and bus safety inspection and enforcement technologies to save lives."

Benefits

- Provide Quantitative Assessments of Technology Benefits and Costs
- Support Technology Deployment Decisions
- Expedite Technology Testing Process
- Flexibility to Address Multiple Technology Types
- Test-bed for Truck and Bus Vehicle Infrastructure Integration (VI) safety applications

Field Operations Testing
Wireless for Truck and Bus Safety

60000
81

40

75

OAK RIDGE
NTRC

The University of Tennessee

Knox County Inspection Stations

2007 Sogion 1 Headquarters

Active testing of infrastructure-based technologies at Inspection Stations

Benchmark testing
Hardware-in-the-loop testing
Driving simulator testing
Real course testing

TDOT

OAK RIDGE

UT

FY-2009 and FY-2010 Milestones

FY-2009

- **Establish MOUs with fleets representing selected vocations; December 2008.**
- **Modify/upgrade data acquisition systems for application to MTDC, December 2008.**
- **Seek a DOE/DOT/EPA joint effort → DOT = Successful; EPA → still working.**
- **Design & tested a wireless data download system; January 2009.**
- **Developed an automatic data downloading capability; February 2009.**
- **Instrument and test data acquisition systems on six test vehicles; February 2009.**
- **Initiate the collection of data on class-7 combination and transit vehicles (Phase-1 of 2); March 2009.**
- **Conduct MOU signing with H. T. Hackney and KAT; July, 2009.**
- **Completed class-8 speed/energy efficiency study; September, 2009.**

FY-2010

- **Initiate LSDC Feasibility Study; October 2009.**
- **Complete Phase-1 MTDC data collection; March 2010.**
- **De-instrument Phase-1 test vehicles; March 2010.**
- **Initiate crosscutting analysis of MTDC Phase-1 data; March 2010.**
- **Recalibrate Data Acquisition Systems for Phase-2 MTDC test vehicles; May 2010.**
- **Instrument MTDC Phase-2 test vehicles; July 2010.**
- **Conduct MOU signing with Dillard Construction Co. and Fountain City Wrecker Services; July 2010.**
- **Initiate MTDC Phase-2 data collection; August 2010.**
- **Complete MTDC Phase-1 Final Report; September 2010.**
- **Complete LSDC Feasibility Study Report; September 2010.**
- **Complete crosscutting analysis of MTDC Phase-1 data and prepare a TRB paper.; September 2010**
- **Support Multi-Agency Commercial Motor Vehicle Research Information Sharing and Partnerships (on-going)**

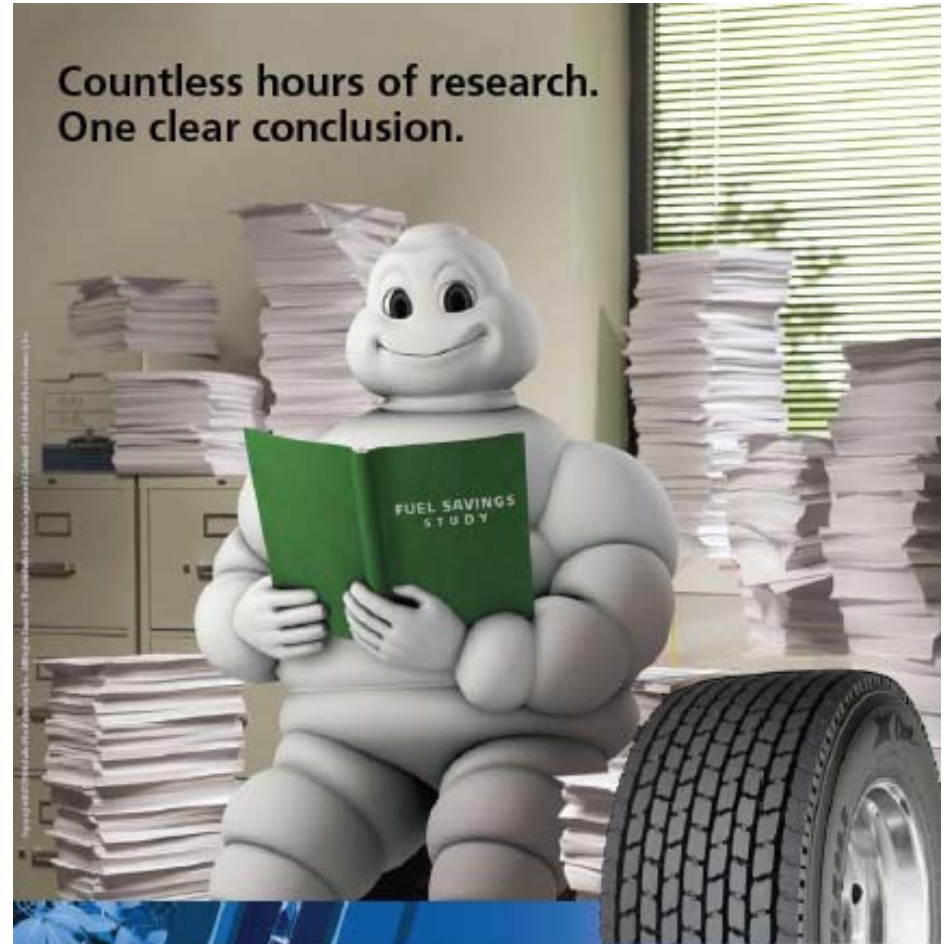
Approach and Unique Features

Collect real-world heavy- & medium-truck duty cycle and performance data from operating fleets and make data, information and analyses available to DOE and research partners

- Identify relevant performance measures (location, speed, fuel consumption, gear, grade, time-of day, congestion, idling, weather, weight, etc.; note – no emissions data)
- Design/test a data acquisition system to collect identified performance measures (field hardened & tested, able to interface with on-board databus and other sensors, communicates data wirelessly/daily/securely)
- Find fleets willing to participate **without direct funding**. Incentives: better introspective data to improve fuel efficiencies, public exposure, public goodwill.
- Instrument and “shake-down” test vehicles.
- Manage data in a cost effective and secure manner (**automatic quality assurance programs to look for data that is out-of-range, missing data, etc.**)
- Develop specialized data manipulation and analysis software (**prototype real-world-based duty-cycle generation tool – DCGenT**)
- Outreach to other agencies/programs for cost leveraging (**DOE/DOT partnership agreement on MTDC**)

Approach and Unique Features

- Conduct specialized studies (EE vs. Speed), (EE vs. Weight vs. single/dual tires).
- ORNL presented a peer-review paper at the Transportation Research Board (TRB) Annual Meeting in January 2010 entitled “Effect of Tires on Class-8 Heavy Truck Fuel Efficiency.” The paper was authored by Oscar Franzese, Bill Knee and Lee Slezak. The paper will be published in the TRB proceedings.



Countless hours of research.
One clear conclusion.

A new study confirms wide single tires are more fuel-efficient.

A four-year study sponsored by the U.S. Department of Energy's Vehicle Technologies Program, conducted by Oak Ridge National Laboratory, verifies what we've been saying for years—wide single tires can save you up to 10 percent in fuel. The 383-page report found that wide single tires like MICHELIN® X One™ tires are more fuel-efficient than duals on heavy trucks, saving 6 percent overall and 10 percent with a fully loaded tractor trailer. So the more you haul, the more you save.

To read the study for yourself, visit www.michelintruck.com. Michelin®. Improving your bottom line through innovation. Now that's a better way forward.



Major Technical Accomplishments, Progress & Results

- Completed MTDC Phase-1 Data Collection/Completed Brake and Tire Performance Data Collection for FMCSA (200 Gbytes) of data.
- Initiated Crosscutting Analysis of MTDC Phase-1 Data.
- Example Initial Results:



: 45K miles (note – regional operation, 8-9 hours/operating day); 18% of operation involves idling; 61% of this idling is in congestion; moving MPG = 7.7; overall MPG = 7.6.



: 49K miles (3 different routes, city circumference, downtown, across-town); 51% of operation involves idling; 30% of this idling is in congestion; 26% of this idling is for 4 hours or more; moving MPG = 5.6; overall MPG = 4.3 (Idling reduces MPG by 23%).

- Completed EE Analysis of the use of wide-based tires by class-8 trucks in long-haul operations (6% overall fuel savings, 10% fuel savings if maximum GVW).
- Jointly conducted MTDC Phase-1 providing real-world data for DOE and DOT/FMCSA.

Collaboration and Coordination with Other Institutions

Partners

- **DOT – Federal Motor Carrier Safety Administration (FMCSA)**
 - Piggybacked on the MTDC effort to collect brake and tire performance. They paid their way and we built on their Wireless Roadside Inspection technologies to download data wirelessly.
- **ANL**
 - Provided duty cycle and associated data for PSAT/Autonomie development and evaluation.
- **H. T. Hackney – Test fleet**
 - Provided free access to three class-7 tractor-trailers.
- **KAT – Test fleet**
 - Provided free access to three class-7 transit busses.
- **Dillard Construction Company – Test fleet**
 - Will provide free access to three class-7 Utility Trucks with Power-Take-Off (PTO) capabilities.
- **Fountain City Wrecker Service – Test fleet**
 - Will provide free access to three class-7 Wrecker-Towing Trucks.
- **DOT Federal Highway Administration (FHWA)**
 - Interested in detailed analysis of fuel efficiency vs. speed, grade and payload.
 - In discussions about support for the new VIUS Project.

Future Work

- **FY10**
 - **Initiate MTDC Phase-2 data collection.**
 - **Complete MTDC Phase-1 crosscutting analysis.**
 - **Complete MTDC Phase-1 final report and LSDC feasibility study report.**
 - **Complete LSDC conceptual design report.**
 - **Seek to start real-world data collection on trucks that are HEVs, PHEVs and Evs.**
- **FY11**
 - **Initiate LSDC pilot study (low cost DAS for duty cycle data collection across vocations).**
 - **Complete collection of Dillard Construction and Fountain City Wrecker Service data.**
 - **Analyze MTDC Phase-2 data.**
 - **Seek partnership with EPA to synthetically generate emissions data for HTDC and MTDC databases.**
 - **Conduct LSDC Pilot Test**
 - **Start to conduct regular energy efficiency analyses on MTDC and HTDC data per DOE's needs and requests from industry.**
- **Beyond**
 - **Develop MTDC and HTDC public website for summarized and analyzed data.**
 - **Seek to broaden the data collection suite to include aerodynamics, parasitic energy losses, rolling resistance measures, and emissions.**
 - **Conduct large-fleet data collection on 5,000 vehicles across multiple vocations.**
 - **Complete the Duty Cycle Generation Tool with the capability of estimating energy demand estimator that includes truck-based energy demands based on real-world events such as idling, coasting, congestion, etc.**

Summary

- The MTDC (and HTDC) efforts are producing a rich database of duty cycle and vehicle performance data that is available nowhere else in the world.
- Duty cycle data has been provided to ANL to support PSAT/Autonomie modeling efforts for class 7 and 8 trucks.
- Cross-agency cooperation and partnerships (DOE/VTP and DOT/FMCSA) demonstrate a win-win situation.
- More cooperation with DOT/FHWA is expected (EE vs. speed, grade, weight; and VIUS).
- Feasibility study for a large scale, low-cost duty cycle effort is being conducted to assess within-vocation duty cycle variability.
- Much data has been collected, and some analyses have been conducted. More analyses should be done.
- Methods for synthetically generating emissions data are being discussed – EPA may be interested.