CRC Report No. CM-138-15-2

Development of an Engine Based Test for Determining the Effect of Spark Ignition Fuel Properties on Combustion and Vehicle Driveability

March 2020

The Coordinating Research Council, Inc. (CRC) is a non-profit corporation supported by the petroleum and automotive equipment industries. CRC operates through the committees made up of technical experts from industry and government who voluntarily participate. The four main areas of research within CRC are: air pollution (atmospheric and engineering studies); aviation fuels, lubricants, and equipment performance; heavy-duty vehicle fuels, lubricants, and equipment performance (e.g., diesel trucks); and light-duty vehicle fuels, lubricants, and equipment performance (e.g., passenger cars). CRC's function is to provide the mechanism for joint research conducted by the two industries that will help in determining the optimum combination of petroleum products and automotive equipment. CRC's work is limited to research that is mutually beneficial to the two industries involved. The final results of the research conducted by, or under the auspices of, CRC are available to the public.

Report FEV312504

Development of an Engine Based Test for Determining the Effect of Spark Ignition Fuel Properties on Combustion and Vehicle Driveability

Coordinating Research Council, INC.

Submitted by FEV Inc:

Alan Zavala
FEV North America, Inc.
4554 Glenmeade Lane
Auburn Hills, MI 48326
Zavala@FEV.com

Table of Contents

Tables and Figures

Appendix

Development of an Engine Based Test for Determining the Effect of Spark Ignition Fuel Properties on Combustion and Vehicle Driveability

Abstract

Cold-start driveability is an important internal combustion engine characteristic that is directly affected by fuel properties. In order for a spark ignition engine to start reliably and operate consistently with good performance the fuel should have adequate properties that allow for stable combustion. The fuel measurement that estimates cold start driveability performance is the ASTM 4814D Driveability Index (DI) which is calculated from the fuels distillation temperatures (DI = 1.5*T10+3*T50+T90). While the effects of hydrocarbons in gasoline fuels are well indicated by the DI equation, the addition of ethanol to gasoline depresses the T50 of the fuel to a varying degree, requiring the DI equation to have ethanol corrections for a representative Driveability Index. Previous CRC studies have documented the effects of ethanol additions to gasoline blends on cold start driveability performance leading to empirical ethanol correction factors in the DI calculation.

These previous CRC test programs have looked subjectively at vehicle responses to changes in fuel driveability index, primarily by trained raters in large scale fleet testing programs. The expense and complexity of evaluating fleets of vehicles under controlled ambient temperatures at a test track, coupled with the impending shortage of trained raters has produced the need for a more objective test approach with instrumented vehicles that could be an alternative to the traditional fleet testing and driver rating method. This study is an attempt to answer five questions. Do vehicles still respond adversely to high DI fuels? Can this be detected with instrumentation? Can the response be quantified with instrumentation? What instrumentation is needed? How do the vehicles respond to high DI splash blended ethanol fuels?

Using heavily instrumented vehicles in climate controlled chassis dyno chambers, this study has correlated DI properties of known test fuels with in-cylinder measurements of poor combustion events, which are the root cause of any irregularities in vehicle driveability. Recording supporting engine management system parameters has helped with the fundamental understanding of how differing test fuels can impact overall vehicle cold start driveability and system adaptability in a controlled and repeatable manner. This objective and repeatable approach can be used to generate the data necessary for the detailed comparative analysis across various programs that would help to further develop fuel standards. In summary some of the primary findings of the report conclude:

- Modern vehicles with GTDI engines still respond adversely to high DI fuels showing that despite advances in engine technology, fuel volatility standards are still relevant and essential for cold-start driveability performance.
- Vehicle instrumentation is able to capture and characterize test fuel driveability effects and important driver evaluations are backed by measured data.
- Ethanol blended fuels can have an enleanment effect that goes uncorrected until closed loop air fuel control. During the enleaned combustion, the engine is more prone to misfire events, hesitation and subsequently driveability degradation.
- Factors that determine time to closed loop air fuel control vary and can be attributed to O2 sensor heating characteristics, exhaust system packaging and design, and the engine management system.
- Vehicle response and adaptation to poor combustion events caused by the test fuels varied differently across the vehicles tested and can be attributed to engine management system controls, adaptations and calibration differences.

I. Introduction

Driveability can be defined as the consistent and smooth response from a vehicle in response to driver input. Poor driveability is associated with difficult engine starts, rough idle, misfires, surging, hesitation and insufficient power, all of which can be affected by fuel characteristics (Yanowitz & McCormick, 2016). Once an engine starts the gasoline fuel must vaporize, inside the combustion chamber, to ensure acceptable levels of combustion stability for warm-up driveability performance. Driveability issues may arise due to insufficient fuel vaporization in cold engine combustion systems. Insufficient fuel vaporization may cause lean combustion leading to irregularities such as misfires that are noted by the driver as a lack of vehicle response.

Starting in 2011, EPA regulations allow fuel manufacturers to introduce up to 15% ethanol by volume into gasoline ethanol blends for use in model year 2001 and newer light duty vehicles. In 2019 EPA further granted E15 fuels the same 1psi vapor pressure summer ozone control waiver as E10 fuels to promote the growth of biofuel consumption (EPA, 2019). The addition of ethanol to gasoline produces a fuel blend that changes the properties of the fuel and effects subsequent in-cylinder combustion.

Concentrations of ethanol (up to 20%) in gasoline affect blended fuel properties in relation to fuel vaporization and driveability in the following ways (Reddy, 2016):

1.) Increased fuel vapor pressure (DVPE) occurs as ethanol forms a non-ideal solution with gasoline. This can increase the front end volatility and help engine startability and driveability.
2.) Increased heat of vaporization and charge cooling due to higher HOV of ethanol relative to gasoline. At low temperatures this can hinder fuel vaporization causing poor warmup air/fuel mixtures that can lead to driveability issues.
3.) Increased lower flammability limit of fuel vapors, due to higher flammability limits of ethanol compared to gasoline, will decrease fuel ignitability and negatively affect cold start driveability.

Taking into account the ethanol's effect on the distillation curve (depressing the T50 boiling point) ASTM has added empirical ethanol offsets into the DI equation to account for this effect and still retain accurate DI properties for blended fuels. However it has been noted in previous studies that predicting the T50 depression caused by ethanol in the blend stock fuel is challenging and T50 depression varies widely across fuels. Therefore regression method based ethanol offsets in the DI calculation may not correlate well to ethanol blended fuels that were not used in the driveability test programs.

Using heavily instrumented vehicles with data acquisition systems, it was the primary goal of this study to develop a test procedure to understand the driveability performance of several different mass market vehicles with the latest Gasoline Turbo Direct Injection technology. This procedure is not exclusive to GTDI engines but can also be used on a wide variety of mass market vehicles. The driveability tests were conducted with well documented high DI test fuels using a test cycle that was used in previous CRC fleet testing programs (CRC report 666). With the instrumented vehicles, the acquired data can be analyzed to see how the vehicles respond to high DI fuels including splash blended ethanol fuels and the subsequent fuel effects on vehicle driveability performance.

These heavily instrumented vehicles come from the USCAR engine benchmark consortium's research activities and typically feature the latest gasoline engine technologies with temperature, pressure and combustion analysis data acquisition systems setup in the vehicle. With the acquired data it can be possible to detect and quantify the vehicle driveability in response to high DI test fuels and provides an alternative for future fuels performance testing.

The objectives of this program are:

- Document the instrumentation and testing procedure for these vehicles.
- Analyze instrumented results coupled with driver impressions and conclude whether high DI fuels still adversely affect modern GTDI engines.
- Determine if instrumentation can detect the effects of high DI fuel on vehicle driveability.
- Quantify fuel effects on vehicle driveability with metrics.
- Determine if ethanol blended fuels have an effect on driveability performance.

II. Test Vehicle and Instrumentation Overview

The test program consisted of testing fully operational heavily instrumented vehicles in a climate controlled chassis dynamometer. The vehicles were sourced from the USCAR engine benchmark consortium's research activities with their approval. Typically, the USCAR engine benchmark program selects competitive vehicles with the latest engine technologies for in-depth review. A series of instrumented vehicle and engine dyno tests are done to measure the capabilities of the selected vehicles. Several vehicles were made available for CRC testing following the USCAR testing activities. This allowed for a cost effective approach by enabling CRC to test available late model vehicles with full data acquisition equipment already installed. Additionally, the benchmarking activities provide insights into cold start strategies and vehicle sensitivities to fuels before CRC testing is conducted. These insights provide bases for recommendations on potential vehicles suited for CRC testing.

The test vehicles conducted as part of this program in order are as follows:

1. 2016 Honda Civic 1.5L GTDI
2. 2017 Ford F-150 3.5L GTDI+PFI
3. 2016 Mazda CX-9 2.5L GTDI with EGR

The vehicles featured both time based and crank angle based combustion analysis data acquisition systems that allow for real time monitoring of vehicle operation parameters during CRC testing. Full powertrain removal is necessary for full instrumentation setup.

The data acquisition systems include 1/16'' K-type thermocouples, static and dynamic pressure transducers; stand-alone wideband AFR sensors, ECU signal sampling equipment and high resolution crank angle encoder based measurements. Figure 1 and Figure 3 shows the Honda Civic used in this study fully instrumented and with data acquisition systems in the vehicle trunk. Figure 2 shows the crank angle encoder on the Mazda CX-9 engine. Typically the vehicles would include these critical measurements:

- In-cylinder pressure transducers for combustion measurements (all cylinders)
    - IMEP - Indicated Mean Effective Pressure (Bar)
    - PMEP – Pumping Mean Effective Pressure (Bar)
    - NMEP- Net Mean Effective Pressure (Bar)
    - CA50 – 50% Fuel Mass Fraction Burn Location (degrees CA ATDC)
    - Peak Pressure – Peak Combustion Pressure (Bar)
    - Peak Pressure Location- Peak Combustion Pressure Location (degrees CA ATDC)
    - Max Rise Rate- Combustion Maximum Pressure rise rate (Bar per degrees CA)
- Fuel injection timing and duration (cylinder 1 only) (degrees crank angle ATDC)
- Ignition timing (cylinder 1 only) (Degrees crank angle ATDC)
- Fuel Pressure (DI system and low pressure supply system) (Bar)
- Ambient air temperature (°C)
- Engine coolant in/out temperature (°C)
- Engine oil sump temperature (°C)
- Exhaust Turbine Inlet/Outlet and Catalyst temperatures (°C)
- Ambient air pressure (kPa Absolute)
- Intake manifold pressure(kPa Absolute)
- Stand-alone exhaust air fuel measurement (Wideband O2 sensors installed next to OEM O2 sensor) (Unit is Lambda)
- Pedal position (%)
- Turbocharger Wastegate Position (% Open)
- Throttle position (% Open)
- EVAP purge solenoid activation (% Duty Cycle)
- OBD-II CAN measurements
    - Short/Long Term Fuel Trims (if available at acceptable update rates) (%)
    - ECT (°C)
    - Ignition Timing (Degrees crank angle BTDC)

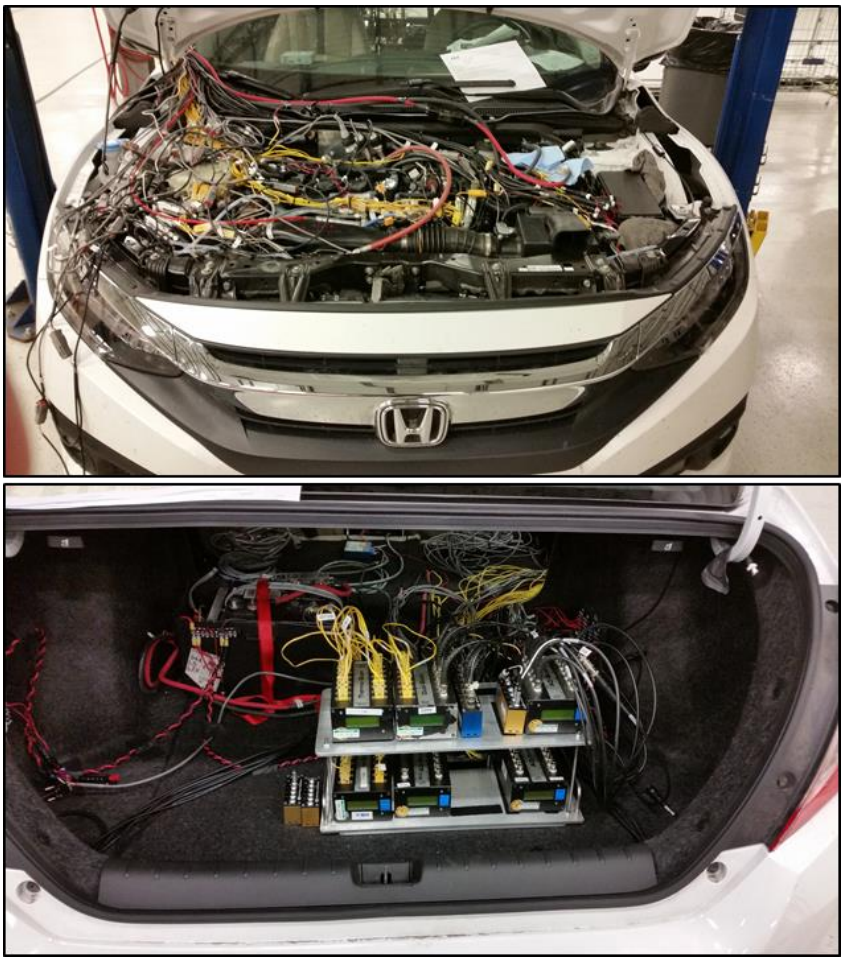


Figure 1. 2016 Honda Civic With Full Instrumentation Installed

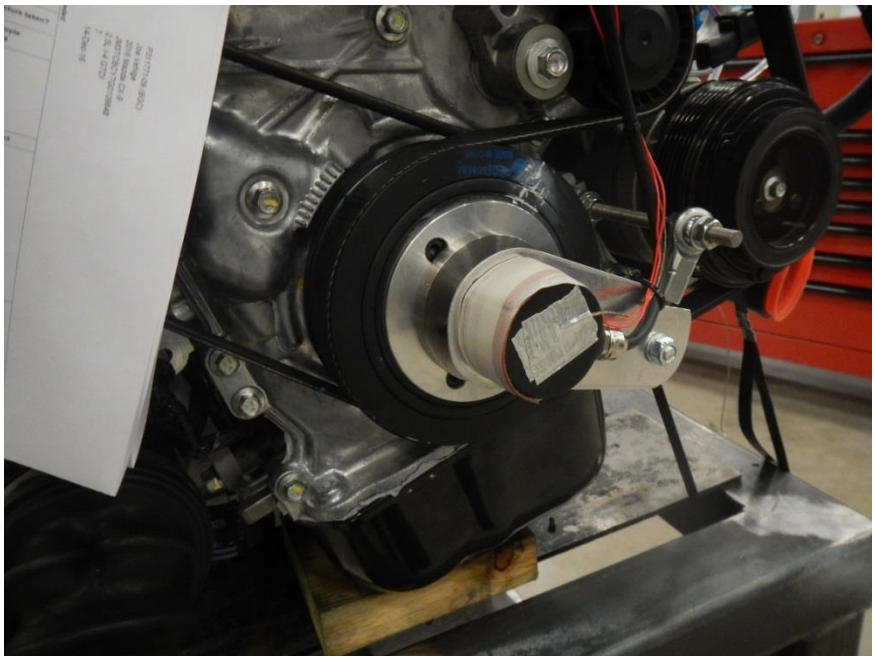


Figure 2. High Resolution Crank Angle Encoder Used on Mazda CX-9

III. Test Fuels

The original test fuels used were supplied by Haltermann Solutions and provided by CRC for tests conducted on the Honda Civic and Ford F-150. There was a medium DI E0 (DI ~ 1150 °F), a high DI E0 (DI ~ 1250 °F) and a very high DI fuel (DI ~ 1350 °F) and E15 and E30 splash blends of these fuels for a total of 9 candidate fuels. A resupply of re-blended fuel was used for the Mazda CX-9 testing; this was supplied by Gage products. It is noted that there is slight differences in the resupplied fuel blend that could have impacted vehicle driveability performance particularly with the CE15 reblend fuel. In addition to the fuel inspection properties supplied by the fuel supplier, samples of the test fuels were also independently inspected by Marathon Petroleum, Chevron and BP. The full inspection summary of both the original and resupplied re-blends is available in Appendix A.

Initial vehicle testing on the Honda Civic commenced with a high DI (1266 °F) hydrocarbon base fuel (B0 TR2335)in order to measure vehicle response and move to either a higher DI rated fuel or a lower DI rated fuel.

For this program in all cases the succeeding fuel was the higher DI rated hydrocarbon fuel (C0 TR2338 or TR2338A in the case of the Mazda), due to all vehicles measuring light driveability degradation in response to the B0 fuel. Following the C0 TR2338 high DI (1358°F) hydrocarbon fuel, splash blended ethanol (15% and 30%) fuels with C0 as the base blend stock were used to compare and analyze results. All fuels tested had 3 tests conducted to establish repeatability of results. For each complete test sequence four fuels were used with 3 repetitive tests for a total of 12 tests per vehicle. A summary of averaged fuel volatility properties and corresponding distillation curves from the fuel inspections are shown in Table 1 and Figure 4 below for the original Haltermann supplied test fuels used in vehicle testing. The resupply Gage fuel volatility properties are distinguished with the “A” letter at the end of the fuel name e.g. B0 TR2335A. The resupplied Gage fuel inspection volatility property averages and distillation curves are shown in Table 2 and Figure 5. An easy to view comparison table between the original and reblended fuel inspection property averages is available in Appendix B – Average Fuel Inspection Properties Original and Reblend Comparison Table.

CRC 2016 CM-138-15-2 Fuel Inspections

Fuel Code			B0 TR2335	C0 TR2338	CE15 TR2339	CE30 TR2340
Property	ASTM Test Method	Units				
API Gravity@60°F	D1298/D287	API	54.5	54.8	53.3	52.4
Density @ 15°C	D1298/D287	kg/L	0.7604	0.7595	0.7633	0.7692
Ethanol Content	D5599	vol %	0.0	0.0	15.2	30.8
DVPE Vapor Pressure	D5191	psi	8.9	8.7	9.6	9.0
Temperature V/L=20 (TVL20)	D5188	°F	137.0	140.4	126.3	130.8
Temperature V/L=20 (TVL20) Calculated	D4814		143.3	150.2	137.6	134.0
Driveability Index Uncorrected	D4814	°F	1266.1	1358.2	1282.4	1066.5
D86 Distillation	D86					
Initial Boiling Point		°F	85.9	83.0	88.7	90.7
5% Evaporated		°F	110.8	108.9	118.0	123.9
10% Evaporated		°F	125.3	126.6	129.9	137.9
20% Evaporated		°F	152.1	165.2	148.8	156.5
30% Evaporated		°F	185.3	213.1	160.6	165.1
40% Evaporated		°F	219.1	247.1	166.9	168.7
50% Evaporated		°F	238.0	267.2	242.4	170.9
60% Evaporated		°F	252.9	285.7	270.7	172.8
70% Evaporated		°F	273.7	306.6	296.0	272.0
80% Evaporated		°F	315.8	329.1	320.1	305.6
90% Evaporated		°F	364.0	366.6	360.3	347.0
95% Evaporated		°F	385.8	387.0	383.8	376.4
Final Boiling Point		°F	409.6	409.5	407.8	401.2

Table 1. Averaged Test Fuel Volatility Properties Summary (Original Haltermann Fuels)

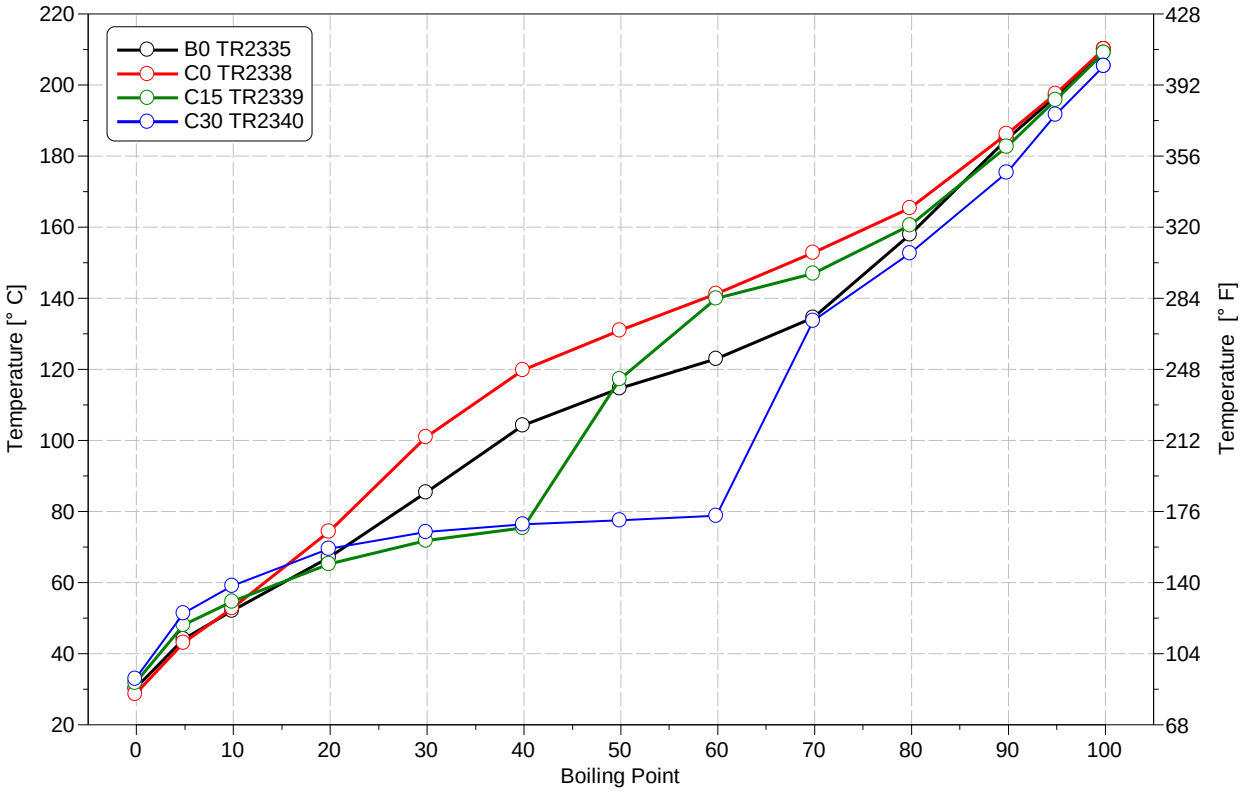


Figure 3. Original Test Fuel Distillation Curves (plotted from averaged fuel inspection D86 distillation))

CRC 2018 CM-138-15-2 Reblended Fuel Inspections

Fuel Code			B0 TR2335A	C0 TR2338A	CE15 TR2339A	CE30 TR2340A
Property	ASTM Test Method	Units				
API Gravity@60°F	D1298/D287	API	52.2	53.1	52.1	51.2
Density @ 15°C	D1298/D287	kg/L	0.7692	0.767	0.7704	0.7743
Ethanol Content	D5599	vol %	0.0	0.0	14.9	29.7
DVPE Vapor Pressure	D5191	psi	8.2	8.2	9.1	8.7
Temperature V/L=20 (TVL20)	D5188	°F	144.8	148.4	132.0	133.8
Temperature V/L=20 (TVL20) Calculated	D4814		147.0		134.8	
Driveability Index Uncorrected	D4814	°F	1278.8	1356.5	1099.5	1066.7
D86 Distillation	D86					
Initial Boiling Point		°F	90.8	89.4	93.0	95.8
5% Evaporated		°F	112.7	111.7	117.6	124.3
10% Evaporated		°F	124.9	126.2	127.9	134.1
20% Evaporated		°F	144.0	149.8	140.9	147.9
30% Evaporated		°F	164.8	178.0	151.1	158.0
40% Evaporated		°F	195.8	219.3	160.2	165.3
50% Evaporated		°F	242.3	266.1	181.2	169.5
60% Evaporated		°F	281.2	291.8	274.4	173.3
70% Evaporated		°F	306.4	313.8	303.0	281.8
80% Evaporated		°F	334.0	339.3	330.2	317.8
90% Evaporated		°F	364.5	369.0	364.0	357.0
95% Evaporated		°F	380.4	382.3	376.3	377.1
Final Boiling Point		°F	414.9	413.0	409.1	405.4

Table 2. Averaged Test Fuel Volatility Properties Summary (Resupply and Re-blended Fuels)

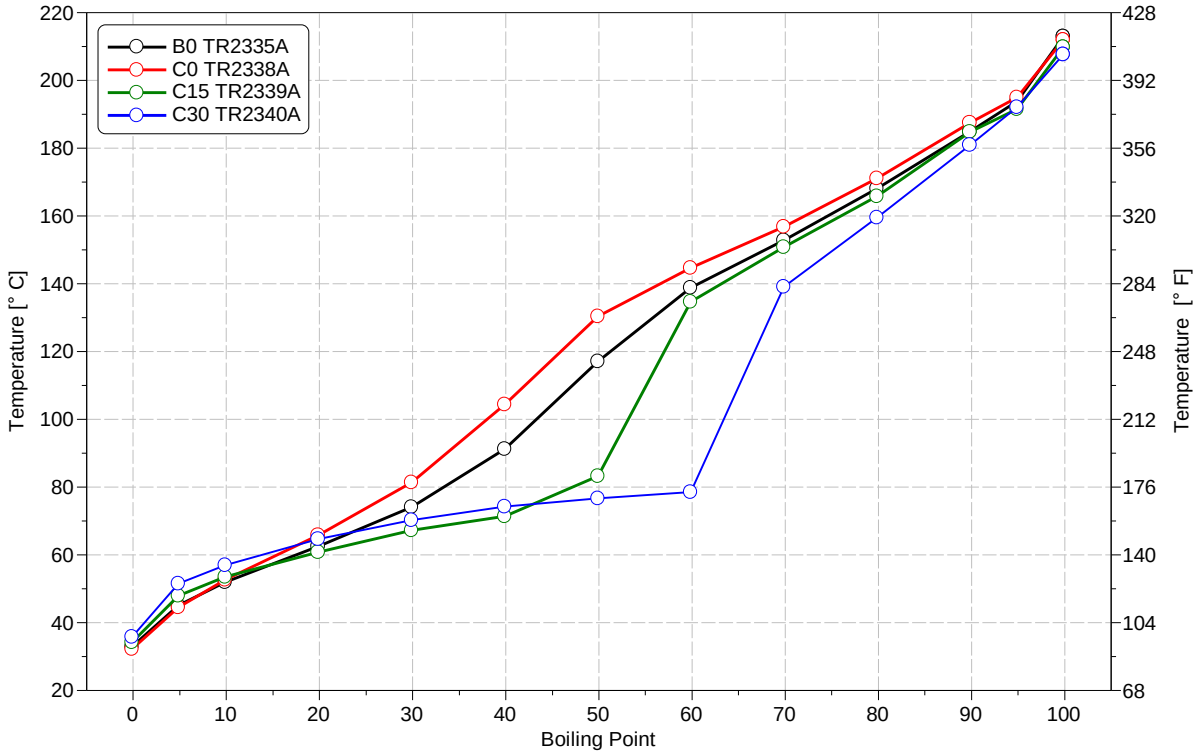


Figure 4. Replacement Test Fuel Distillation Curves (plotted from averaged fuel inspection D86 distillation))

Figure 5 below shows the original and resupply fuel distillation curves overlaid over each other for comparison, there is a noteworthy difference in the T50 point between the CE15 test fuels.

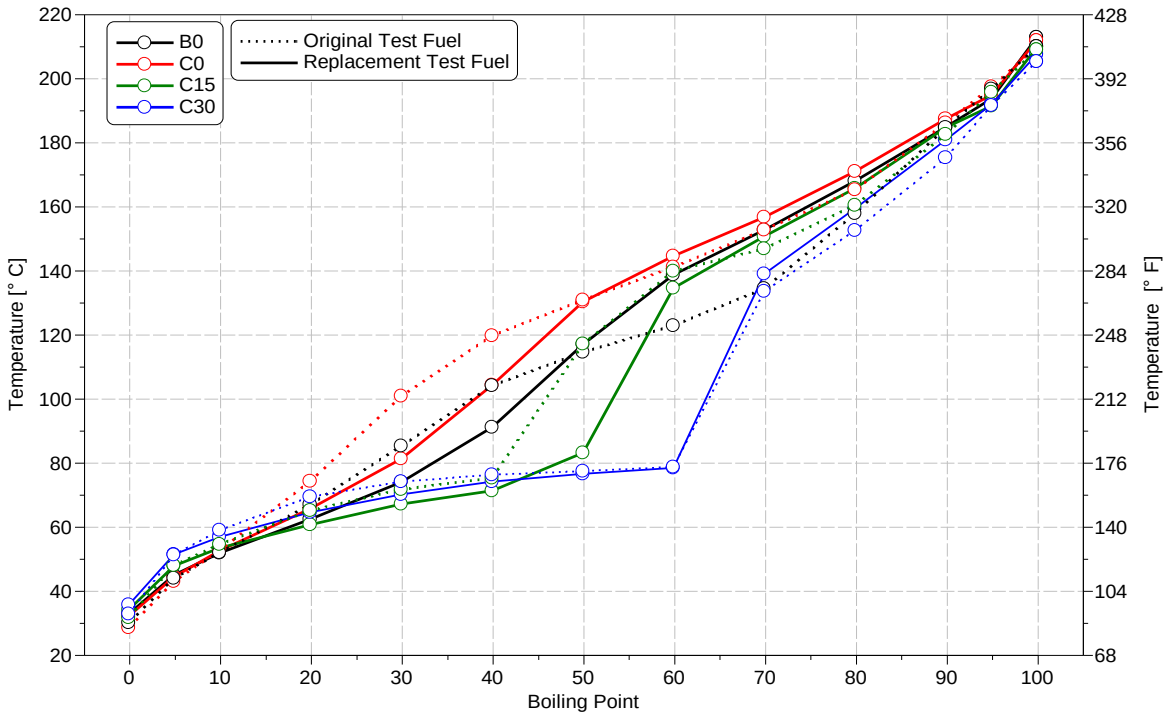


Figure 5. Comparison of distillation points between Original and Resupply test fuels

IV. Test Site

All testing was conducted at a climate controlled chassis dynamometer facility with controlled humidity and ambient temperature set at 40°F. Testing on the Honda Civic and Ford F-150 was conducted at EDP Technical Services Facility in Livonia, Michigan. Testing on the Mazda CX-9 was conducted at FEV's Vehicle Development Center in Auburn Hills, Michigan. All vehicles tested on the chassis dynamometers were road load matched using EPA emission certification road load coefficients pertaining to each particular vehicle. Each vehicle was also run in "dyno mode" using manufacturer specified procedures to disable ABS control in order to fully enable vehicle operation on a chassis dyno as is done in emissions certification testing.

Depending on drive train configuration and emissions certification procedures, the tested vehicles were tested in either FWD or RWD configuration.

Each facility featured forced cooling systems dedicated to the insulated chassis dyno chamber. This allowed for rapid cooling and conditioning for the testing of each vehicle. Additionally with controlled ambient conditions, external boundary conditions can be kept consistent between tests and vehicles allowing for repeatability of test results. Each facility also featured variable road speed fans to replicate frontal road wind speeds.

Since vehicle emission measurements were not part of this program scope all exhaust emissions were vented out of the facility using an exhaust chute. The driver also used a standard computer display with the specified drive cycle to follow on the dyno rolls.

The chassis dynamometer at EDP Technical services featured a Mustang Eddy Current controlled Dyno while the FEV Vehicle Development Center features a fully controlled AC current dyno. Since either chassis dyno is fully controllable to be able to match target road load coefficients and have ambient climatic control the testing done between facilities is directly comparable. This is also a motivation for future testing at facilities with these capabilities as the ambient conditions will be kept constant. Figure 6 and 7 below shows the Ford F-150 at EDP climatic chassis dyno chamber.

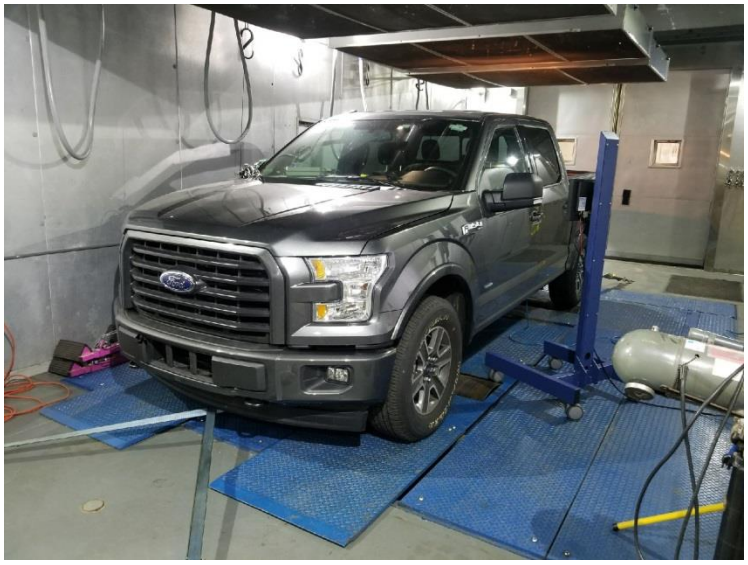


Figure 6. Ford F-150 Setup Inside Climate Controlled Chassis Dynamometer Chamber

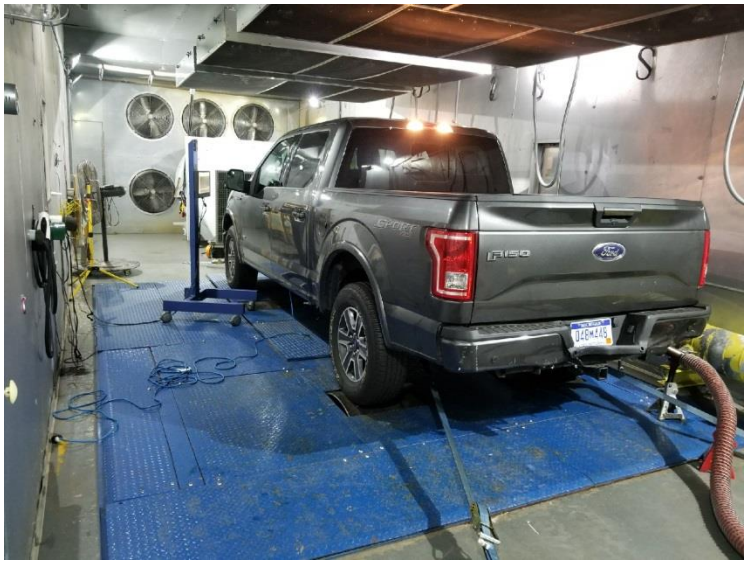


Figure 7. Ford F-150 setup inside climate controlled chassis dynamometer chamber rear view

V. Test Procedure

A. Fuel Drain and Change Over

A heavy emphasis on a thorough fuel changeover process to avoid fuel cross contamination between tests was part of the program scope. Initially a day tank setup was recommended by CRC to avoid any possibility of cross contamination. This day tank setup would be an auxiliary fuel tank accessible on the side of the vehicle that would bypass the main fuel tank and allow for quick and thorough test fuel changes. However the complexity of modern EVAP systems and on board fuel tank sensors would likely incur Diagnostic Trouble Codes in relation to an induced bypass in the fueling system with a day tank setup. Therefore FEV developed and validated a fuel drain procedure with additional instrumentation on the fuel system that ensured a complete fuel flush prior to the reintroduction of a new test fuel. In summary the procedure involved removing the OEM fuel tank from the test vehicle and instrumenting it with a dedicated drain at the lowest part of the tank. Depending on tank design sometimes two fuel drains were installed in the case of a saddle type tank. Figure 8 and 9 below shows setup for 2016 Honda Civic and is representative of the setups for all vehicles tested.

Figure 8. Fuel Tank Drain installation

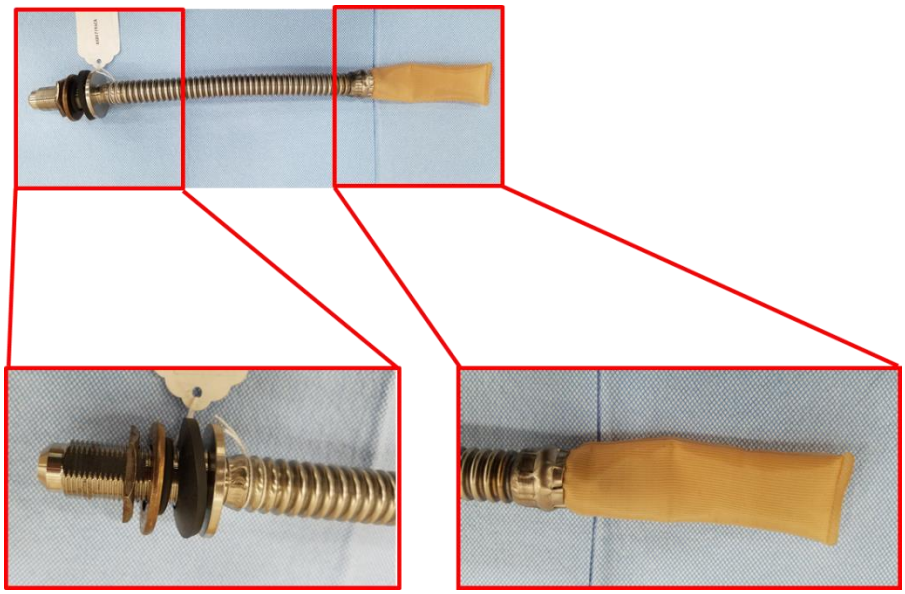


Figure 9. Special drain tube used to reach fuel in the lowest collection point of fuel tank

In addition to a complete fuel tank drain additional instrumentation points in the fuel system allow for draining of the low pressure fuel lines prior to the Direct Injection fuel pump as well as the high pressure direct injection fuel rail. All drain points used an auxiliary fuel pump to induce a vacuum drain at each fuel system drain point. A process flow of the fuel drain procedure going into vehicle prep prior to drive cycle testing is shown in Figure 10 below:

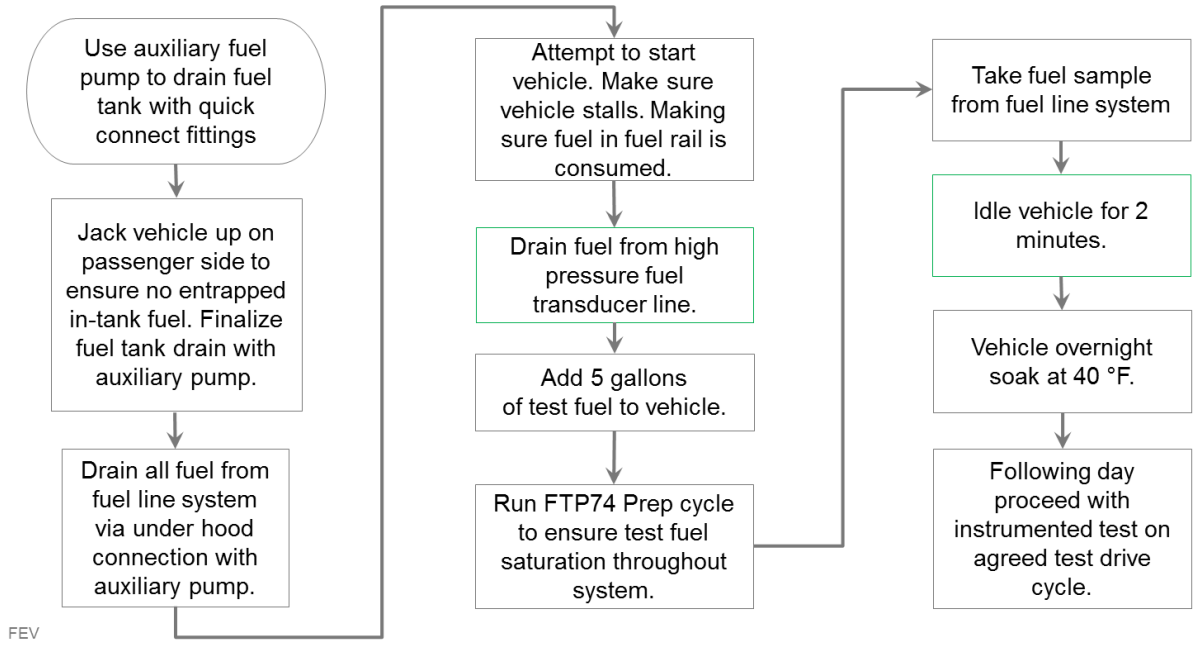


Figure 10. Fuel drain and vehicle prep procedure process flow

The fuel drain was validated by carefully quantifying the drain efficiency by volume by completely emptying the fuel system and measuring the fuel input and drain amount. The results are summarized in Table 3 below.

Fuel Drain / Refill Efficiency Study	Trial 1	Trial 2	Trial 3
Fuel In:	15,000 mL	15,000 mL	15,000 mL
Fuel Out (Fuel Tank Drain):	14,300 mL	14,320 mL	14,300 mL
Fuel Out (Under hood Fuel Drain):	510 mL	600 mL	580 mL
Total Fuel Out:	14,810 mL	14,920 mL	14,880 mL
Fuel Remaining in vehicle:	190 mL	80 mL	120 mL
Fuel Volume Drain Efficiency:	98%	99%	99%

Table 3. Fuel drain volume efficiency results

In addition to draining the fuel from the fuel tank and the low side fuel pressure (under hood fuel drain) it was later also found to be beneficial to drain the fuel from the high pressure direct injection fuel rail using the instrumented pressure sensor adaptor line. This would further increase the fuel volume drain efficiency; this step is captured in the fuel drain procedure outlined in Figure 10 and was used on all tested vehicles. Another important part of the procedure is after the fuel drain when all test vehicles underwent FTP74 prep cycles before cold ambient testing commenced; this served to baseline the vehicles consistently and also ensures any residual fuel left by the fuel drain is consumed

during the prep cycle, leaving only the intended test fuel for the first test. For fuel transportation each test fuel had newly furnished and dedicated fuel containers ensuring no fuel contamination during transport from the fuel barrel to vehicle fill occurred. It is also noted that during the start of the test following the cold soak the vehicle fuel system was naturally primed with the OEM fuel pump with no external alteration.

The intent of the CRC test program was to replicate previous CRC test program drive cycles from CRC report 666. In preparation for the drive cycle following the fuel drain procedure and the addition of test fuel, the vehicle was loaded on the chassis dyno. If needed, a road load derivation was run as well as an FTP74 drive cycle at 75°F. Ensuring a consistent baseline prep for all vehicles so that vehicle fuel adaptations were all subject to the same prep cycle procedure thus maintaining consistency across vehicles.

Following the FTP74 prep a fuel sample was drawn from the low side fuel pressure drain (at least 120ml for distillation analysis). The vehicle was allowed to idle for 2 minutes following this sample draw so as to avoid any air pockets developing in the fuel line system and adversely affecting start up and driveability on the following test cycle. After the fuel sample was drawn and vehicle idled the vehicle was shut off and the chassis dyno chamber was forced cooled to 40°F and the vehicle left overnight for a cold soak.

The following morning the vehicle data acquisition systems are powered on, monitored, recorded and the testing drive cycle is run. Following the three tests the remaining test fuel is drained using the developed fuel drain procedure and properly disposed. In preparation for further testing on a different test fuel the vehicles are filled with commercially available gas station pump fuel and the vehicle is driven on road in order to reset and normalize fueling adaptations. During this the fuel trims were monitored to ensure that fueling compensation was (+/- 5%) so as to baseline the fuel trim compensation system. In summary prior to each test fuel being introduced (prior to procedure outlined in figure 10), the vehicle fueling adaptations were reset or baselined with the appropriate commercially available gas station pump fuel. The fuel properties of the commercially available pump fuel were not collected and it was later found that resetting fuel trim adaptations with a factory scan tool was more effective than using pump fuel for fueling adaptation reset and baseline, however none of the vehicles tested used the scan tool method to reset fueling adaptations.

B. Original Drive Cycle

The original CRC report 666 drive cycle procedure is in Appendix C of this report. Figure 11 shows a plot generated from the drive cycle procedure. In this report this drive cycle is called the “CRC 666 Original (Mild) Drive Cycle” to distinguish it from the “Modified (Aggressive) Drive Cycle” described in Section C below.

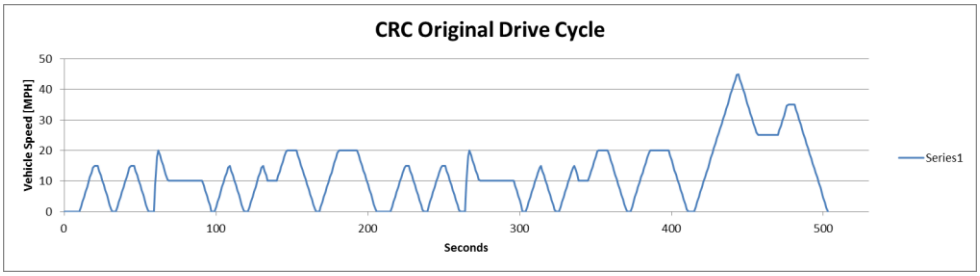


Figure 11. CRC Original Drive Cycle

The drive cycle is driven by using a heads-up display visible to the chassis dyno driver. It was important for the driver to start the drive cycle once the engine had successfully started and then countdown to 5 seconds from engine start for a properly timed transmission shift from Park to Drive and have a vehicle drive away at approx. 10 seconds. This was to maintain consistency with the drive cycle procedure in CRC report 666. Maintaining consistent drive away times is important for capturing driveability issues as the longer the vehicle is able to idle the warmer the combustion chamber gets and the less sensitive the vehicle is to high DI fuel induced driveability issues during transient driving.

Once the drive cycle was complete the data was saved on a test laptop, the vehicle was shut off and data acquisition systems powered off. The vehicles were then left for an overnight cold soak at 40°F in preparation for further testing. The following day the second test was run, likewise the third test was run on the third test day. In all 4 days on the chassis dyno facility where allocated for this test procedure.

C. Drive Cycle Modification – Modified (Aggressive) Drive Cycle

Following testing on the Honda Civic and the Ford F-150 on the CRC report 666 original drive cycle a lack of driveability degradation was noted in the data analysis. It was noted early on that the first two drive away accelerations hereafter known as drive cycle “hills”, were not very aggressive in acceleration profile and did not load the vehicle engine to a high degree where driveability issues may be measured. Individual testing done on the Ford F-150 with C0 TR2338 at ambient temperatures close to 40°F revealed that if a more aggressive initial acceleration was introduced in the drive cycle, fuel induced engine misfires resulted in severe driveability degradation that was evident to the driver (Figure 12). It was concluded that the driveability degradation resulted from incomplete/poor combustion caused by the fuels; it was later found during continued F-150 testing on C0 TR2338 fuel that an after effect of the incomplete combustion, due to fuels influence, frequently caused heavy carbon deposits to develop on the spark plug electrode tip and prevented the spark plug from proper ignition (plug fouling). The malfunction of the spark plug caused by excess carbon deposits further causes poor combustion quality that compounds the already present driveability degradation caused by fuels. When this occurs it is difficult to distinguish the driveability effects attributed to spark plug carbon deposit build up and sole fuels influence on driveability, this is further examined and addressed in section D. Spark Plug Investigation and Procedure Update. Figure 12 shows the in-cylinder IMEP measurements during this modified (aggressive) drive cycle investigation. In cylinder IMEP is the positive work extracted from the combustion process, when IMEP drops to zero no work is being output from the combustion process and is a characteristic of cylinder misfire behavior or poor combustion that directly results in driveability performance issues which are obvious to any driver. It is noted from the driver who experienced the misfires captured in Figure 12 below that the vehicle driveability was severely degraded and vehicle considered “undriveable”.

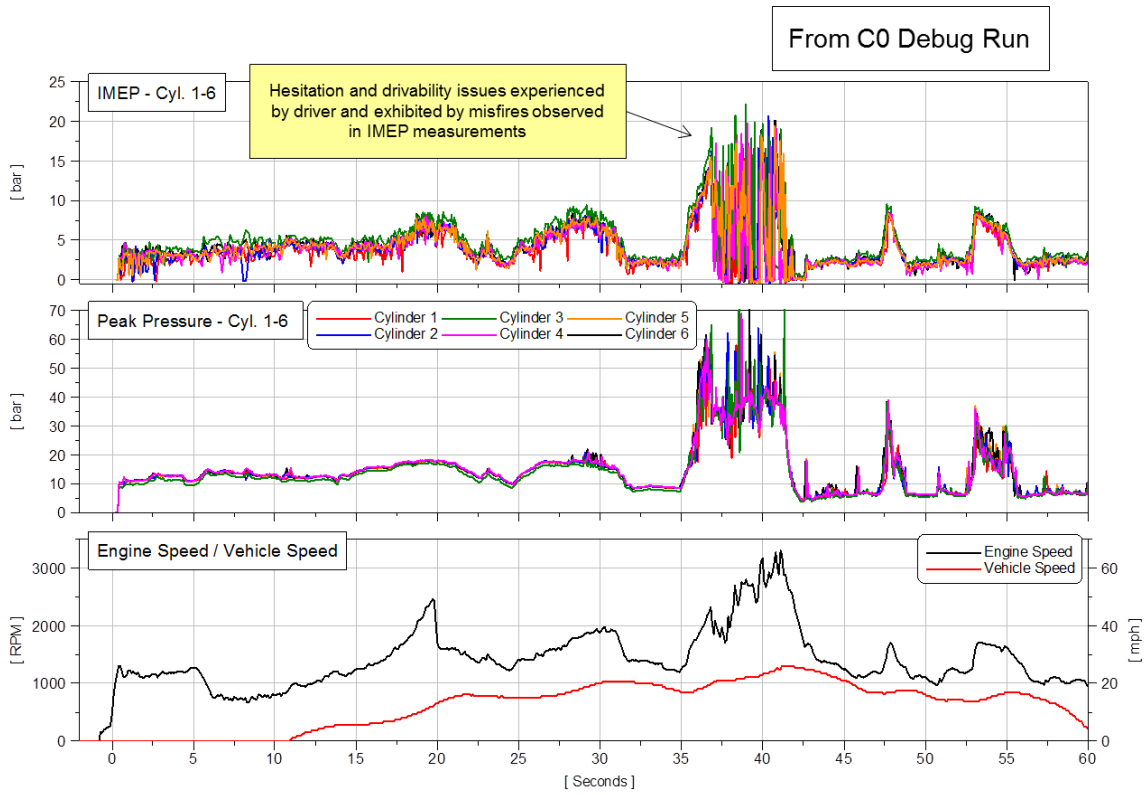


Figure 12. Ford F-150 Engine Misfires during additional testing on C0 TR2338 test fuel

This separate investigation regarding initial acceleration profile prompted a close look at the testing procedure and a joint decision between FEV and CRC was made to modify the drive cycle for a more aggressive profile in order to increase fuel induced driveability degradation as captured above in Figure 12. FEV modified the drive cycle by using the third hill in the original CRC report 666 drive cycle which had the most aggressive acceleration profile and came up with a drive cycle composed solely of this drive cycle hill. In this manner the initial drive away at 10 seconds would be with an aggressive acceleration that would repeat throughout the test and it would be possible to capture and compare the driveability data at the beginning of the cycle where the combustion chamber is still warming up and sensitive to high DI fuel and the last sections of the drive cycle where the engine is warmed up and able to vaporize the test fuel and mitigate any driveability concerns, Figure 14. Figure 13 below shows the section of the original CRC report 666 drive cycle to be used in the newly modified drive cycle.

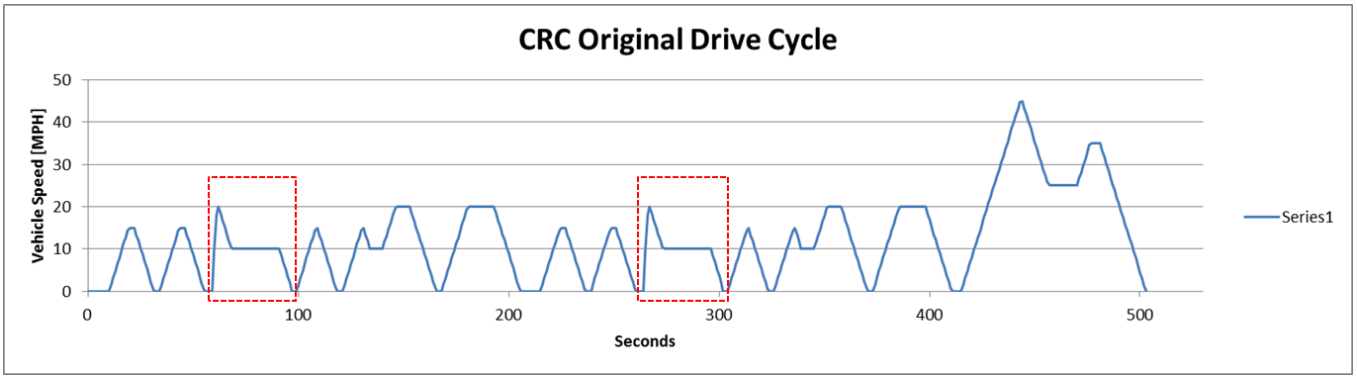


Figure 13. CRC Report 666 Original (Mild) Drive Cycle third hill used for modified drive cycle

Figure 14 below shows the final modified drive cycle with the repeated aggressive acceleration profile.

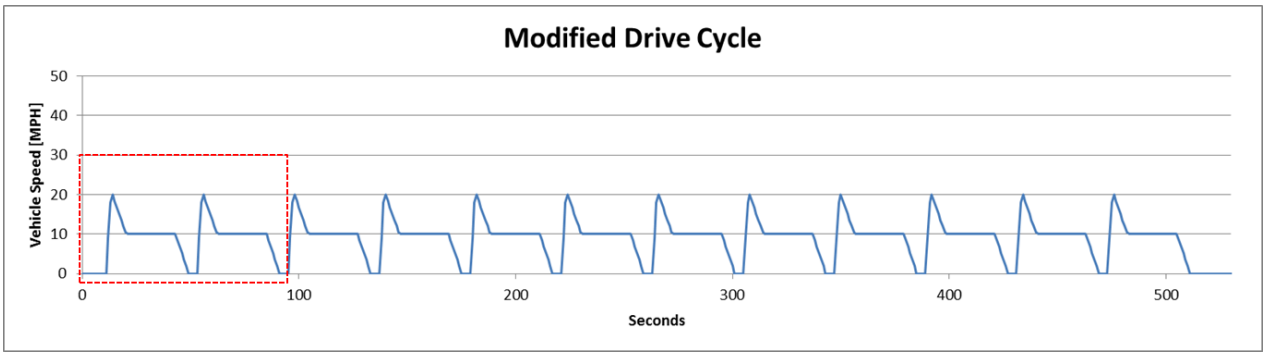


Figure 14. FEV Developed Modified (Aggressive) Drive Cycle

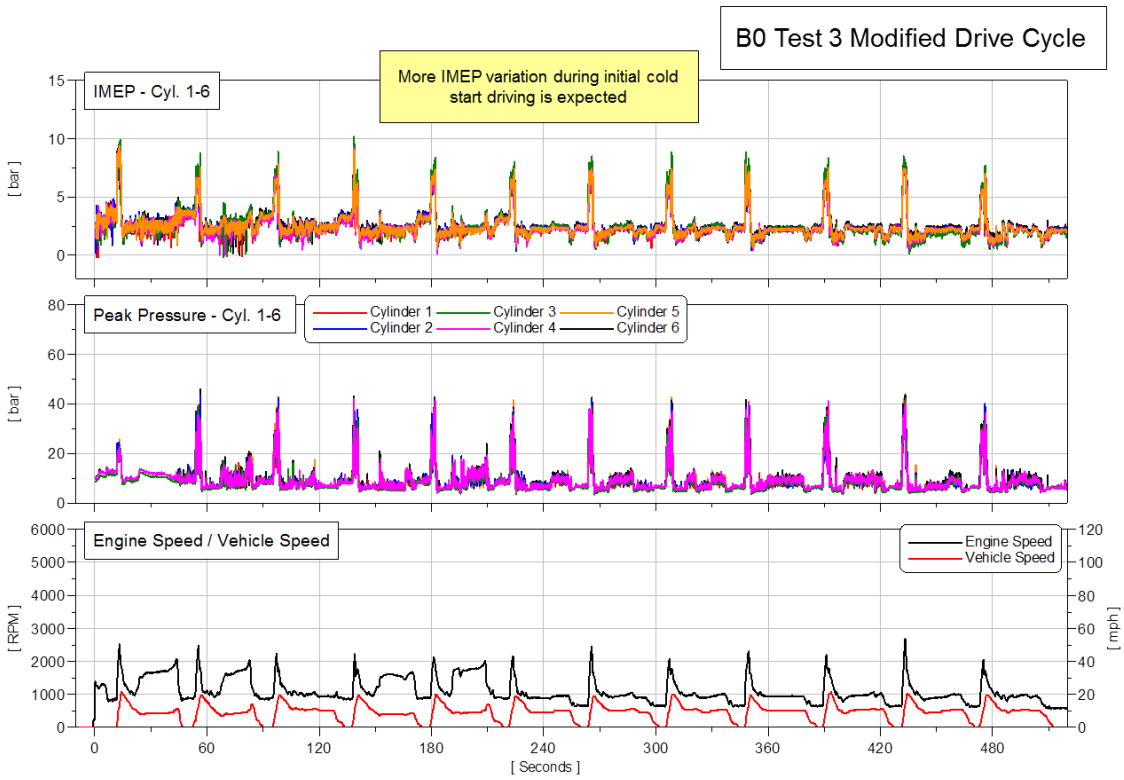


Figure 15. Engine IMEP Instability Improving As Engine Warms Up

It was expected that the driveability concern area would be in the first 100 seconds due to the engine not being fully warmed up. Much of the data analysis focuses on the first two hills of the drive cycle for vehicle driveability, outlined in red in Figure 14. Figure 15 shows the Ford F-150 combustion IMEP stability, noted by the variation in measurement, improving as the vehicle progresses in the drive cycle and the combustion chambers warm up.

The decision was made to retest the Ford F-150 on all 4 test fuels using the modified drive cycle and all the Mazda CX-9 testing was done using solely the modified drive cycle. There was an increase in driveability issues captured with the Ford F-150 on the modified drive cycle. Likewise the Mazda CX-9 exhibited measurable driveability issues on the modified drive cycle. The Honda Civic which was the first

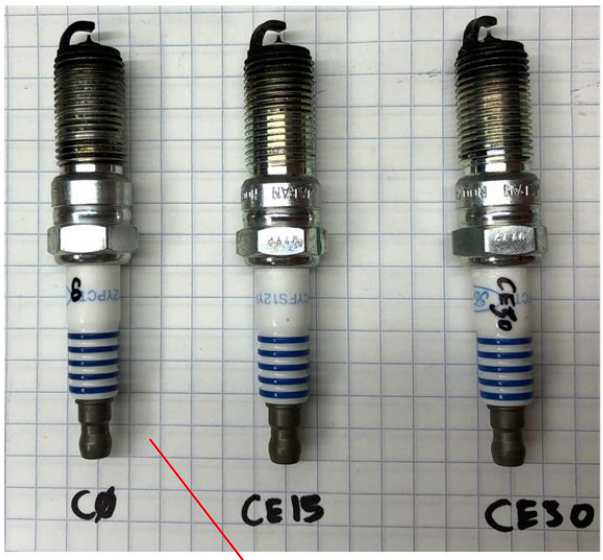
vehicle tested in the program was not available to rerun the tests on the modified drive cycle because the vehicle had already been retired from the test program when the modified aggressive drive cycle was developed. Therefore only results from the original CRC report 666 original drive cycle are available for the Civic. Once the change over to the modified drive cycle occurred; all other standard procedures remained the same, including fuel change, vehicle prep, vehicle start-up, Park to drive shift, and initial drive away time.

D. Spark Plug Investigation and Procedure Update

Another change in the procedure resulted from spark plug fouling due to excessive carbon deposits on the insulator and electrode of the spark plug developing as a result of fuels testing. This was first noted during the Ford F-150 testing on the modified drive cycle during C0 TR2338 fuels testing. This was a concern due to potential misfire and driveability issues being compounded by spark plug fouling over subsequent test days and difficulty distinguishing further driveability effects solely due to fuels influence. It is concluded that the cause of the spark plug fouling is due to poor/incomplete combustion caused by the test fuels which create excess carbon deposits on the spark plug tip. It is the case that no plug fouling would have occurred unless the test fuel had caused severe misfire leading to partial combustion and in-cylinder soot accumulating on the spark plug. The initial misfires and poor combustion due solely to fuels influence is evident in subsequent data and consistently noticeable to the driver (examples can be found under subsection B. 2016 Ford F-150 Data Review under section VI. Results Overview).

Following a spark plug investigation and discussions with CRC, spark plug documentation and replacement became part of the standard test procedure to avoid carry over spark plugs fouled by the test fuels further influencing subsequent testing. Three sets of OEM spark plugs were purchased in advance so that after every fuel test the spark plugs would be changed to a new set for the next test eliminating the possibility of carry over spark plug foulied induced driveability issues from occurring during the following test's cold start. This change was to maximize the fuels influence on vehicle driveability. During testing on the F-150 on C0 TR2338 and CE30 TR2340 the spark plugs were consistently fouled after a cold start test due to fuels influence. Figure 16 below shows the spark plugs for the F-150. This procedure change was done following Ford F-150 C0 TR2338 fuel testing with the modified drive cycle. All the following tests on the Ford F-150 and Mazda CX-9 incorporated spark plug changes following each test. A complete overview of the test sequence and subsequent modifications for each vehicle is available in Appendix F: Vehicle Test Sequence and Test Modifications.

SPARK PLUG INVESTIGATION FINDINGS



Sparkplug comparison
C0 and CE30 show heavier soot and carbon deposits on the electrode tips when compared with CE15 spark plugs. Spark plugs are collected and documented after every test. They are replaced with a new set of plugs prior to each test.

Figure 16. Ford F-150 Spark Plug Findings

E. Cold Start Driveability Metrics

Previous CRC test programs with high DI gasoline fuels relied on subjective driver ratings in order to quantify the driveability effects of fuel properties. This often relied on data normalization to correct for driver bias and differences in ambient conditions. This test program provided the unique opportunity to measure the underlying effects the test fuels have on vehicle warmup driveability and quantify the effects. In order to analyze the acquired data, vehicle metrics had to be collected in relation to the effects of the test fuels. There were three main data metrics that were closely analyzed.

1.) Engine Startability
This was the necessary crankshaft revolutions and recorded time needed to successfully start the engine, an important driveability metric that can be directly influenced by the fuel. Longer crank times are an indication of a lack of fuel vaporization, hindering successful ignition and combustion. Since a high resolution (360°) crank angle encoder was used, an accurate reading of

the time needed to start the engine as well as the number of crankshaft rotations was captured. Once the engine started rotating, the measurement equipment was able to pick up the crankshaft rotation. Successful engine startup was considered to be the point when engine speed flared past 400 RPM to a successful engine idle. Start time was hence the time from start of crankshaft rotation to 400 RPM as illustrated in Figure 17 below. Due to the varying effects the vehicle battery state of charge can have on starter motor cranking, the number of crankshaft revolutions provided the best indication of engine start up quality since it is independent of time.

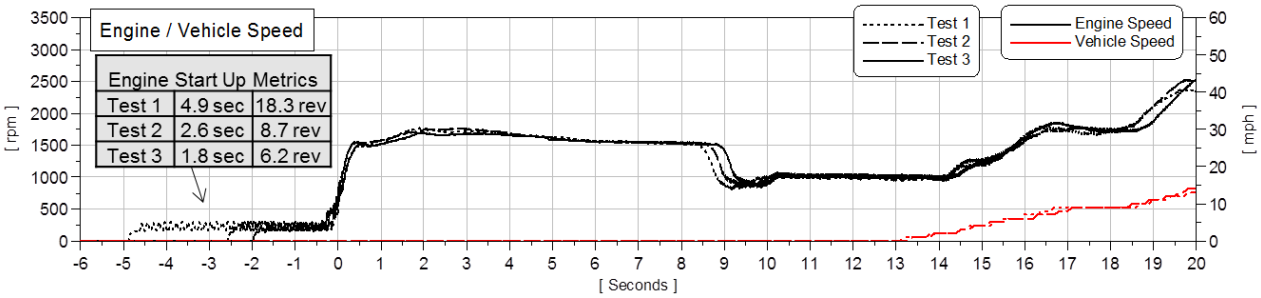


Figure 17. Honda Civic CE30 TR2340 Engine Start Up Times

2.) Engine Idle Quality (IMEP Standard Deviation)

Engine combustion stability can be characterized by calculating the standard deviation of each cylinder's combustion IMEP. This requires the engine to be at steady state conditions such as during engine idle immediately after engine start. In order to measure the fuel effects on combustion stability the cold start idle in park (first 5 seconds of the drive cycle following engine start up) was chosen to be analyzed for IMEP standard deviation across all engine cylinders. Figure 18 below shows the first 10 seconds of the drive cycle engine speed and the sample point for IMEP standard deviation based on engine steady state operation. The higher the standard deviation the more combustion instability, torque variations and general engine "roughness". Since this is during the first seconds of engine startup this was a good measurement point for fuel influence on combustion stability.

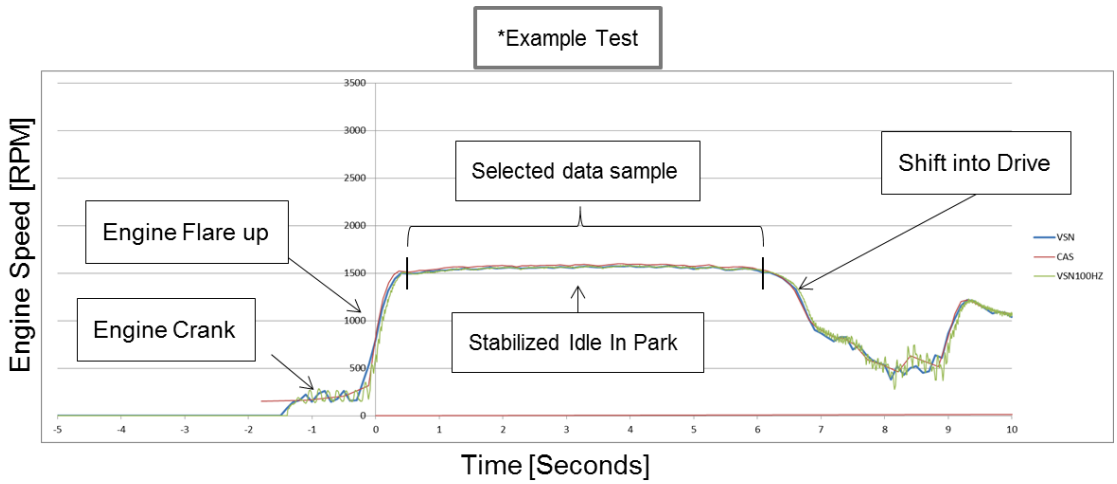


Figure 18. Example engine RPM where steady state engine operation allows for combustion stability measurement

In order to assign an average standard deviation across all cylinders in the engine several averaging methods were assigned to create an overall engine IMEP standard deviation. The averaging methods are described below (Method 1 is what is used in the Plots):

1. **Engine Average Standard Deviation**: The CAS (Combustion Analysis System) system outputs an IMEP.EA (EA = Engine Average) parameter. This method looks into the stability of each engine cycle and uses the average IMEP values of all cylinders for each engine cycle. After the engine average is output the standard deviation of the selected sample is calculated, in this case the IMEP.EA corresponding section of the drive trace is selected for analysis and averaged over the length of the sample. This was the primary method used for analysis and plotting.
2. **Mean Average Cylinder Standard Deviation**: Takes the standard deviation of each individual cylinder for each engine cycle separately. The mean average of these values is subsequently the engine average StdDev. This method separates the data by cylinder to look into the engine average of each cylinder's stability.
3. **RMS Average Cylinder Standard Deviation**: Takes the standard deviation of the cycle by cycle IMEP values for each individual cylinder separately followed by the Root-Mean-Square averaging method for the deviation values. This method separates the data by cylinder to look into RMS engine average of each cylinder's stability with the statistically significant RMS method.

The results were plotted across all test fuels. Figure 19 below shows the results gathered from the Ford F-150 testing. Each datum point represents an engine average IMEP standard deviation with the green box datum point being the average IMEP standard deviation of all three tests.

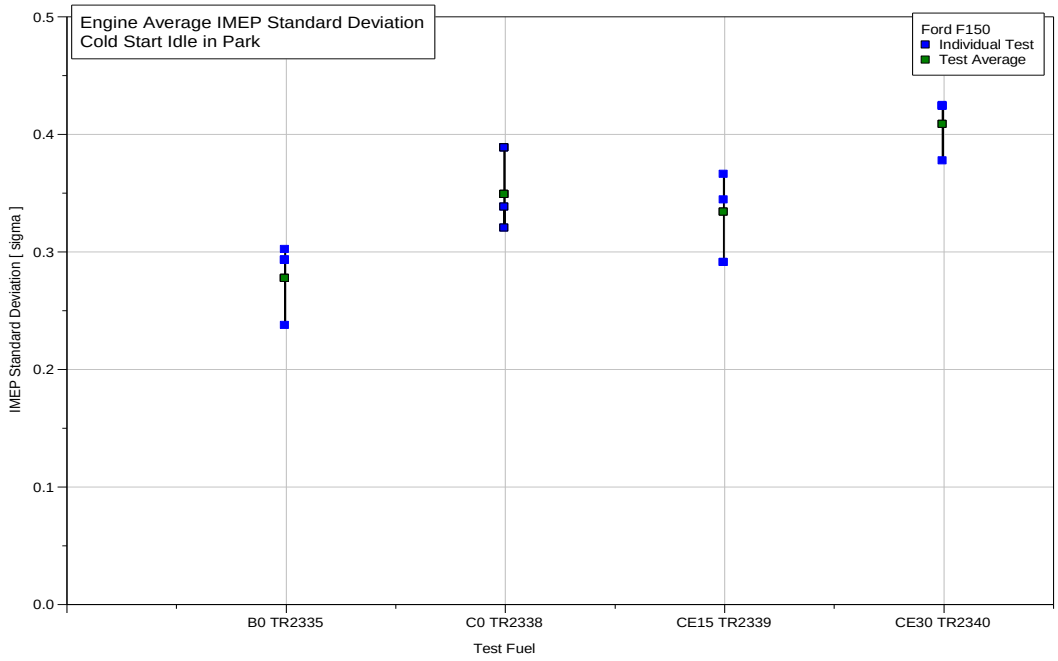


Figure 19. Ford F-150 IMEP Standard Deviation Cold Start Idle In Park Original Drive Cycle

3.) Vehicle Drive Away Driveability Analysis: Pedal Request to IMEP output.
A direct measurement of driveability can be made using the vehicle pedal position and measured engine IMEP. The pedal position is the driver torque request input to the engine control module. The engine IMEP is the positive combustion work that will be converted into eventual torque at the wheels for vehicle response. If there is a mismatch in the torque request to torque output ratio then there is a driveability concern as the vehicle is not responding to driver input. The plot in Figure 20 below shows the analysis done to measure and detect driveability issues. As shown in Figure 20 below, at second 14 during the initial vehicle drive away the driver is holding a consistent 65% pedal and the IMEP output from the engine has a notable lag resulting in engine hesitation and subsequent vehicle hesitation. This type of careful analysis was done on the vehicles to identify driveability degradation.

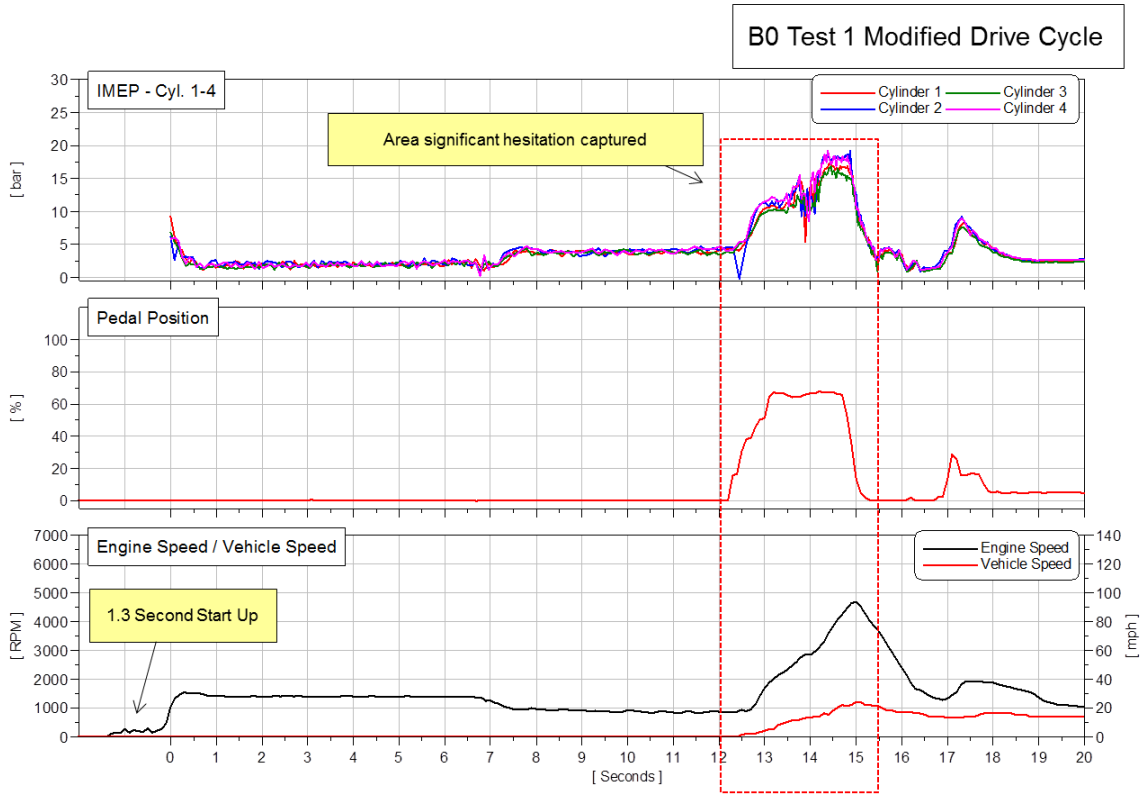


Figure 20. Mazda CX-9 Testing on B0 TR2338 Fuels testing showing driveability issues during vehicle drive away

Metrics Conclusion:

The driveability metrics focus on three parts of the drive cycle that consist of the first 30 seconds of the drive cycle. This being the engine start, engine idle quality and engine response to initial vehicle transient operation (drive away accelerations). Collected data shows that engine exhaust temperatures quickly exceed 300°C in the first seconds of engine start, this due to the catalyst heating strategy implemented by the cold start emissions reduction strategy. Although much of the in cylinder heat goes to the exhaust during this strategy the fast rate of temperature rise measured at the exhaust indicates that in-cylinder temperature likely will also have quick warm up and fuel evaporation in accordance with the distillation curve. Therefore the fuel effects may potentially be isolated to the first 20-30 seconds following engine start. Figures 21-23 below show the exhaust temperature profiles for the test vehicles. The turbine inlet exhaust temperatures all exceed 300°C by 5 seconds.

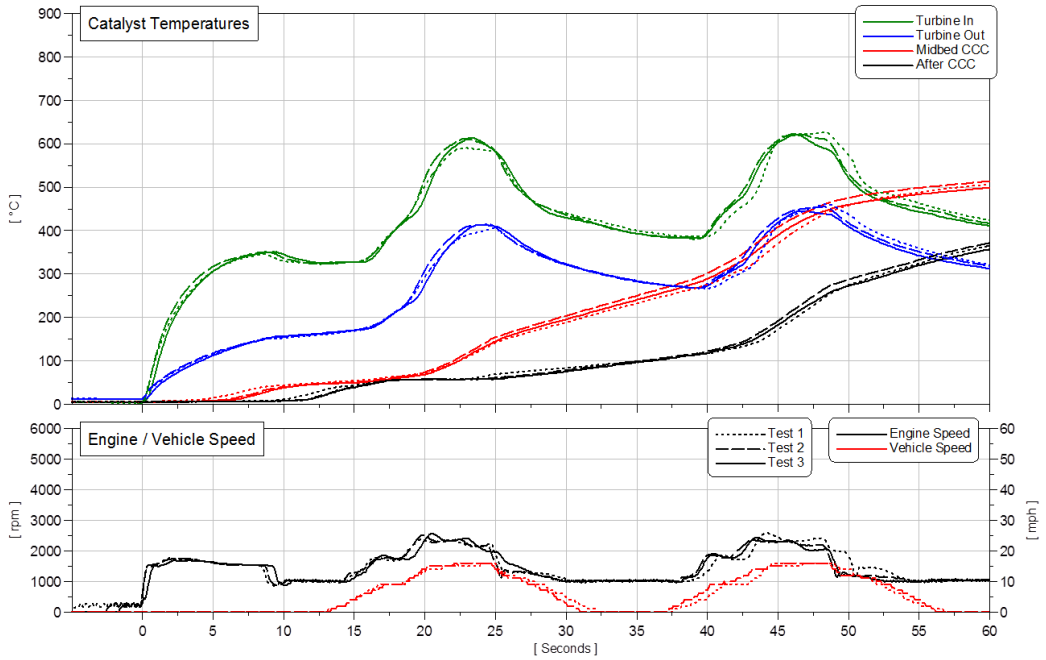


Figure 21. Honda Civic Exhaust Temperature Profile

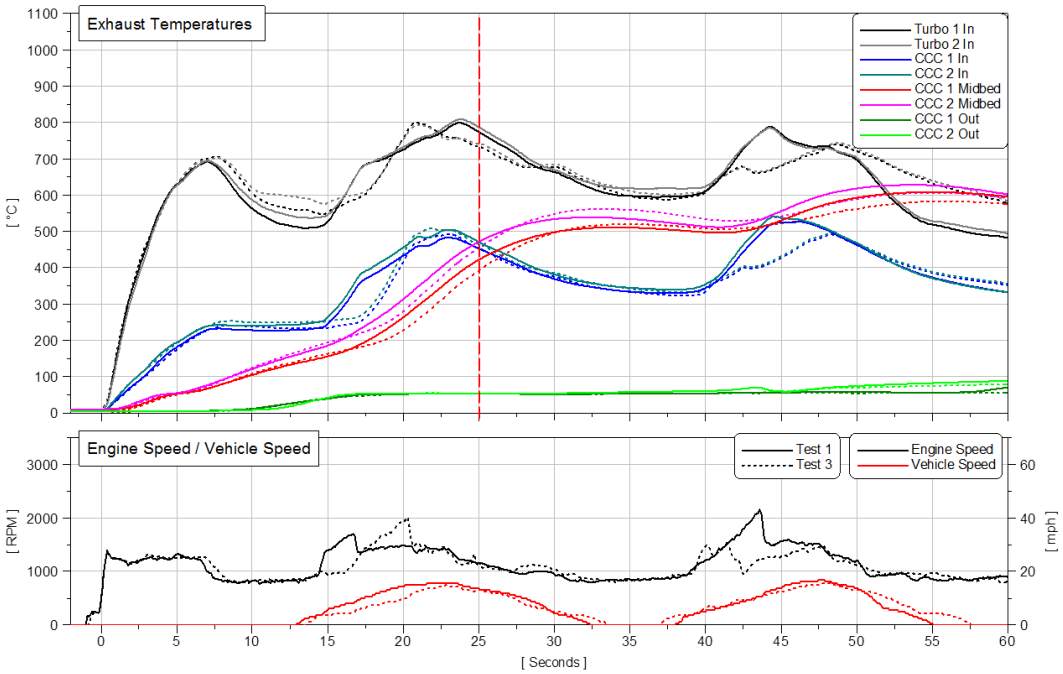


Figure 22. Ford F-150 Exhaust Temperature Profile

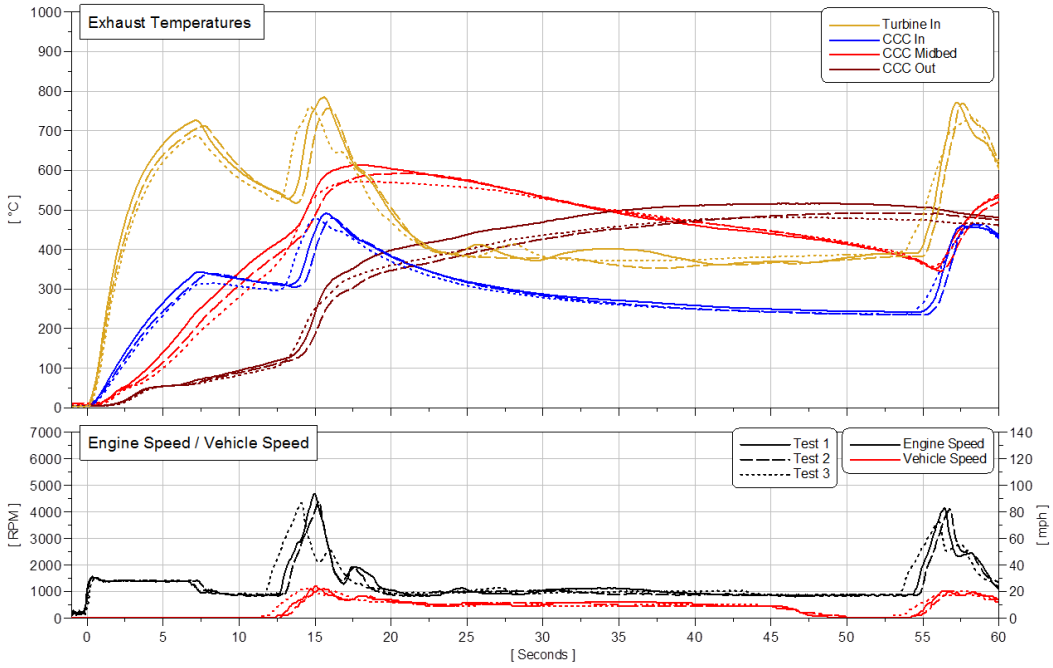


Figure 23. Mazda CX-9 Exhaust Temperature Profile

VI. Results Overview

A. 2016 Honda Civic Data Review

Vehicle specifications:
2016 Honda Civic
Engine: 1.5 Liter Inline 4 cylinder GTDI
Transmission: CVT (Continuously Variable Transmission)
Engine Start Activation: Automatic Start Button (automatic crank until engine start)

Figure 24. 2016 Honda Civic

Test Findings

Since the Honda Civic was the first vehicle in the test program the original CRC report 666 drive cycle was solely used. The results showed varied response to the test fuels with a minimal impact on driveability once the vehicle began driving, none significantly notable to the driver, potentially attributed to the CRC report 666 drive cycle not having the necessary acceleration profile to induce the higher engine loads that can result in driveability issues. There was, however, measureable degradation of vehicle startability and engine stability during cold start idle.

Initial testing on the base hydrocarbon fuel, B0 TR2335 with DI=1266°F, did not incur significant driveability issues or engine stalls. No misfires present in combustion data, combustion IMEP data is present in Appendix D. A close look at the vehicle data did however indicate active cold start adaptations being implemented by the engine management system that improved engine startability. The first test had 16 crankshaft revolutions (4.3 seconds) before the engine successfully started; this was noted by the driver as a startability concern. The prolonged engine start times are likely solely due to fuel influence. The following second and third test had reduced engine start up time of 1.7 and 1.8 seconds respectively, typically a car start needs to be less than 1 second for driver satisfaction. The improved engine startability over consecutive testing suggests that the engine control module had implemented adaptive changes in response to the high DI fuel to ensure faster engine start-up. Prolonged start up injection durations are noted and also correspond to rich exhaust Lambda measurements (ratio of the amount of oxygen in the exhaust to stoichiometric AFR condition, a Lambda lower than 1.0 indicates enriched operation and higher than 1.0 means lean conditions). Please note that the instrumented wideband exhaust oxygen measurement equipment is only able to calculate AFR and subsequent Lambda with combusted exhaust oxygen measurements; hence no data is available

prior to engine start where combustion is not present. Once the engine does fire and successfully start the exhaust oxygen measurements respond and are able to measure the engine cold start AFR and Lambda measurements as shown in Figure 25. The differences in cold start enrichment as testing progressed are an indication of the vehicle ECM compensating for the low fuel volatility by increasing fuel injection to enable combustion and engine start. Figures 25 and 26 (below) respectively show the prolonged engine start up times and the high injection durations. The evidence for cold start adaptations prompted the later inclusion of short term and long term fuel trims for all future testing in order to capture fuel trim adaptation response to the test fuels. It comes to note that below a certain RPM threshold (200 rpm) the CAS (Combustion Analysis) system is not able to sync and accurately output fuel injection timing and duration. As a consequence the fuel injection duration is not available during engine cranking but only after the engine has successfully fired and started (Figure 26). Due to the minor vehicle response to B0 TR2338 fuel, it was decided to progress onto C0 TR2338 test fuel (DI = 1358°F).

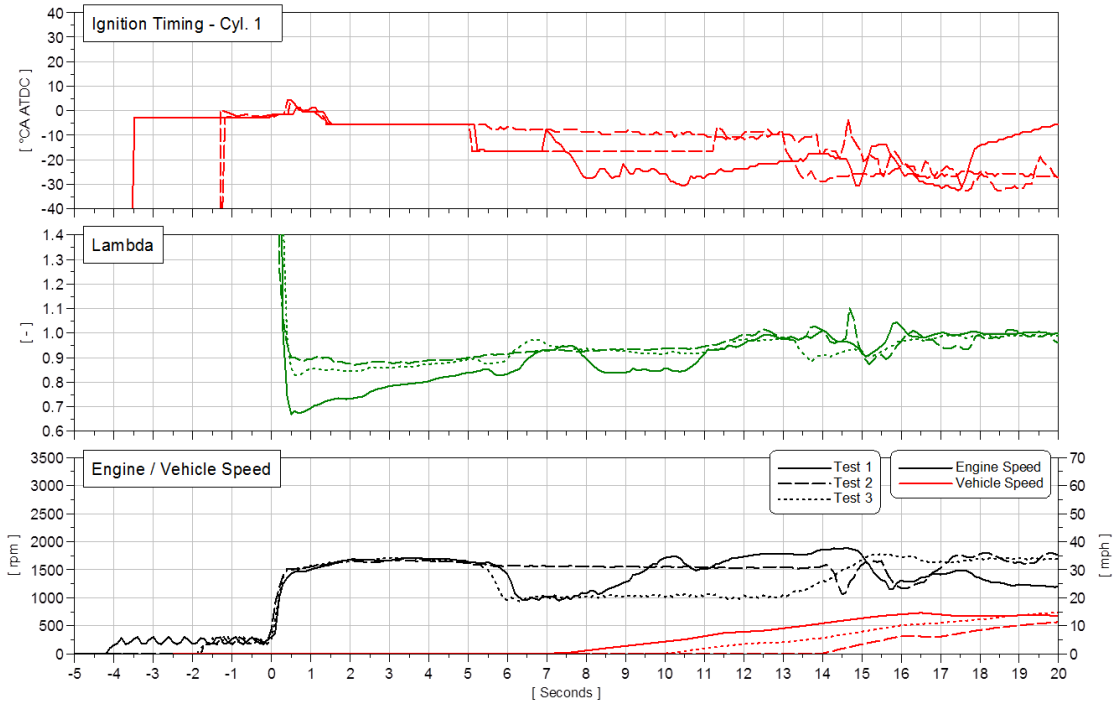


Figure 25. Honda Civic B0 T2335 Testing Cold Start Lambda (All Tests)

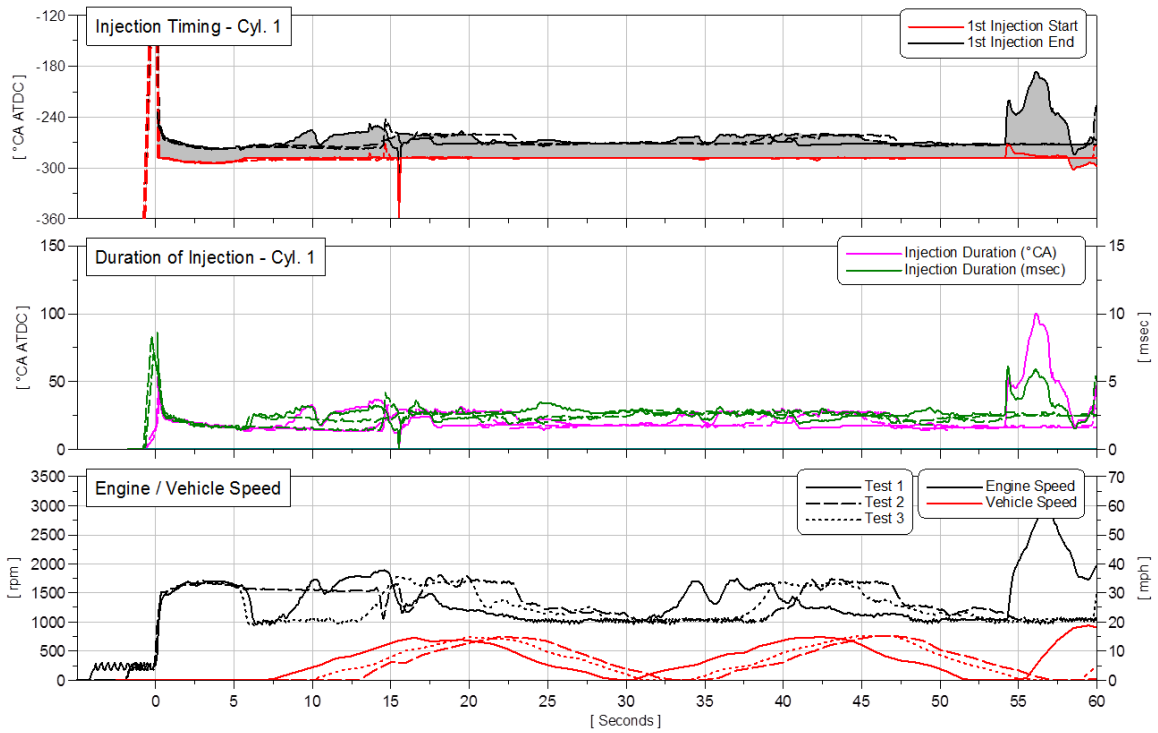


Figure 26. Honda Civic B0 TR2338 Testing Injection Duration (All Tests)

Testing on C0 TR2338 fuel caused the Honda Civic to repeatedly stall during the transmission shift from park to drive in the first test exclusively. Following three repeated engine start, shift to drive and engine stall events the test was considered a complete stall event. An engine stall event is defined as the vehicles engine coming to an unintended halt (RPM = 0) and requiring driver to manually re start the engine again (typically major driver complaint). Further examination of the data showed that the vehicle repeatedly stalled the engine during the shift from park to drive when the fueling was still in open loop control, indicated by fuel trim activation. Any engine stall event would be extremely evident to any driver/customer and would not require any instrumentation to detect. When the engine is shifted into drive the transmission is engaged, increasing engine load. During increased engine loads combustion burn rates become increasingly critical in order to avoid misfires. By keeping track of short term fueling activity it was determined that closed loop operation occurs at approximately 10 seconds after engine start up. Figure 27 below shows the first day of testing on C0 TR2338 test fuel and three repeated engine stalls. Cold start enrichment adaptation was observed in the external standalone AFR (Lambda) measurements with each start attempt progressively increasing cold start fueling and settling at 0.85 Lambda. It is noted that the engine coolant temperature at the OEM sensor remained constant at 40°F during all start up and shift attempts, indicating that the change in cold start enrichment was due to fueling adaptations and not primarily in response to any coolant temperature changes.

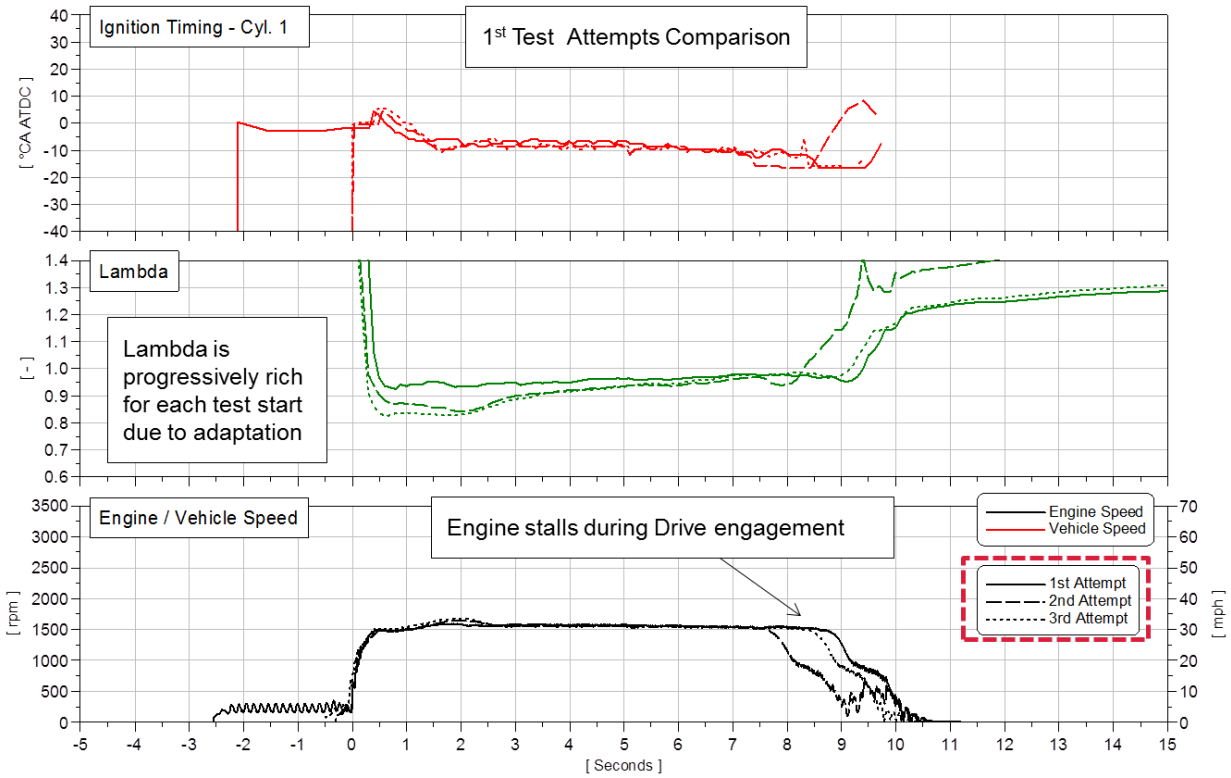


Figure 27. Honda Civic C0 TR2338 first test start up attempts

During the second and third tests, each tested on separate days following cold soaks; the vehicle successfully started and completed the drive cycle with no engine stalls or significant driveability issues. This improvement in vehicle response to C0 TR2338 test fuel can possibly be attributed to fueling adaptions the ECM implemented following the first test's start up attempts. Test 2 cold start enrichment (0.85 Lambda) was likely a learned value from the previous test start attempts. There was still evidence of fuels influence in the shift from park to drive as lean conditions are measured but this condition is followed closely by short term fueling corrections indicating closed loop operation. The lean conditions are corrected as evidenced by the positive short term fuel trim values and Lambda in Figure 28. (Positive short term fuel trims add fueling to compensate for lean conditions.) Running lean during cold start conditions with high DI fuels often leads to combustion stability issues that result in engine stall or rough running conditions as witnessed in the first test attempts. The findings suggest that the Honda Civic is sensitive to the test fuels in open loop fueling control conditions where as a result of insufficient fueling coupled with high DI fuel the engine has a tendency to stall in response to a transition to higher engine load situations (shifting into drive). Combustion IMEP plots for C0 TR2338 tests are available in Appendix D.

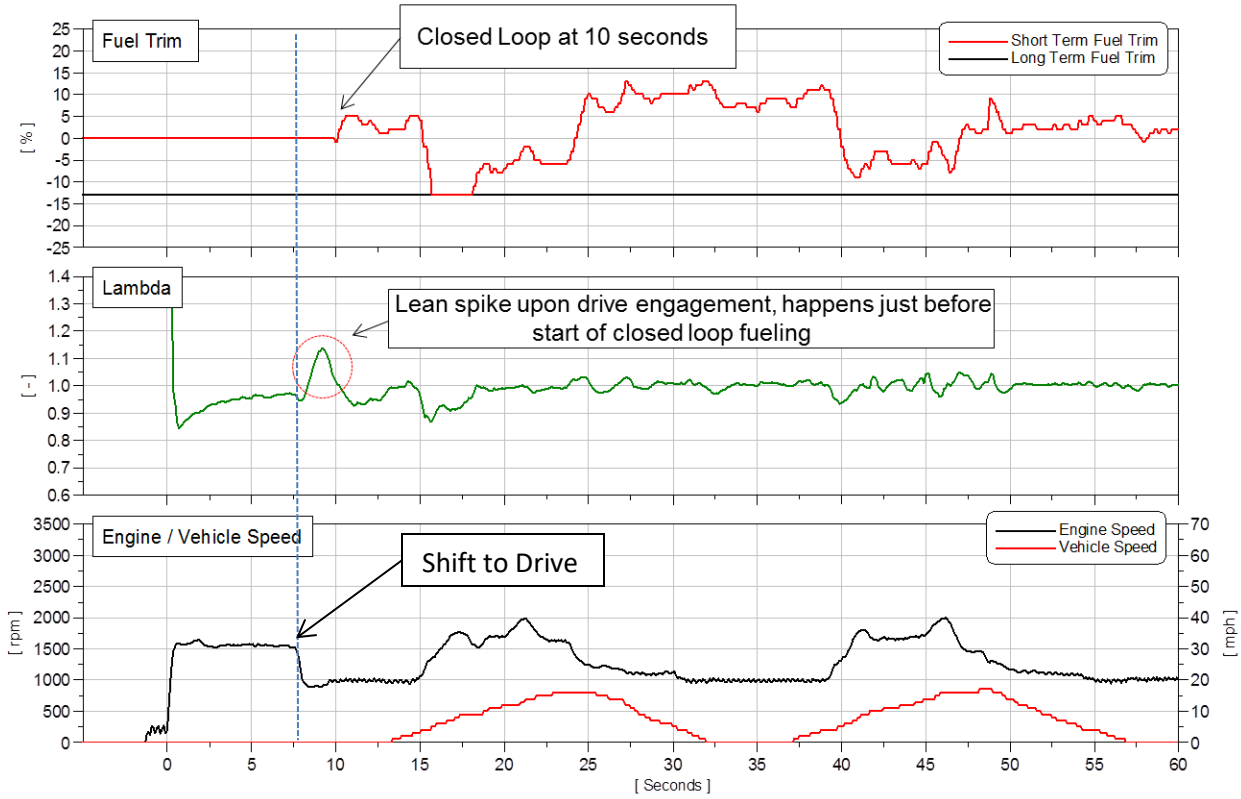


Figure 28. Honda Civic C0 TR2338 second test

The next fuel that was tested was CE15 TR2339 which was the C0 TR2338 blend stock fuel splash blended with 15% ethanol. The data results were similar to the findings from C0 TR2338 fuel. Again cold start fueling adaptations were observed with increased cold start enrichment during each consecutive test. Distinct to this fuel was a notable increase in short term fueling corrections to correct for lean conditions. Figure 29 below shows all three tests for CE15 TR2339 overlaid. Note the progressive enrichment in the cold start lambda measurement following consecutive tests indicating cold start fueling adaptations. There was also an instance of severe engine misfires and hesitation that was noted by the driver and evident in the data during test 2. This occurred during the shift from park to drive and observing the lambda measurements there was significant en-leanment prior to closed loop operation that nearly stalled the engine. The combustion measurements were also able to capture the misfires during this section as shown in the red dotted circle in Figure 30.

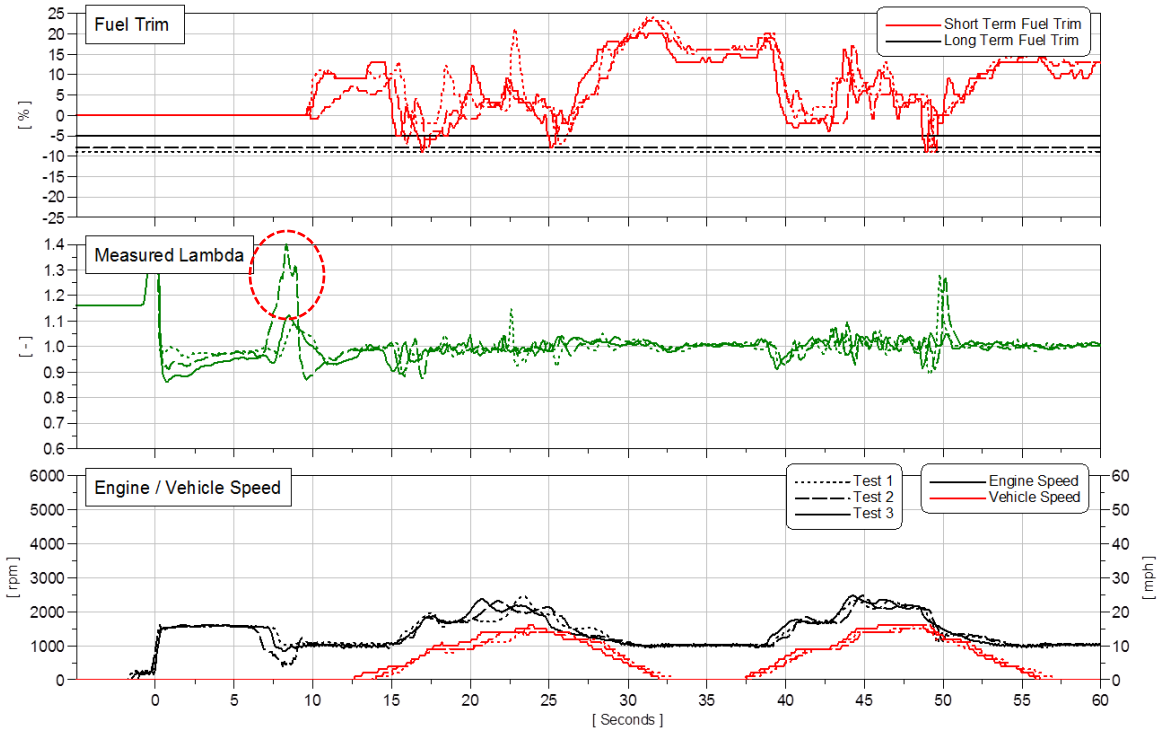


Figure 29. Honda Civic CE15 TR2339 Fuel Trims and Cold Start Enrichment

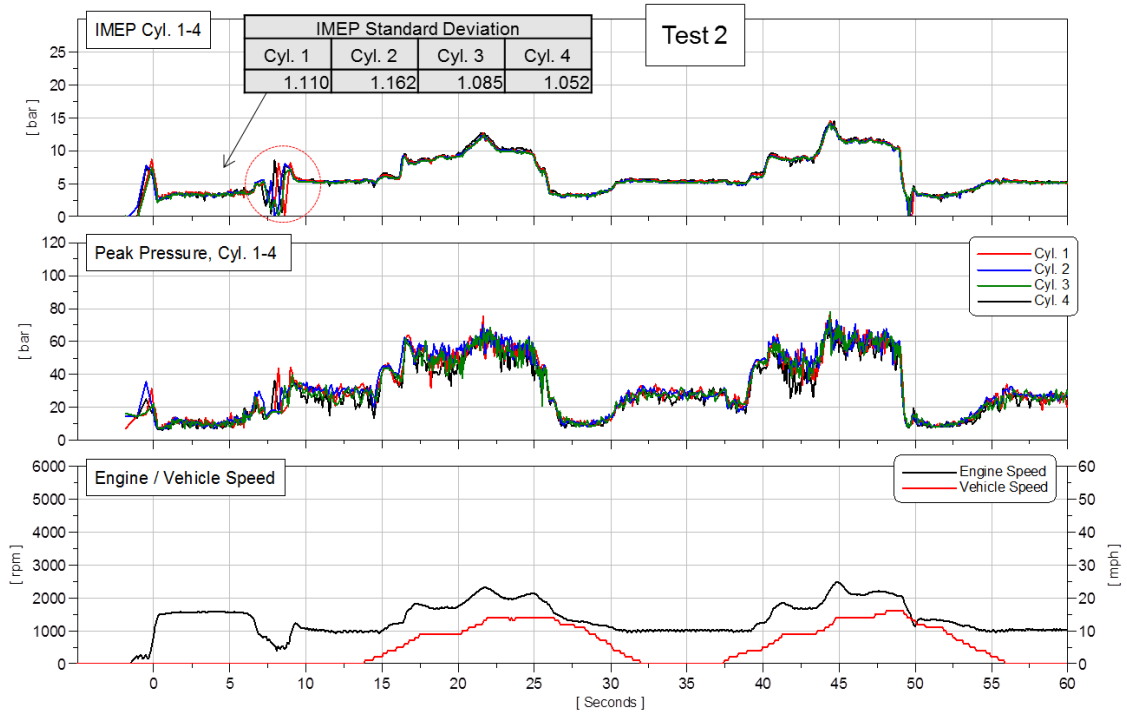


Figure 30. Honda Civic CE15 TR2339 Test 2 Engine Stability Issues Circled In Red Dotted Circle

The final fuel that was tested was CE30 TR2340. Results were similar to CE15 TR2339 test fuel but the engine start-up times were notably prolonged in comparison to the rest of the fuels. Figure 31 below has a table outlining the engine start up times. As the fueling adaptations are enabled it is observed that engine start up time improves but is still considered long at 6.2 crankshaft revolutions (1.8 seconds) by the third test. Fuel trims were observed to add the most compensation out of all the test fuels at up to 25% (figure 32). There were no significant driveability issues measured during testing on CE30 TR2340 once closed loop operation was achieved and during vehicle drive off.

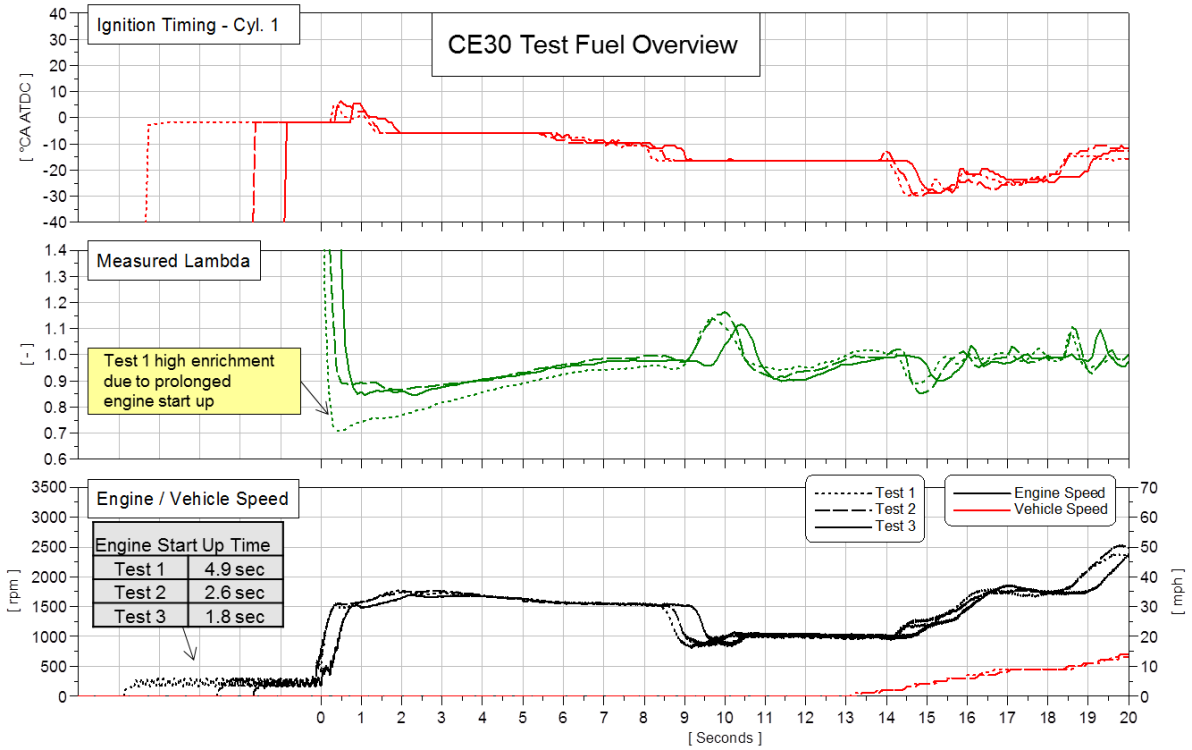


Figure 31. Honda Civic CE30 TR2340 Lambda Adaptation and Prolonged Engine Start Up Metrics

	Engine Start-Up Comparison		
	Test 1	Test 2	Test 3
	Seconds	Seconds	Seconds
B0	4.3	1.7	1.8
C0	2.3	1.2	0.9
CE15	1.5	1.3	1.0
CE30	4.8	2.5	1.6
	Crank Rev.	Crank Rev.	Crank Rev.
B0	16	6	6.6
C0	8.9	4.6	3.3
CE15	5.3	4.3	3.8
CE30	18.3	8.7	6.2

Table 4. Honda Civic Engine Start Metrics

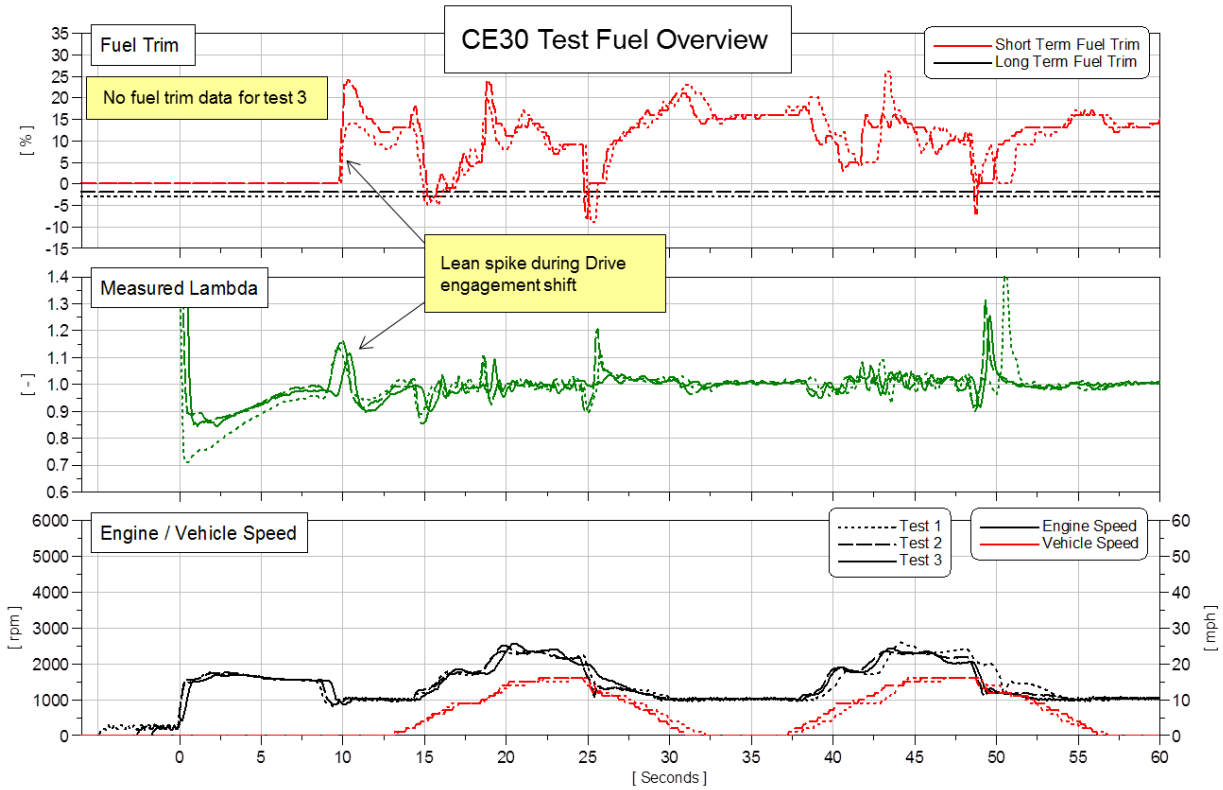


Figure 32. Honda Civic CE30 TR2340 Short Term Fuel Trims Corrected for Lean Conditions

Summary

The Honda Civic exhibited severe driveability malfunctions including repeating engine stalls on C0 TR2338 (very high DI) fuel. Stalls (engine rpm = 0) occurred at the same point in testing; immediately after cold start idle after shifting into drive to start the first acceleration. On the other test fuels (B0 TR2335, CE15 TR2339 and CE30 TR2340), the vehicle exhibited minimal driveability hesitation during vehicle drive away and transient operation. Much of the hesitation and combustion stability issues occurred during the cold start idle in open loop conditions due to the engine control module not being able to actively monitor and correct measured AFR. Once the vehicle entered closed loop conditions, fuel trim corrections were observed and vehicle drive away was not hindered. Prolonged engine start times were measured likely due to the test fuel properties. The ECM was able to make cold start fueling adaptions, by adjusting cold start AFR following each test to reduce engine start up times and improve combustion stability.

Being the first test vehicle in the test program the learnings from the testing prompted attention to the short and long term fuel trims to monitor fueling adaptations. Also it was difficult for the chassis dyno driver to accurately time the shift to drive following successful engine start often resulting in the shift being made several seconds after 5 seconds, prompting a tolerance of several seconds. The IMEP standard deviation was calculated during the vehicle cold start idle in park following engine stabilization. The results are shown in Figure 33 below. Standard deviation results overlap with each other resulting in no statistical distinction between fuels. Individual tests on C0 TR2338 and CE15 TR2339 did measure higher standard deviations. CE30 TR2340 test fuel results have the highest engine start metrics as shown in Table 3. The results from the Honda Civic suggest that the fuels with most impact on driveability are

C0 TR2338 and CE30 TR2340 test fuel as C0 TR2338 fuel exhibited engine stalls while CE30 TR2340 test fuel exhibited prolonged engine start up times.

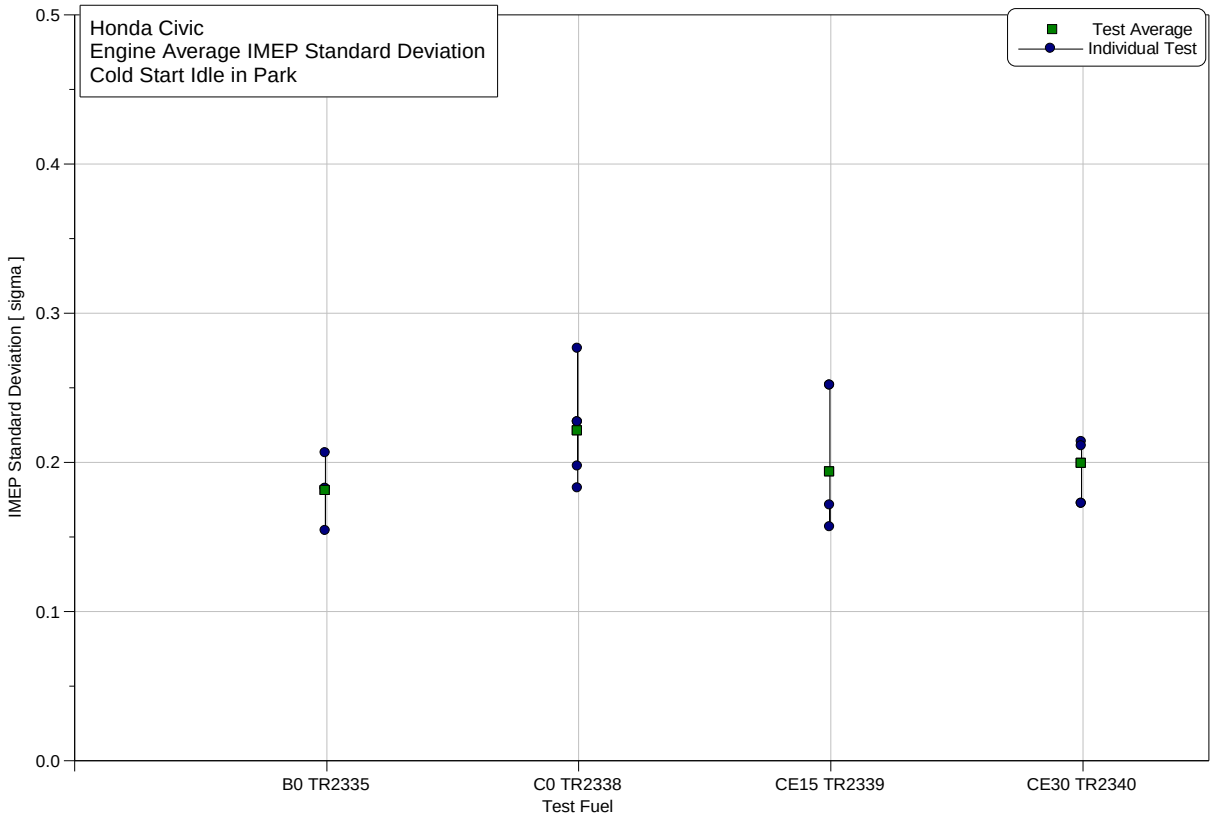


Figure 33. Honda Civic All Test Fuel IMEP Standard Deviation Plot

B. 2016 Ford F-150 Data Review

Vehicle specifications:
2017 Ford F-150
Engine: 3.5 Liter V-6 cylinder GTDI +PFI
Transmission: 10 Speed Automatic
Engine Start Activation: Keyed Engine Start (Driver holds key until engine start up)

Figure 34. 2017 Ford F-150

Test Findings

The 2017 F-150, with the 3.5L powertrain configuration, features an uncommon Direct Injection and Port Fuel Injection engine design. Each individual engine cylinder has a direct fuel injector injecting fuel directly into the combustion chamber as well as a dedicated port fuel injector mounted on each individual cylinder's intake runner. Engine operation on either PFI and/or Direct fuel injection has benefits in different operating areas of the engine. During cold starts both sets of injectors (PFI + Direct Injection) inject fuel while the vehicle is in the catalyst heating and cold-start emissions reduction phase.

Initial testing on the CRC report 666 drive cycle did not measure significant vehicle response to test fuels hindering vehicle driveability. Subsequently a separate investigation revealed that more significant vehicle driveability issues can be induced with a more aggressive drive cycle. Testing was then repeated on the four fuels with the more aggressive modified drive cycle. The results on the modified (aggressive) cycle showed severe driveability impacts caused by the fuels. The higher engine loads caused by the aggressive drive cycle resulted in engine misfires caused by test fuel influence which directly impacted driveability. Figure 34 below shows the first test on B0 TR2335 fuel conducted on the CRC 666 original drive cycle and while there is a degree of variability in the IMEP measurements during the cold start and first drive away, the engine responds to a degree where the driver cannot perceive any driveability degradation. To note, it is important to distinguish any drop in IMEP from a transmission gear shift, driver pedal input and fuels influence. Figure 35 has a drop in IMEP due to the driver easing off the pedal in order to maintain the light acceleration during the initial drive away, this is not considered a driveability degradation as the driver is requesting a reduction in engine output. Figure 36-38 show similar results for the rest of the test fuels. Figures 35-38 show the first test on each test fuel with combustion IMEP, the results show vehicle is able to maintain drive cycle and the driver did not note any serious driveability concern.

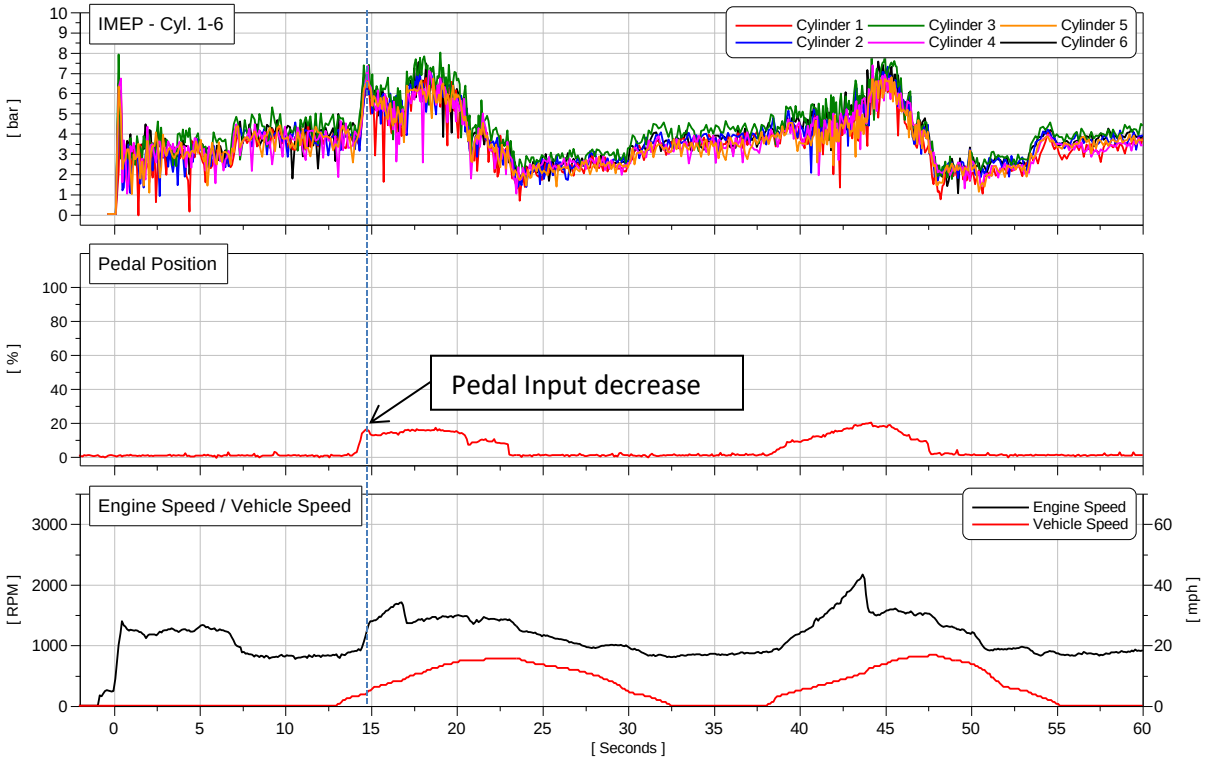


Figure 35. Ford F-150 First B0 TR2335 Fuel Test on CRC 666 Original Drive Cycle

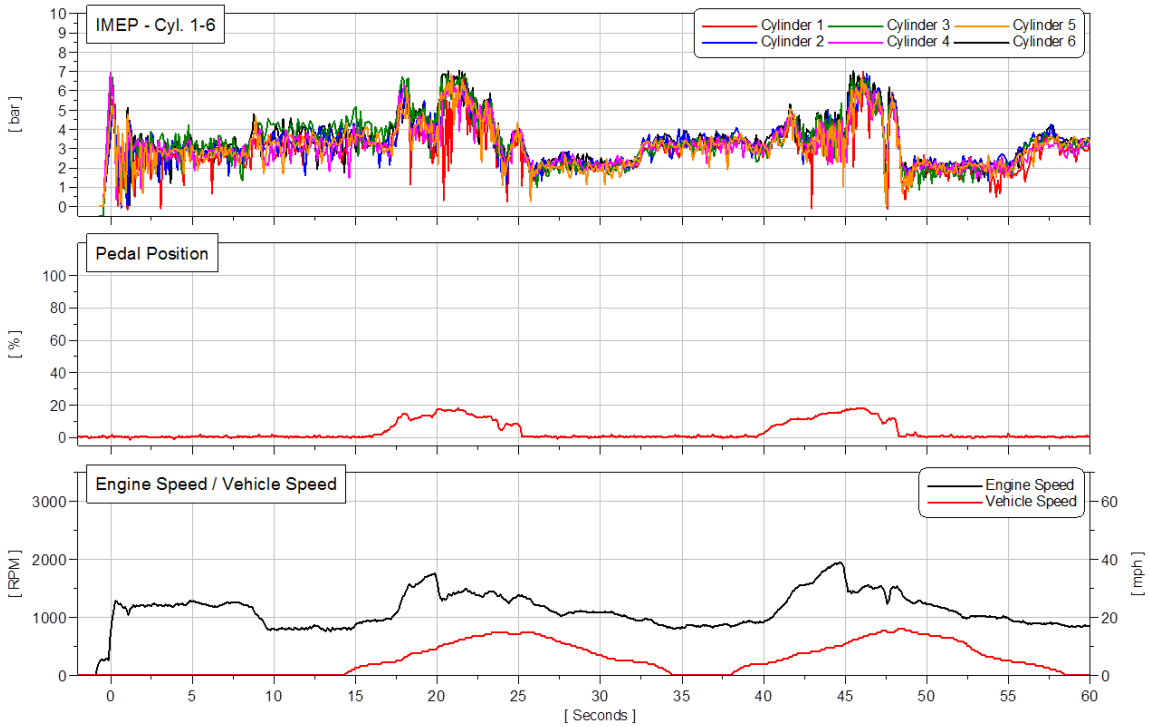


Figure 36. Ford F-150 First C0 TR2338 Fuel Test on CRC 666 Original Drive Cycle

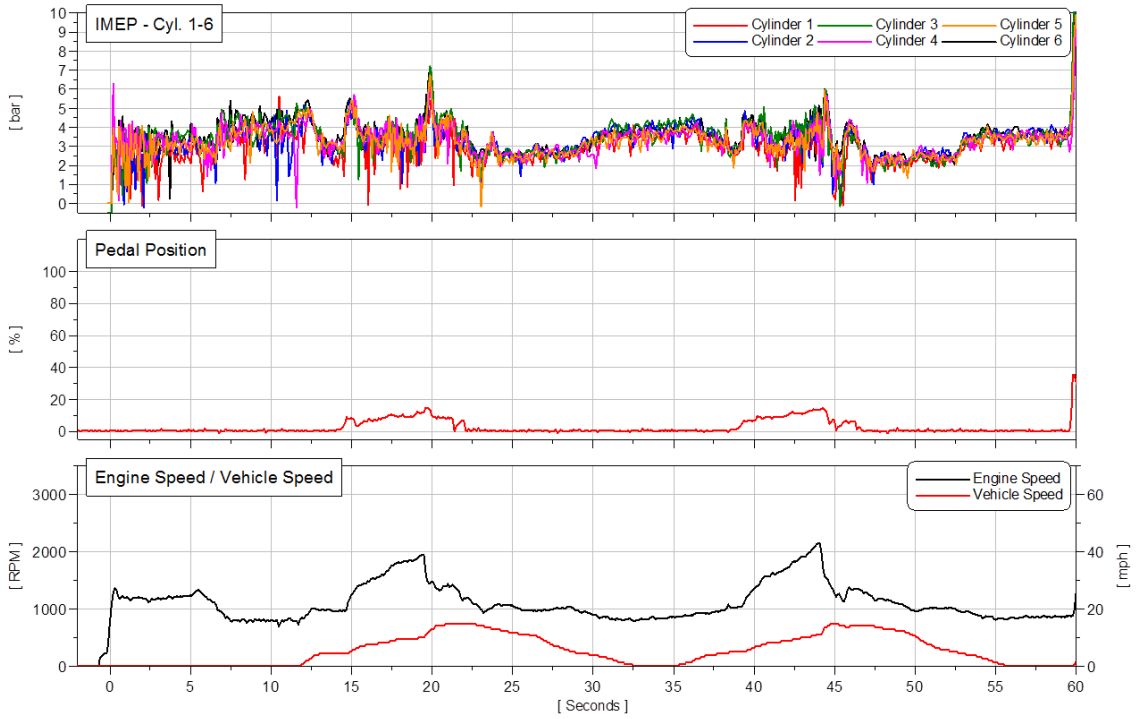


Figure 37. Ford F-150 CE15 T2339 Fuel Test on CRC 666 Original Drive Cycle

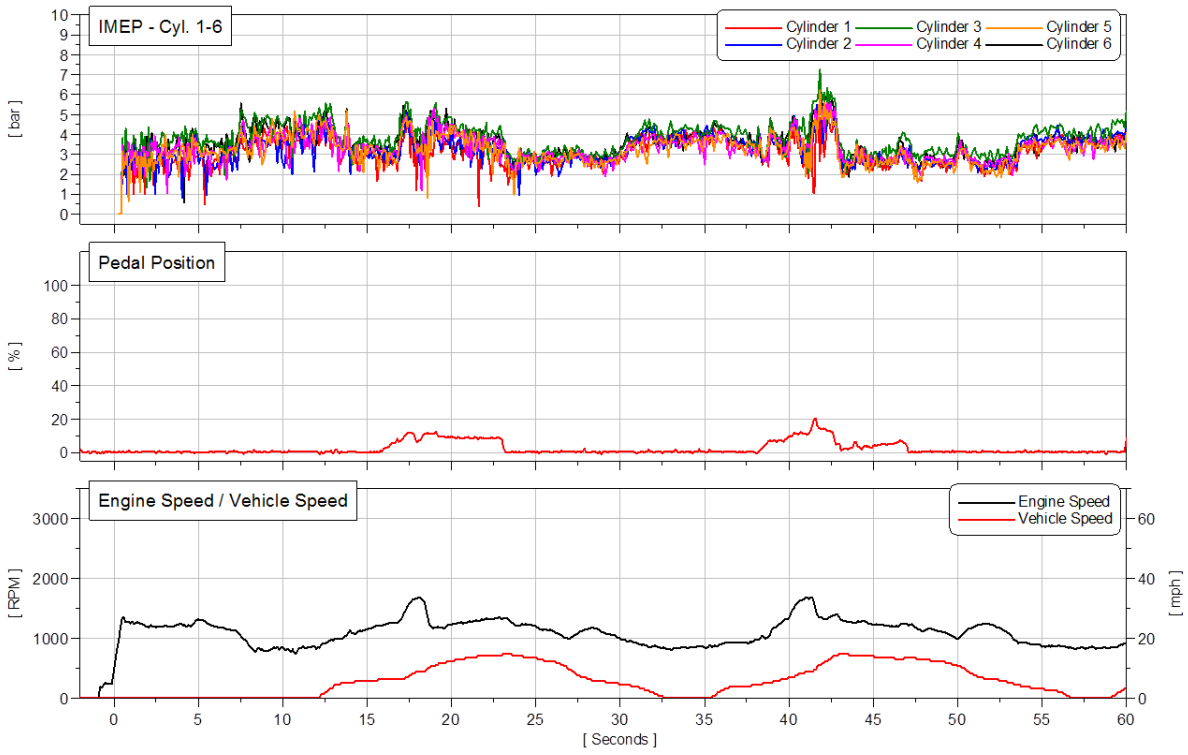


Figure 38. Ford F-150 First CE30 TR2340 Fuel Test on CRC 666 Original Drive Cycle

	Engine Start Comparison (sec)		
	Test 1	Test 2	Test 3
B0	0.98	0.74	0.73
C0	0.76	0.64	0.64
CE15	0.86	0.66	0.64
CE30	0.89	0.73	0.75

	Engine Start (Crank Revolutions)		
	Test 1	Test 2	Test 3
B0	3.57	2.58	2.61
C0	3.03	2.26	2.27
CE15	3.13	2.25	2.27
CE30	3.2	2.57	2.6

Table 5. Ford F-150 Engine Start Time Metrics for CRC 666 Original Drive Cycle

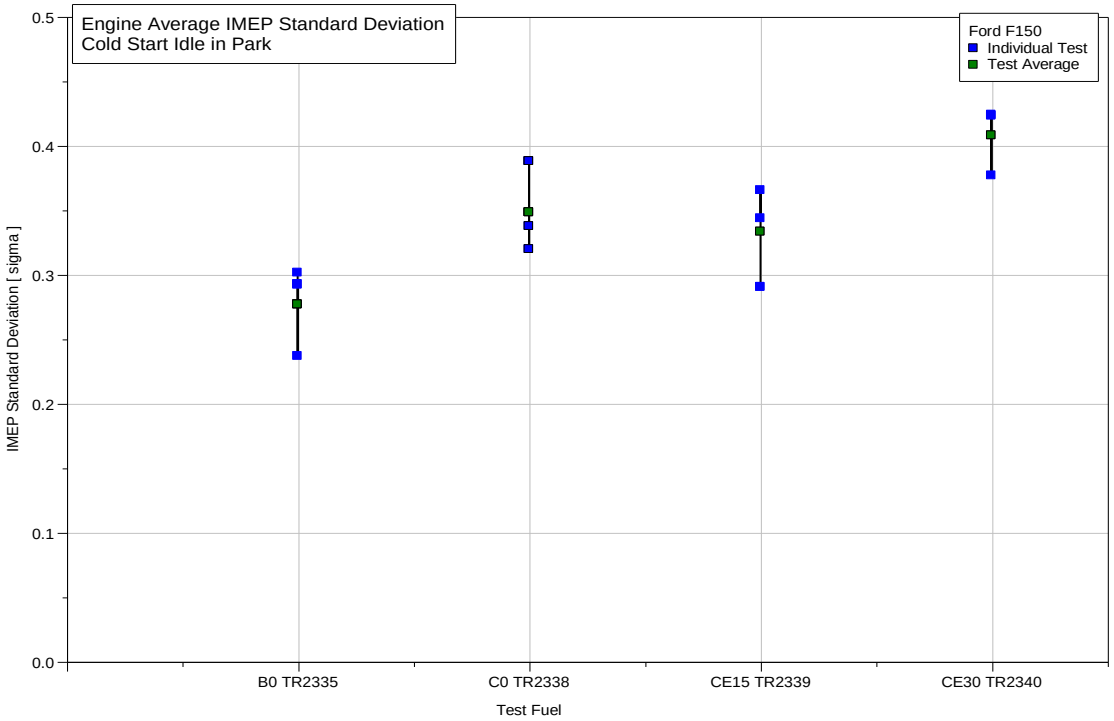


Figure 39. Ford F-150 IMEP Standard Deviation Overview CRC Original Drive Cycle

	IMEP Standard Deviation						Method 1
Test Fuel	Cylinder 1	Cylinder 2	Cylinder 3	Cylinder 4	Cylinder 5	Cylinder 6	Engine Average
B0 Test 1 (40°F)	0.7491	0.6477	0.5026	0.6261	0.6308	0.4692	0.3013
B0 Test 2 (40°F)	0.5936	0.5647	0.5592	0.4461	0.4603	0.3939	0.2365
B0 Test 3 (40°F)	0.6433	0.6744	0.4118	0.4364	0.5574	0.4328	0.2925
C0 Test 1(40°F)	0.8067	0.7480	0.6682	0.4852	0.7164	0.6708	0.3372
C0 Test 2 (40°F)	0.6188	0.6667	0.6505	0.6735	0.4971	0.4845	0.3194
C0 Test 3 (40°F)	0.8048	0.7980	0.8898	0.6913	0.7188	0.4971	0.3877
CE15 Test 1 (40°F)	0.5290	0.5283	0.7362	0.5624	0.743	0.4638	0.3434
CE15 Test 2 (40°F)	0.6744	0.7032	0.6237	0.5010	0.5440	0.5725	0.3651
CE15 Test 3 (40°F)	0.8073	0.7145	0.6393	0.5178	0.6875	0.5930	0.2901
CE30 Test 1 (40°F)	0.5759	0.6631	0.5700	0.5534	0.5950	0.6165	0.4237
CE30 Test 2 (40°F)	0.8251	0.6306	0.5558	0.5639	0.5495	0.6147	0.3765
CE30 Test 3 (40°F)	0.6227	0.6722	0.6628	0.5839	0.6205	0.6661	0.4231

Table 6. Ford F-150 IMEP Standard Deviation Results Original Drive Cycle

Present in the data from Figures 35-38 is variation in the combustion IMEP across cylinders causing high IMEP standard deviations and indicating combustion instability. The measureable increase in combustion instability is exhibited by higher IMEP standard deviations as plotted in Figure 39 and tabulated in Table 6. Standard deviation results again overlap across fuels making it difficult to statistically distinguish. Individual tests and the test averages provide some insight into the effects the fuels have on combustion stability. Higher levels of combustion instability measured on the F-150 can be due to various factors. Analyzing the data in depth showed that the engine cold start Lambda consistently targeted 1.0 (stoichiometric AFR) during cold start idle, potentially a cold-start strategy in order to reduce cold-start emissions. Figure 40 show this during C0 TR2338 fuel testing with a consistently measured Lambda for the cold starts at 1.0 for all three tests. While running the cold engine at Lambda 1.0 reduces cold start emissions it also increases the engine sensitivity to high DI fuel, due to the lack of fuel vaporization causing lean dilute conditions in engine combustion and increasing combustion instability. Figure 41 shows where the cold start IMEP measurement sample is taken from, a degree of variability is evident based on the plots and later quantified with standard deviation calculations made visible in the Figure 39 plot.

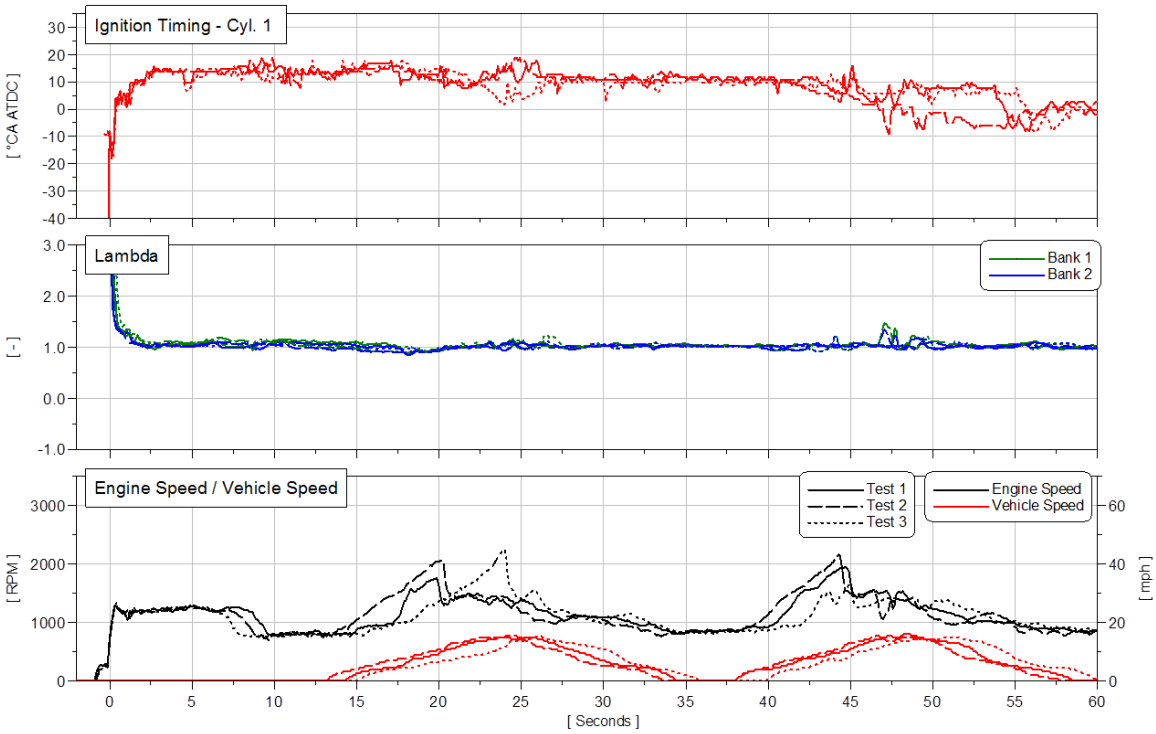


Figure 40. Ford F-150 C0 TR2338 Tests Cold Start Lambda

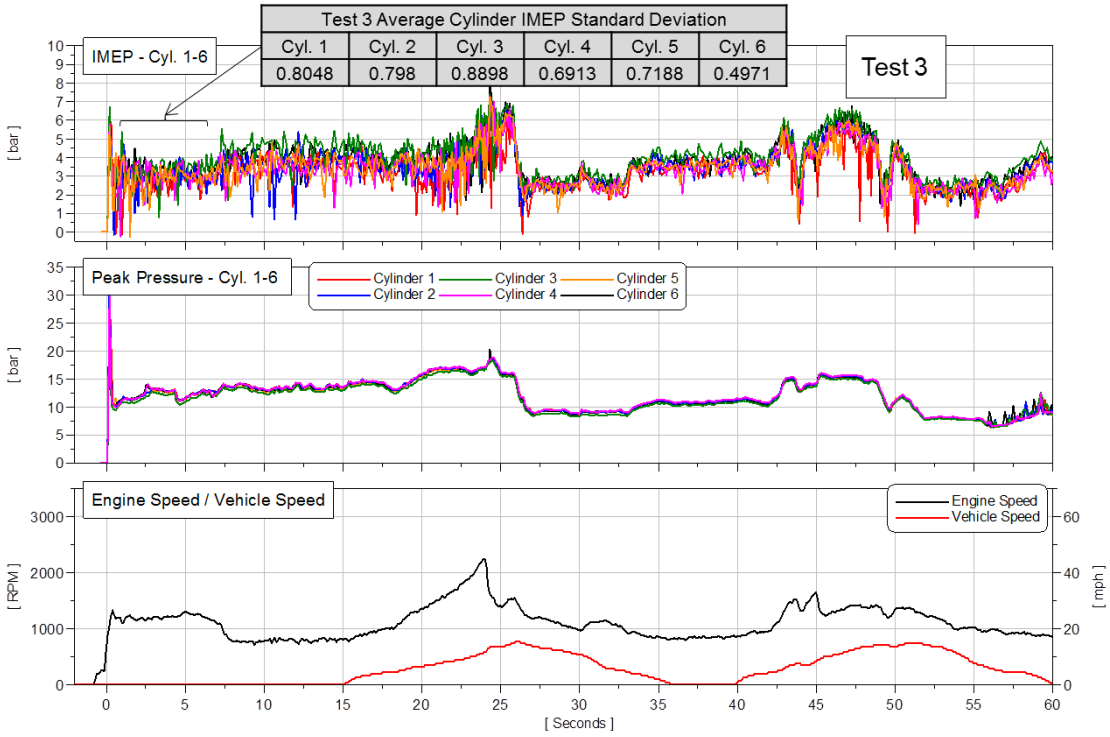


Figure 41. Ford F-150 C0 TR2338 Test 3 IMEP Cold Start Data and Standard Deviation

From previous testing on the Honda Civic it was noted that closed loop AFR control is crucial for correcting fueling and improving engine stability and driveability. The Ford F-150 short term fueling corrections were not indicated via short term fuel trim activation until 17-19 seconds after engine start up (after first hill drive away). Figure 42 below shows the F-150 testing on CE30 TR2340, where the STFT's do not activate until 18 seconds indicating start of closed loop operation. It can be noted that prior to short term fueling corrections the AFR is lean across both engine banks, potentially due to the high ethanol content of CE30 TR2340 and the lack of active fueling corrections.

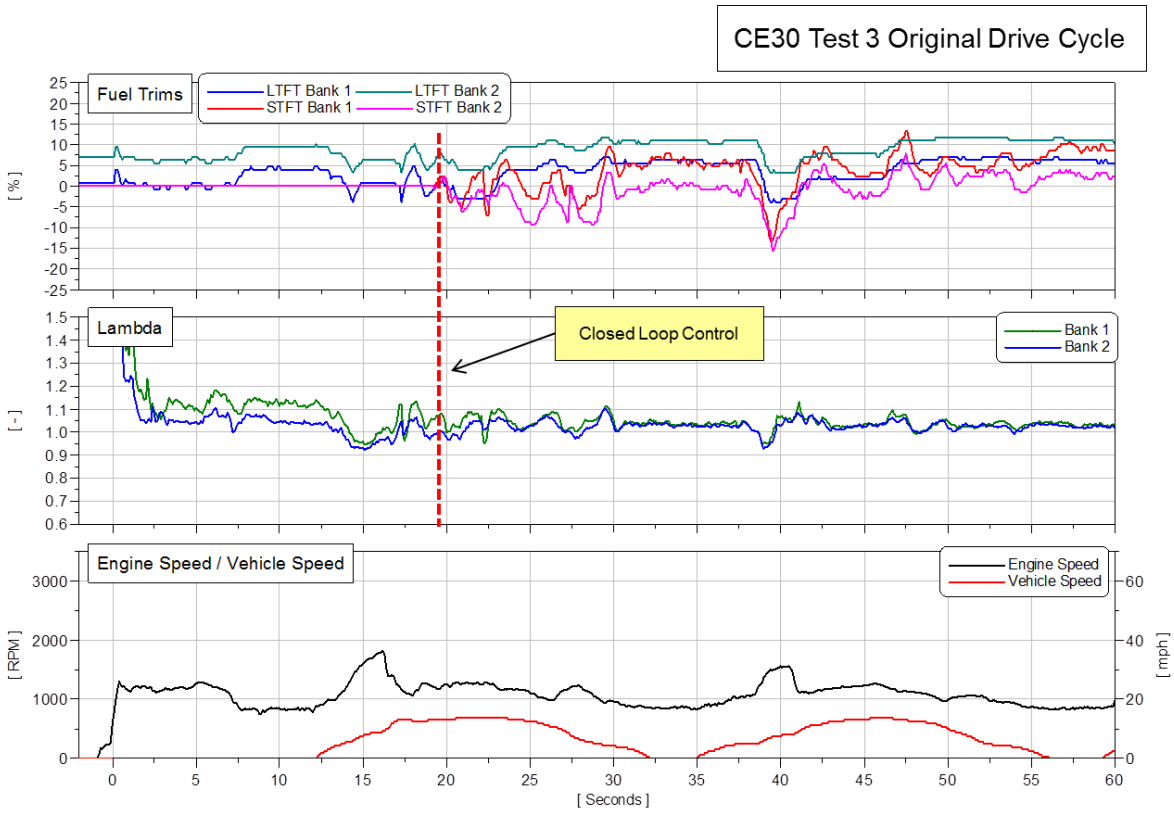


Figure 42. Ford F-150 CE30 TR2340 Test 3 Closed Loop Operation Indicated by STFT activation

Modified Drive Cycle Data Review

Up until this point most of the fuel effects on the vehicles were not captured during vehicle transient driving operation. After the switch over to the modified drive cycle a degradation of driveability became measureable. The most adversely affected fuels were C0 TR2338 and CE30 TR2340. Figure 43 shows the first test run on C0 TR2338 test fuel and the severe misfires on all cylinders as evidenced by the IMEP measurements dropping to zero. It is also notable that the misfires continued into the second drive cycle hill after closed loop operation and warming of the combustion chamber, believed to be caused by excess spark plug carbon deposits herein called spark plug fouling

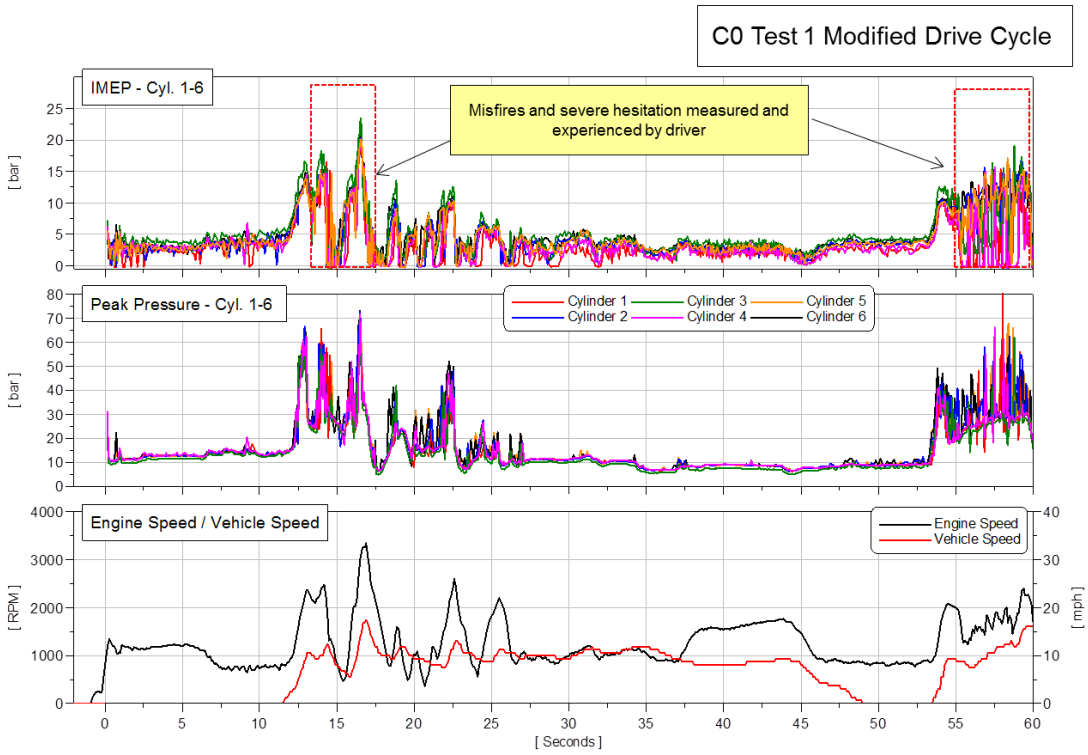


Figure 43. Ford F-150 C0 TR2338 Test 1 severe driveability degradation evidenced by misfires

The misfires were severe enough to prevent the vehicle from successfully following the drive cycle up to 20 mph, apparent in the vehicle speed trace. Despite the pedal request from the driver (100%) the vehicle could not maintain vehicle speed, shown in Figure 44.

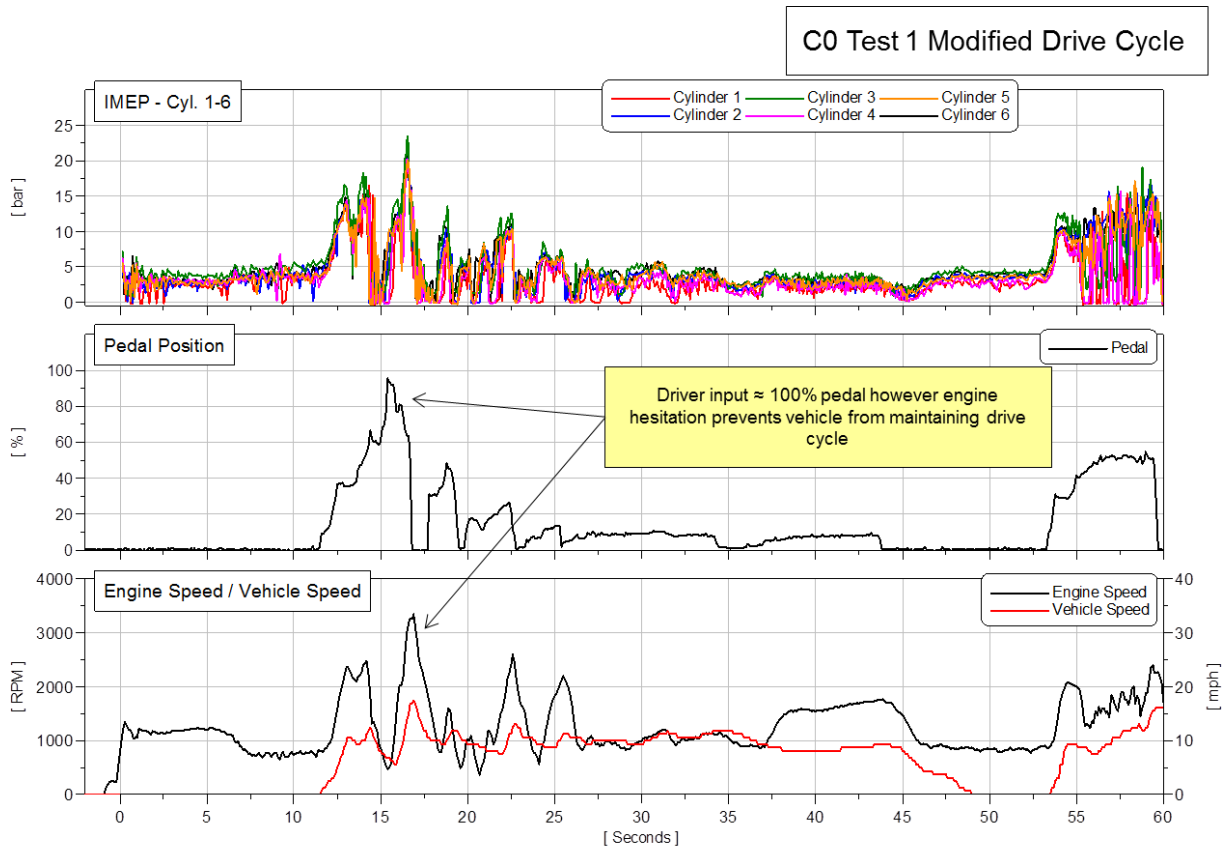


Figure 44. Ford F-150 C0 TR2338 Test 1 Showing Driver Pedal Input

Rather than improve consecutively as testing progressed due to fueling adaptations, the misfires and driveability degradation persisted. The second test on C0 TR2338 test fuel witnessed the vehicle engine stall out during the drive away, shown in Figure 45. The vehicle would then fail to restart; a further root cause investigation revealed that the spark plugs had excessive carbon deposits due to incomplete combustion preventing proper spark plug firing. Changing spark plugs after every test, thus ensuring that each test began with clean and new plugs, became incorporated in the standard testing procedure to eliminate the effects of spark plug fouling carried over into subsequent repeat tests. A full review of test procedure modifications during the program is available in Appendix F Vehicle Test Sequence and Test Modifications.

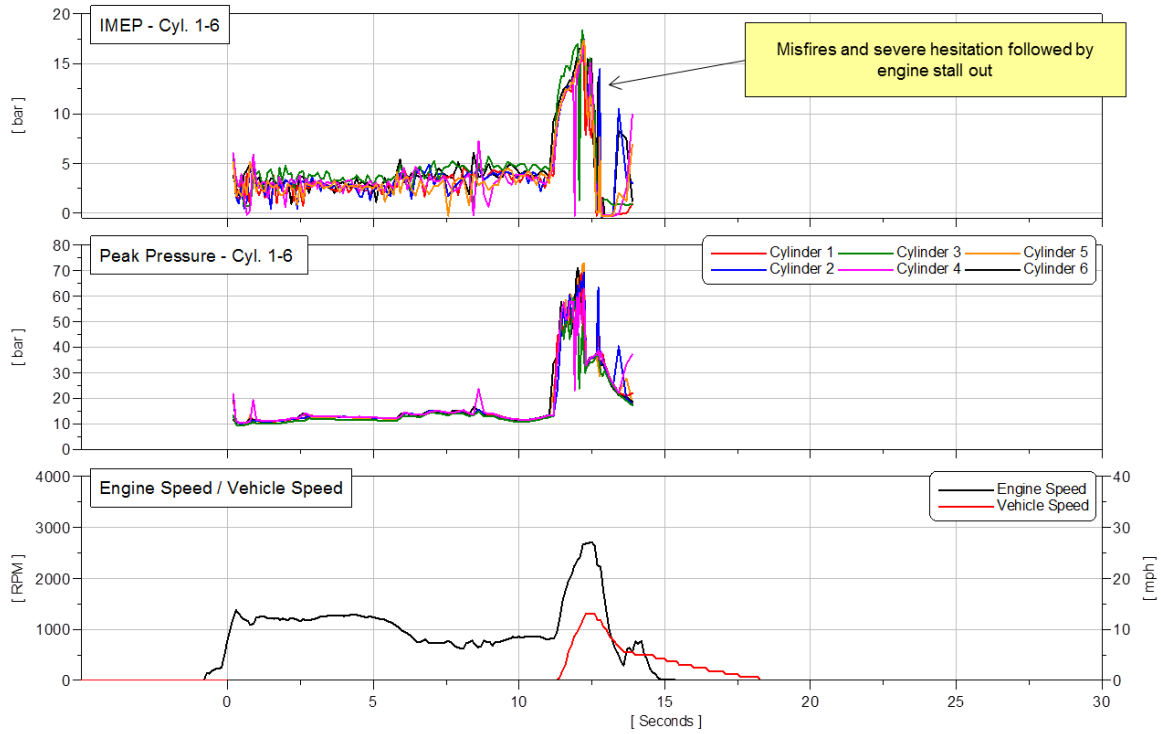


Figure 45. Ford F-150 C0 TR2338 Test 2 Engine Stall due to spark plug fouling

Based on severity and number of misfires, hesitation, and engine stalls, the driveability impact was highest on the C0 TR2338 and CE30 TR2340 test fuels. However, the IMEP standard deviation plot in Figure 48 (measured during cold start idle in park) shows no statistical difference between the four test fuels, although the test average was higher for CE30 TR2340. Figure 46 shows an IMEP comparison on all fuels on test day 3, the data shows consistent and severe driveability degradation on the C0 TR2338 and CE30 TR2340 fuel. Despite high LTFT's to compensate for lean conditions caused by the fuels, the engine still misfired considerably causing driveability degradation that was very evident to the driver. Figure 47 shows unstable AFR fueling measurements and high levels of STFT instability, the LTFT is also learned from the previous 2 tests and show a significant positive fueling correction to compensate for lean conditions. Regardless of fueling adaptations and corrections the vehicle struggled to operate with C0 TR2338 and CE30 TR2340 fuels, the typical driver would consider vehicle cold start driveability unacceptable in these cases.

Figure 46. Ford F-150 Modified (Aggressive)Drive Cycle Test 3 All Fuels

Results captured in Figure 46 show severe misfires during the initial drive away from 10-40 seconds of the modified aggressive cycle. By second 50 the combustion chamber has warmed up sufficiently to mitigate the fuel effects. Any IMEP drops past second 50 are due to driver pedal request or transmission gear shift causing the engine to reduce output. Due to the 10 speed automatic transmission there is a significant amount of transmission shifting.

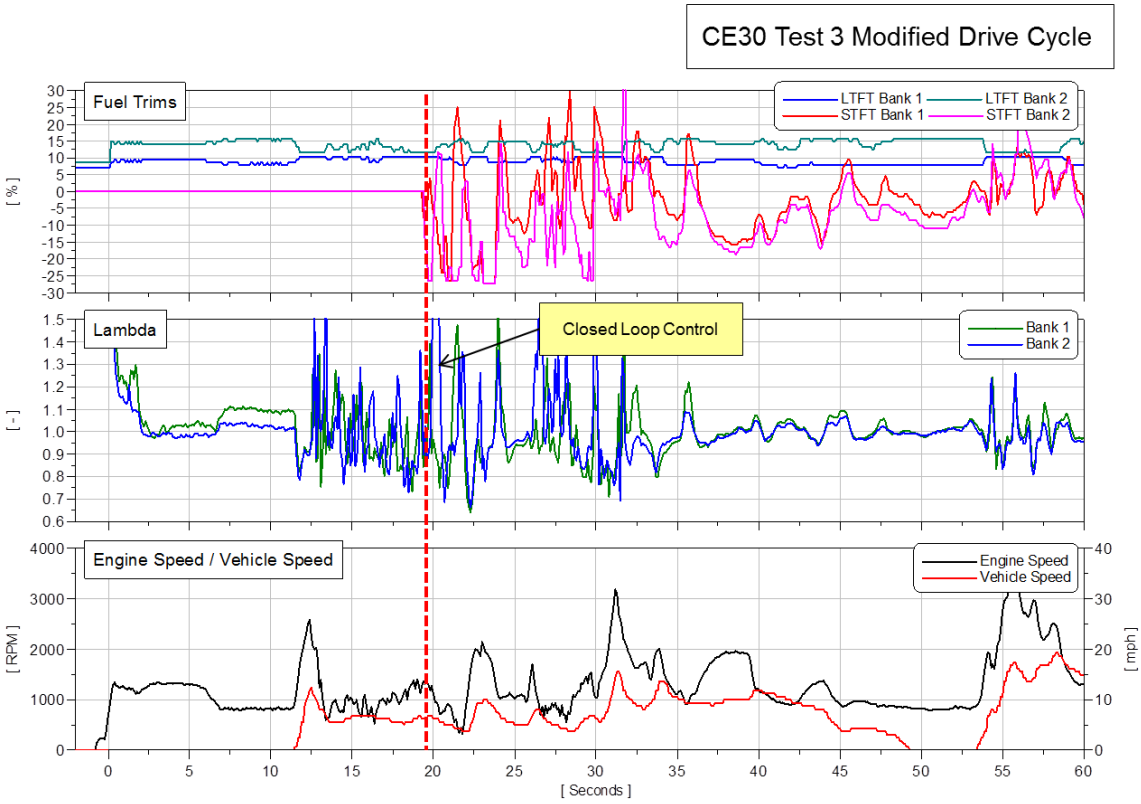


Figure 47. Ford F-150 Modified Drive Cycle CE30 TR2340 Fuel Test 3

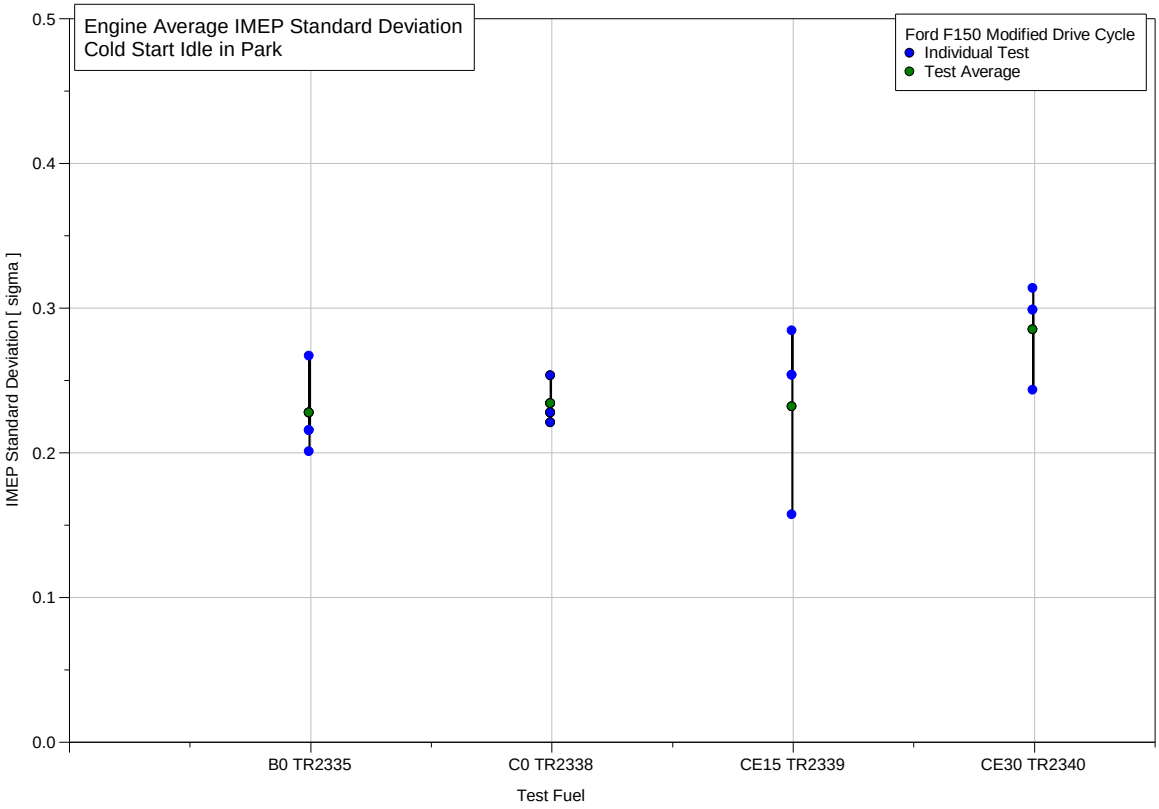


Figure 48. Ford F-150 Cold Start IMEP Standard Deviation Plot Modified Drive Cycle

	Engine Start Comparison (sec)		
	Test 1	Test 2	Test 3
B0	1.01	0.77	0.75
C0	0.84	0.77	0.70
CE15	0.91	0.71	0.70
CE30	0.93	0.78	0.79

	Engine Start (Crank Revolutions)		
	Test 1	Test 2	Test 3
B0	3.8	2.5	2.3
C0	2.5	2.1	2.5
CE15	2.9	2.1	2.5
CE30	2.95	2.6	2.25

Table 7. Ford F-150 Engine Start Time Metrics for Modified (Aggressive) drive cycle

Summary

Testing on the Ford F-150 provided very valuable insight into driveability degradation caused by the high DI test fuels. Initially testing on the original CRC 666 original drive cycle did not have a severe driveability impact, further investigation revealed that a more aggressive drive cycle would capture higher levels of driveability degradation. The combustion IMEP standard deviation measurements were notably high but statistically the same across fuels. Testing on the modified CRC drive cycle revealed serious driveability degradation particularly with C0 TR2338 and CE30 TR2340 fuel. The average IMEP standard deviation was higher for CE30 TR2340 than for the other three test fuels. Additionally after an engine stall event on C0 TR2338 fuel during the modified drive cycle testing, it was found that spark plug fouling was occurring. A separate spark plug investigation found that the plugs most affected by carbon deposits causing plug fouling were from C0 TR2338 and CE30 TR2340 testing, also in accordance with the driveability findings. In order to reduce the effects of improper spark plug function due to fouling the test procedure was modified to include spark plug changes after every test. It is not known how fast spark plug fouling occurred and whether the sustained driveability issues measured in C0 TR2338 and CE30 TR2340 testing was solely due to fuels influence or a combination of spark plug fouling and fuels influence. It was concluded that spark plug fouling occurred due to misfires/poor combustion caused by the test fuels. This is further backed by data showing high IMEP variation, misfires in combustion data, and unstable AFR measurements, Figures 46 and 47.

Measurements and results were repeatable across all three tests for each fuel with consistent misfires measured and degraded driveability observed on C0 TR2338 and CE30 TR2340 fuel. Despite long term fueling adaptations the driveability degradation did not improve by the third test on C0 TR2338 and CE30 TR2340 fuels. B0 TR2335 and CE15 TR2339 were more stable in comparison with similar levels of driveability degradation. The data shows that C0 TR2338 testing was more severe than CE15 TR2339 testing indicating that the 15% splash blended ethanol fuel does not degrade driveability but actually improves compared to C0 TR2338, more testing is needed for this to be a conclusion and is an observation at this point. One of the causes for the elevated degradation of combustion stability and driveability performance across all fuels may be due to the cold start strategy the F-150 employs which targets Lambda 1.0. The low volatility high DI nature of the fuels will cause partial fuel vaporization which will create a leaner combustion mixture than intentionally targeted by the ECM causing combustion stability issues. Additionally it was observed that the ethanol blended fuels cold-start Lambda up until short term fueling correction in closed loop control was often measured as lean (1.1-1.2 Lambda) which further inhibits combustion stability with poor volatility high DI fuels. The en-leanment on ethanol blended fuels can be attributed to the higher oxygen content of the fuels. The time for short term fuel trim activation was also lengthy as it did not occur until 17-20 seconds after engine start, this could also help explain the serious driveability issues that occurred during the initial drive away at approx. 10-15 seconds while the vehicle is still in open loop control (not actively measuring AFM and using calibrated tables for fueling). The results show that even modern vehicles with the latest technologies are still sensitive to high DI fuels and ethanol blended fuels do have a discernable effect as they particularly affect open loop fueling conditions due to the high DI volatility properties and potentially oxygenate levels.

C. 2016 Mazda CX-9 Data Review

Vehicle specifications:
2016 Mazda CX-9
Engine: 2.5 Liter Inline 4 cylinder GTDI with high pressure external EGR
Transmission: 6-Speed Automatic
Engine Start Activation: Automatic Start Button (automatic crank until engine start)

Figure 49. 2016 Mazda CX-9 Tested

Test Findings

Testing on the Mazda CX-9 was conducted using the modified aggressive drive cycle and fully implemented the spark plug set change following every individual test to eliminate potential effects of spark plug fouling on driveability measurements. For the Mazda the original test fuel stocks were depleted and resupplied replacement test fuel supplied by Gage Products was used, refer to Appendix A: Fuel Inspection sheets for fuel properties. It is to be noted that the re-blended fuels did have slight differences in the volatility properties that may have affected this vehicles test results. Figure 5 shows the distillation curves of the original and re-blended fuels compared with one another.

This vehicle came equipped with an external high pressure EGR system; however this system is not active until the engine is fully warmed up and did not have a role in any of the driveability measurements for this testing. Unique to this engine are multiple ignition events measured during engine start up, up to 4 events are measured. This multi-spark strategy during engine turn over and start helps flame propagation for combustion and contributes to faster engine start up times, multiple ignition events are shown in Figure 54 and 56.

Starting with B0 TR2335A fuel the vehicle exhibited driveability degradation with engine hesitation on the first test's initial drive away. Engine start and idle were stable but during the initial pedal tip-in a misfire on cylinder 2 is noted. As the vehicle continued acceleration there is observed engine hesitation shown by the drop in IMEP during acceleration while pedal input by the driver is held

constant at approximately 65% (Figure 50). The driver did note the drive away hesitation but regarded it as minor and may pass unperceived by the average layman.

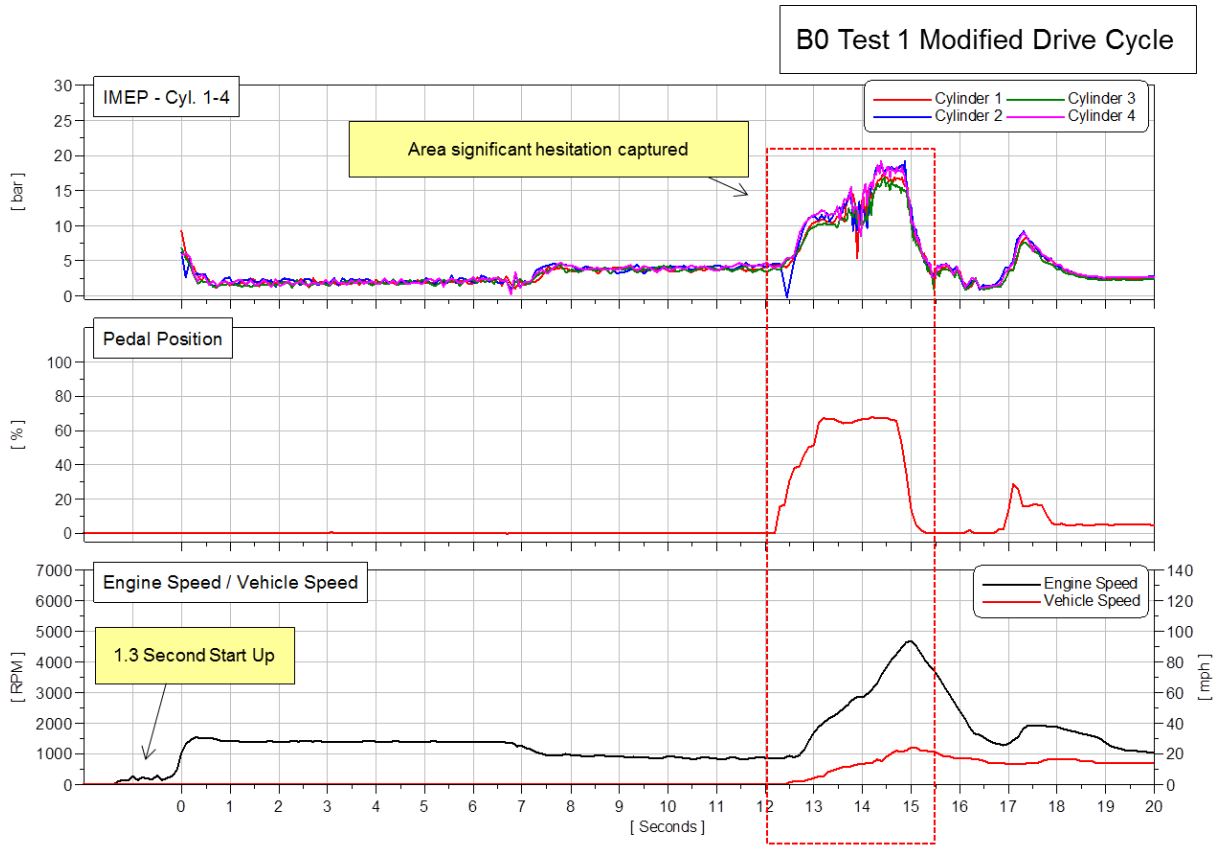


Figure 50. Mazda CX-9 B0 TR2335A Test 1 Engine Hesitation

Active short term fueling corrections occurred between seconds 10 and 13, Figure 51, coinciding with the pedal tip-in on the first drive away. It is not known whether the active fueling corrections were implemented during initial tip in response where a single cylinder misfire is repeatedly captured, Figure 50 second 12.5. Long term memory fueling adaptations were present across tests with adjustment to cold start Lambda. On B0 TR2335 fuel test 2 and 3 the driveability hesitation observed during test 1 during the first drive away was no longer present, indicating fueling adaptations improving driveability performance.

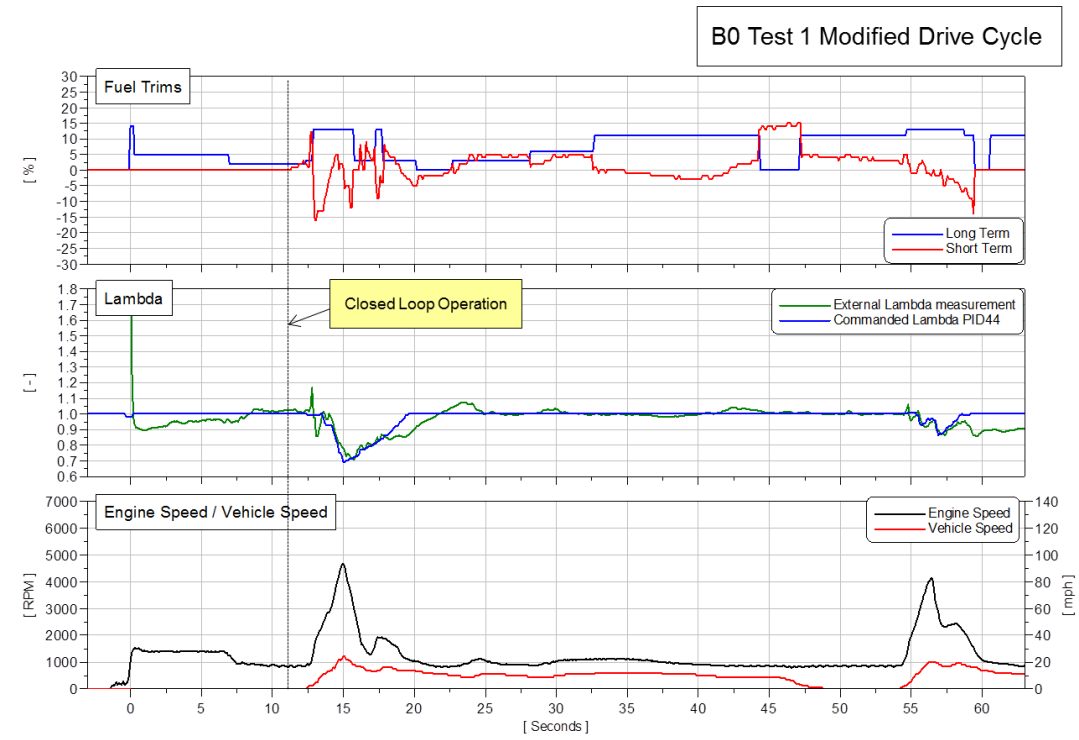


Figure 51. Mazda CX-9 B0 TR2335A Test 1 Measured Lambda and Fuel Trim Adaptations

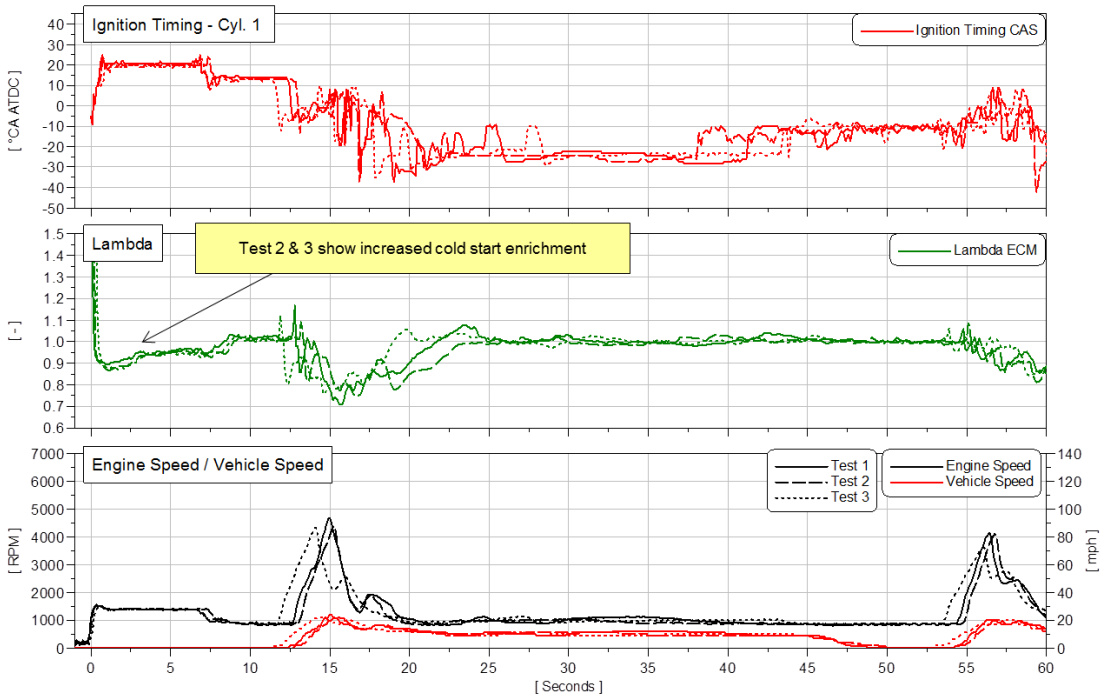


Figure 52. Mazda CX-9 B0 TR2335A Test Comparison Cold Start Enrichment Adjustments

Testing on C0 TR2338A test fuel confirmed a consistent single cylinder misfire at pedal tip-in during the first drive away, Figure 53. This occurred for all three tests of fuel C0 TR2338A as shown in Appendix D. In accordance with the misfire event the Lambda measurement would have a lean reading due to the lack of combustion in one cylinder passing non-combusted air into the exhaust, Figure 54. There was no driveability degradation on C0 TR2338A test fuel measured and the vehicle responded well to the test fuel contrary to results from previous vehicles tested. A close look at fueling adaptations showed the fuel trims applying high corrections in response to the test fuel, Figure 55. The long term fuel trims are set to increase fueling while the short term fuel trims counter balance and reduce over-fueling during vehicle accelerations. It was noted that at 50°C Engine Coolant Temperature the fuel trims reset, indicating that the vehicle had different fuel trim adaptation tables for different engine temperature set points. The first test on C0 TR2338A test fuel had the long term fuel trims set at an 8% increase in fueling correction. This may be that the fueling correction was learned from the vehicle fill up and FTP74 drive cycle prep the previous day and carried over. It was later learned that a more thorough way to reduce carry over adaptations from vehicle prep is to clear fuel trim memory using a manufacturer scan tool, this was not done on any of the vehicles in this program.

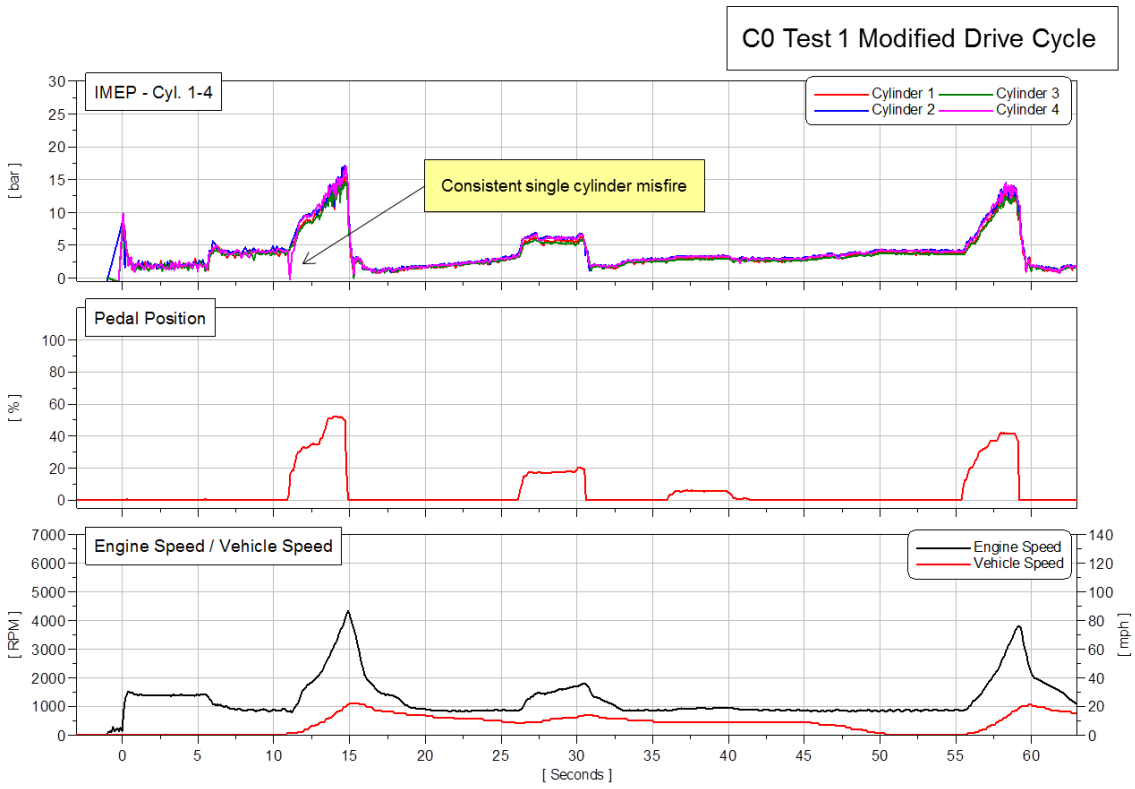


Figure 53. Mazda CX-9 Test 1 on C0 TR2338A Fuel Consistent Single Cylinder Misfire

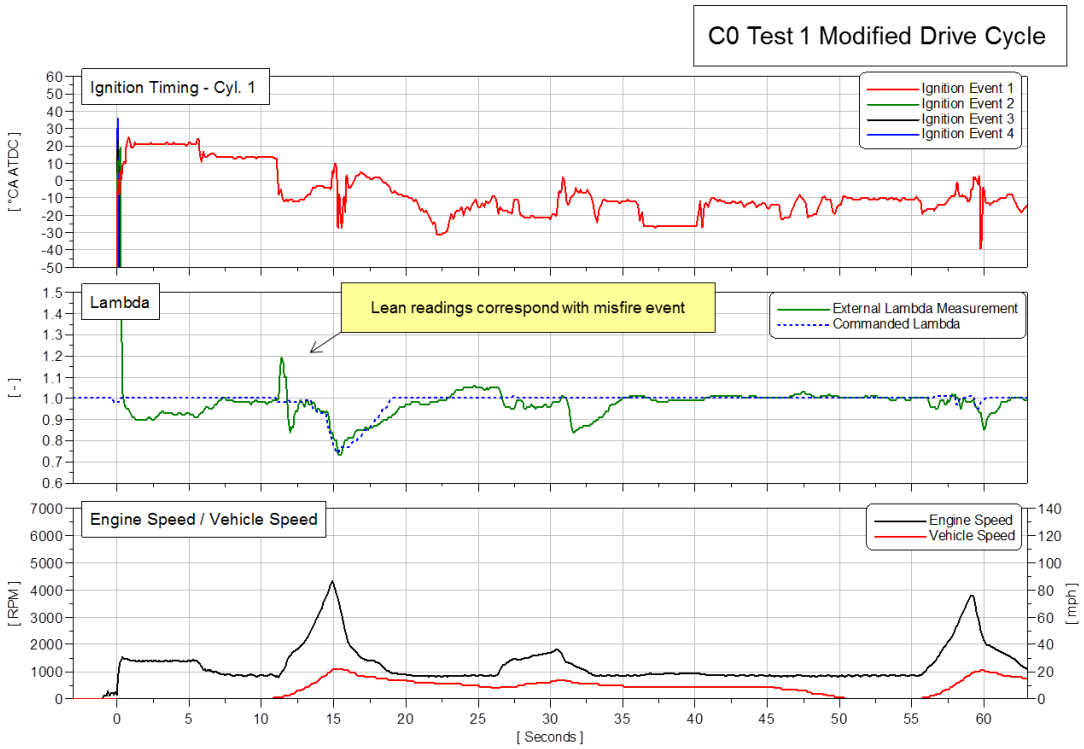


Figure 54. Mazda CX-9 Lean Lambda Measurement Due to Single Cylinder Misfire

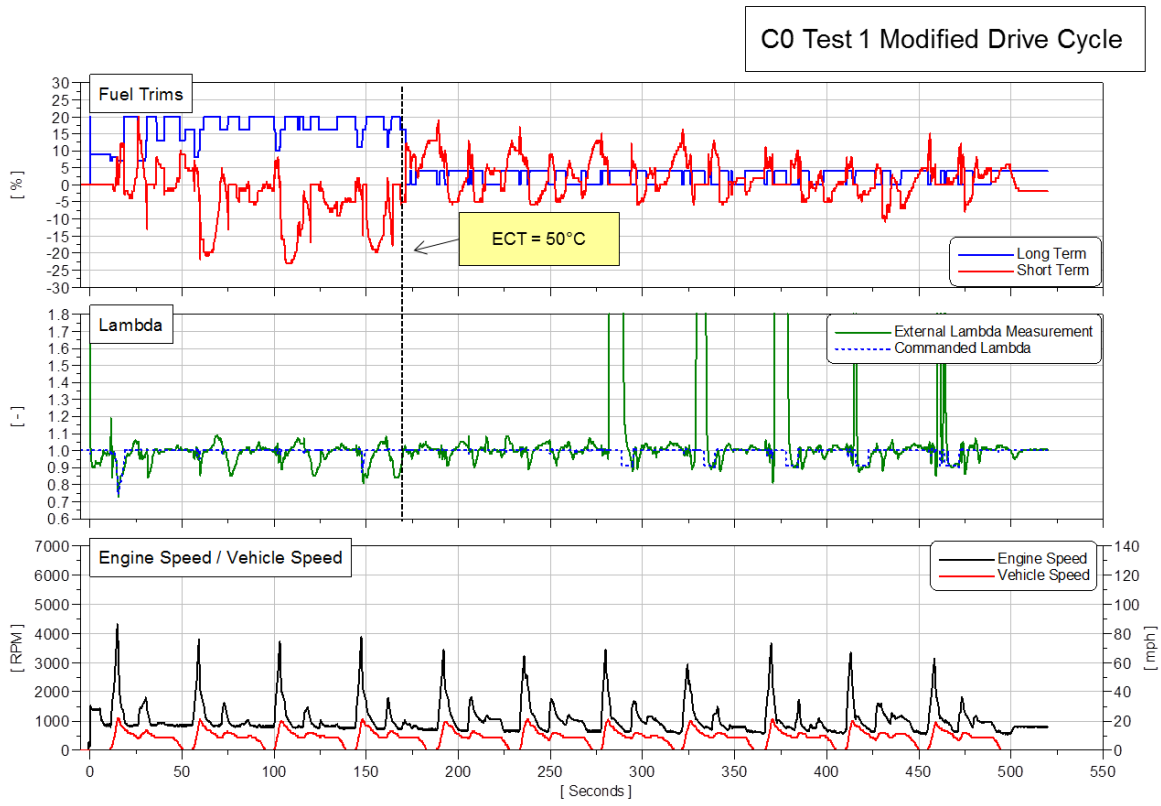


Figure 55. Mazda CX-9 Fuel Trims on C0 TR2338A Test Fuel

Testing on CE15 TR2339A fuel caused an engine stall event on the first test, shown in Figure 56. On the second start attempt the engine successfully started and vehicle completed the drive cycle. A close look at the data showed elevated levels of combustion instability during engine idle, potentially due to open loop fueling consistently at lean conditions (1.1 Lambda), Figure 58. In response to the engine stall the engine control module implemented rapid adaptations with a different engine start and warm up strategy. Instead of an active catalyst heating strategy, characterized by late ignition timing and a double fuel injection, a different strategy was implemented. The fuel injection strategy changed to a single injection event and there was no active catalyst heating as the ignition timing was not retarded past TDC. This change in strategy was likely due to the engine control module recognizing the initial engine stall and changing over to a safer calibration strategy that prioritizes engine stability over cold start emissions reduction. On this second start attempt, following initial engine stall during the first attempt, the vehicle drive away on the first drive cycle hill observed significant driveability degradation caused by engine IMEP hesitation, Figure 57. A look at the ignition timing during the engine hesitation does show brief retardation that is consistently present during this area of engine operation, Figure 58. The ignition retard causes a reduction in engine IMEP that can be compounded by fuels influence. There can be a variety of reasons for the ignition retard in that section of engine operation, one plausible explanation may be for engine knock mitigation purposes. The fuel trims following the lean open loop fueling also max out at 30% positive correction in response to CE15 TR2339A fuel, indicating very high fueling corrections being implemented, Figure 59.

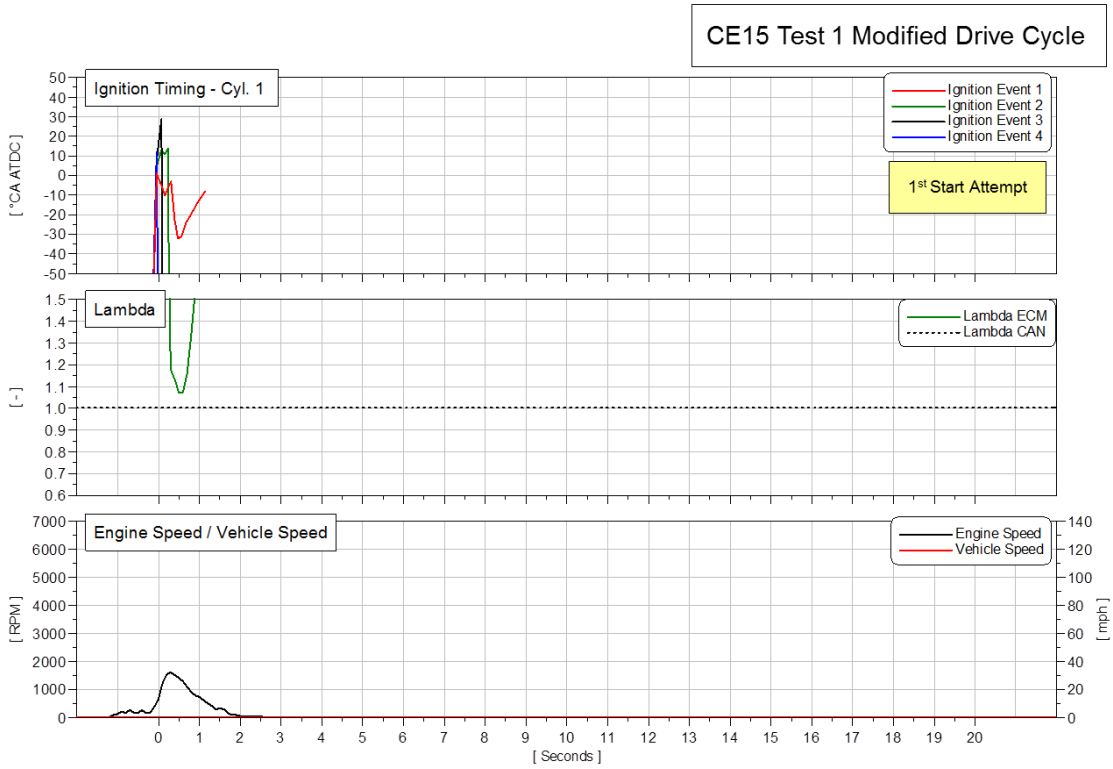


Figure 56. Mazda CX-9 CE15 TR2339A Test 1 Engine Stall first start attempt

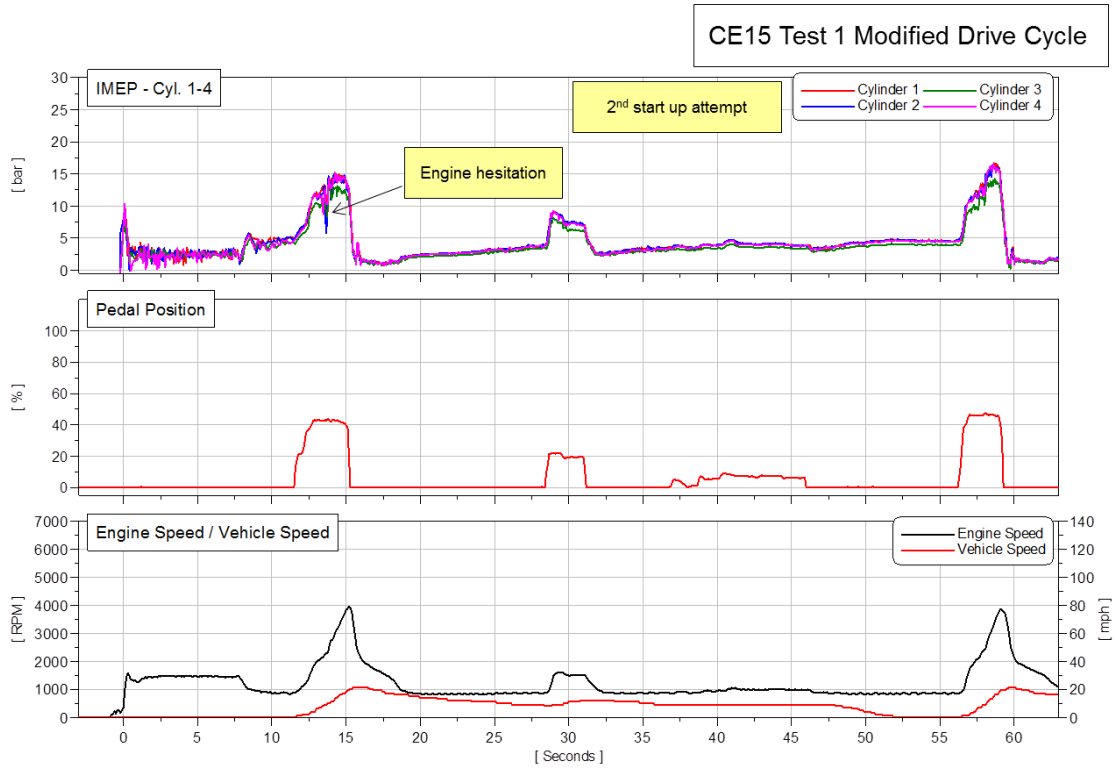


Figure 57. Mazda CX-9 CE15 TR2339A Test 1 second Start Attempt

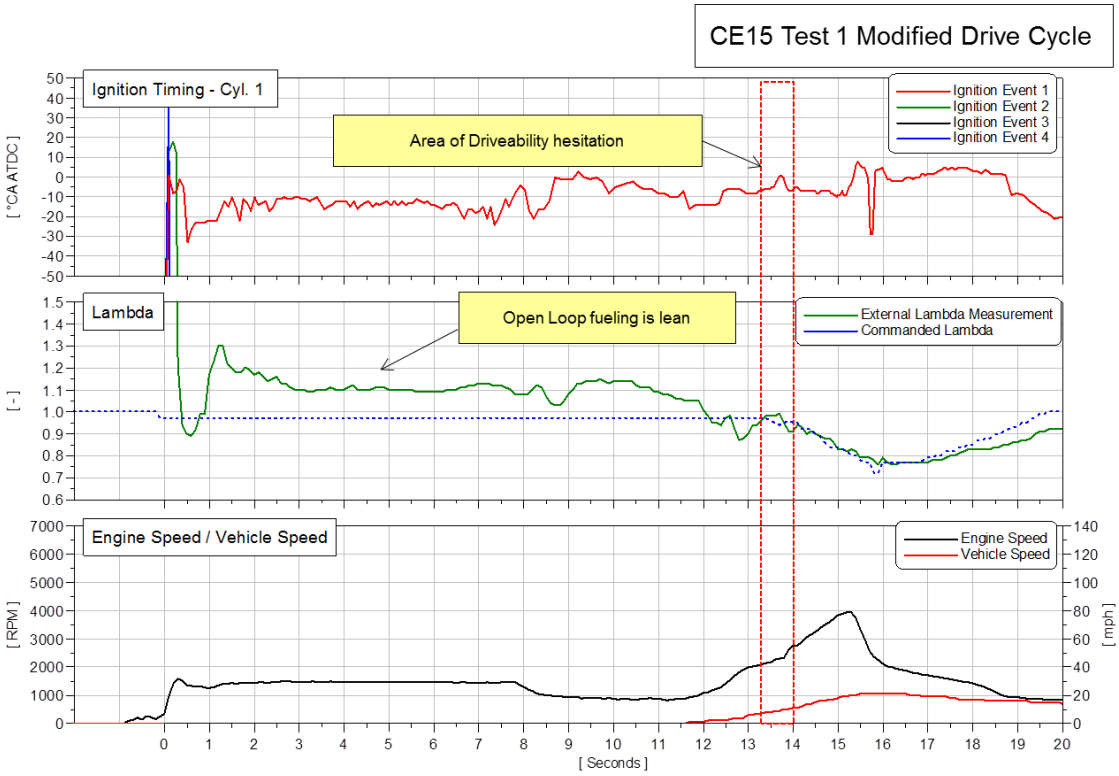


Figure 58. Mazda CX-9 CE15 TR2339A Second Start Up on Test 1

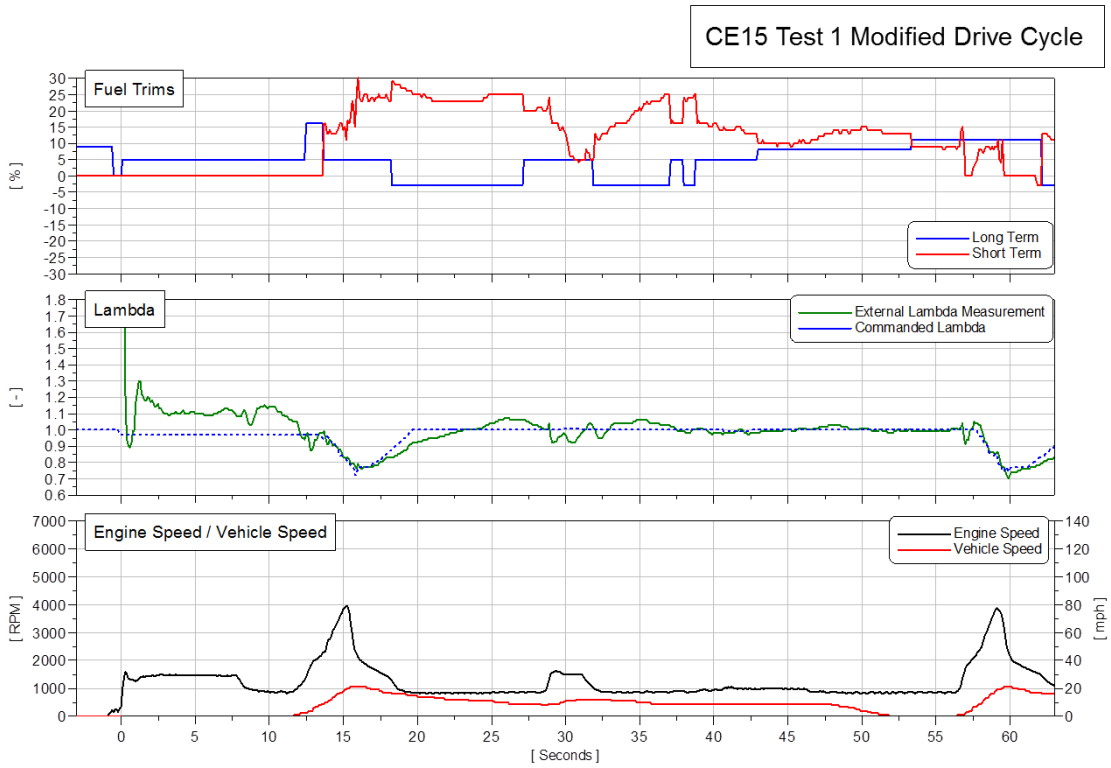


Figure 59. Mazda CX-9 CE15 TR2339A Test 1 Fuel Trims

For the remaining tests on CE15 TR2339A fuel, the cold start calibration strategy reverted to a catalyst heating strategy for cold start emissions reduction. The open loop fueling was no longer lean but likely adapted with the learned long term fuel trims from the first test. There was still driveability degradation from engine hesitation during the first drive away, possibly due to the ignition timing strategy used. Figure 61 more clearly shows the reduction in cylinder combustion pressure caused by the ignition timing retard that causes engine hesitation; it is also present in the engine speed trace. Figure 60 shows the corresponding ignition timing retard, engine speed hesitation and measured Lambda.

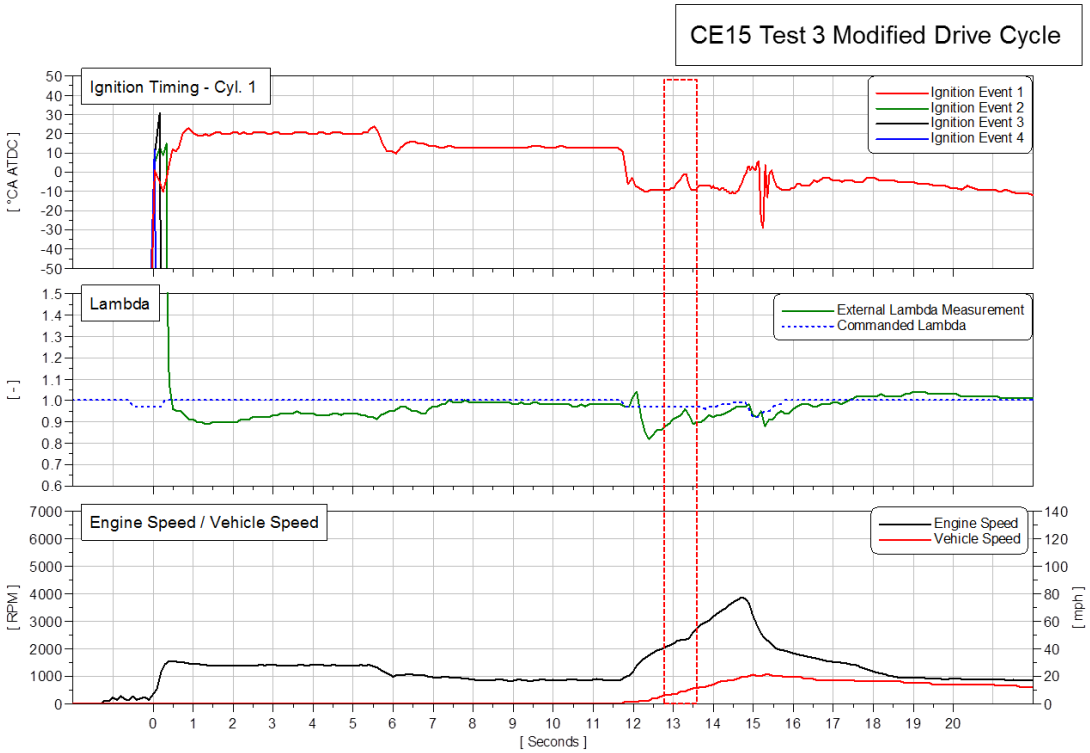


Figure 60. Mazda CX-9 CE15 TR2339A Test 3 Cold Start Strategy

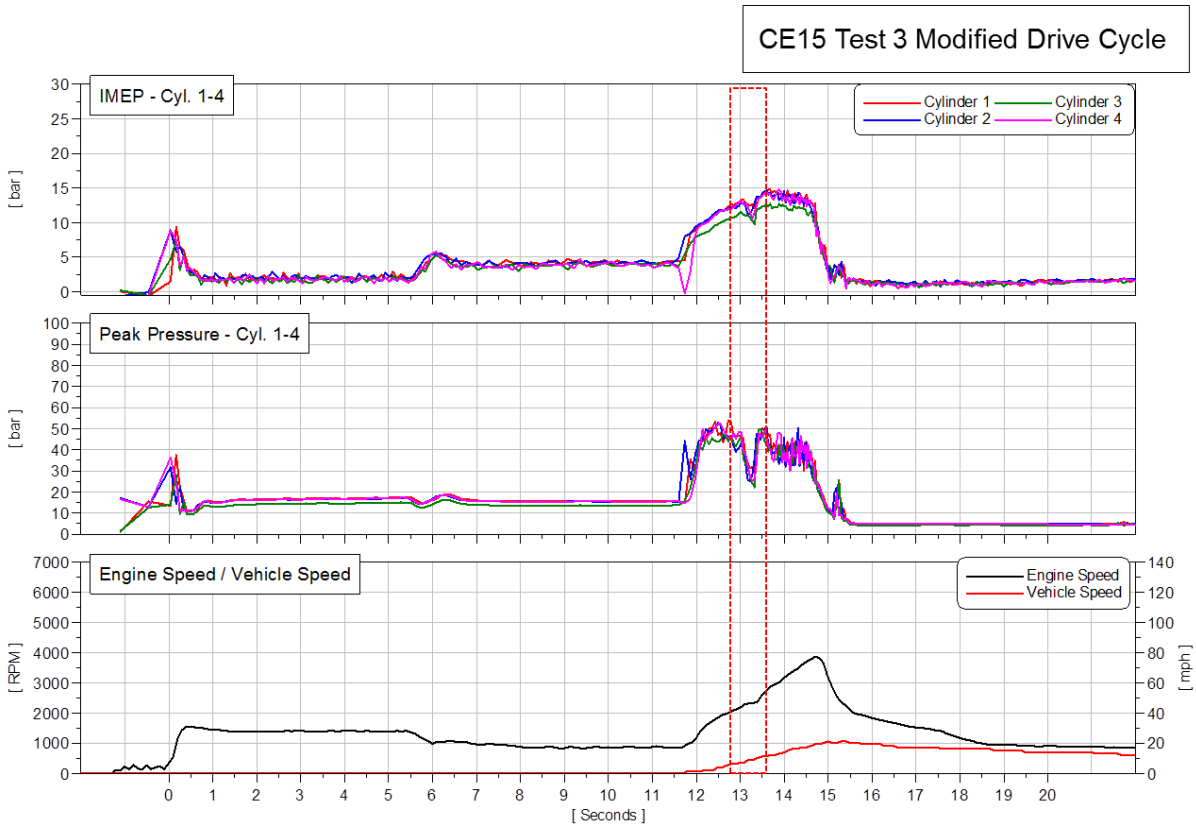


Figure 61. Mazda CX-9 CE15 TR2339A Test 3 Combustion IMEP and Pressures affected by ignition retard

The final tests run on CE30 TR2340A test fuel did not show the same level of driveability degradation during the first drive away. Open loop fueling was consistently lean for all three tests despite fuel trim adaptations close to maximum levels for correcting lean conditions (Figure 62). Following the third and final test the vehicle set a “Check Engine Light” that was a P0171 engine bank 1 too lean code. This code was likely caused by the high ethanol content of the CE30 fuel (30% ethanol). This occurred even though the fuel trims were correcting for lean conditions; they were likely at maximum authority and could not adequately compensate for the fuel and eventually an engine code was set.

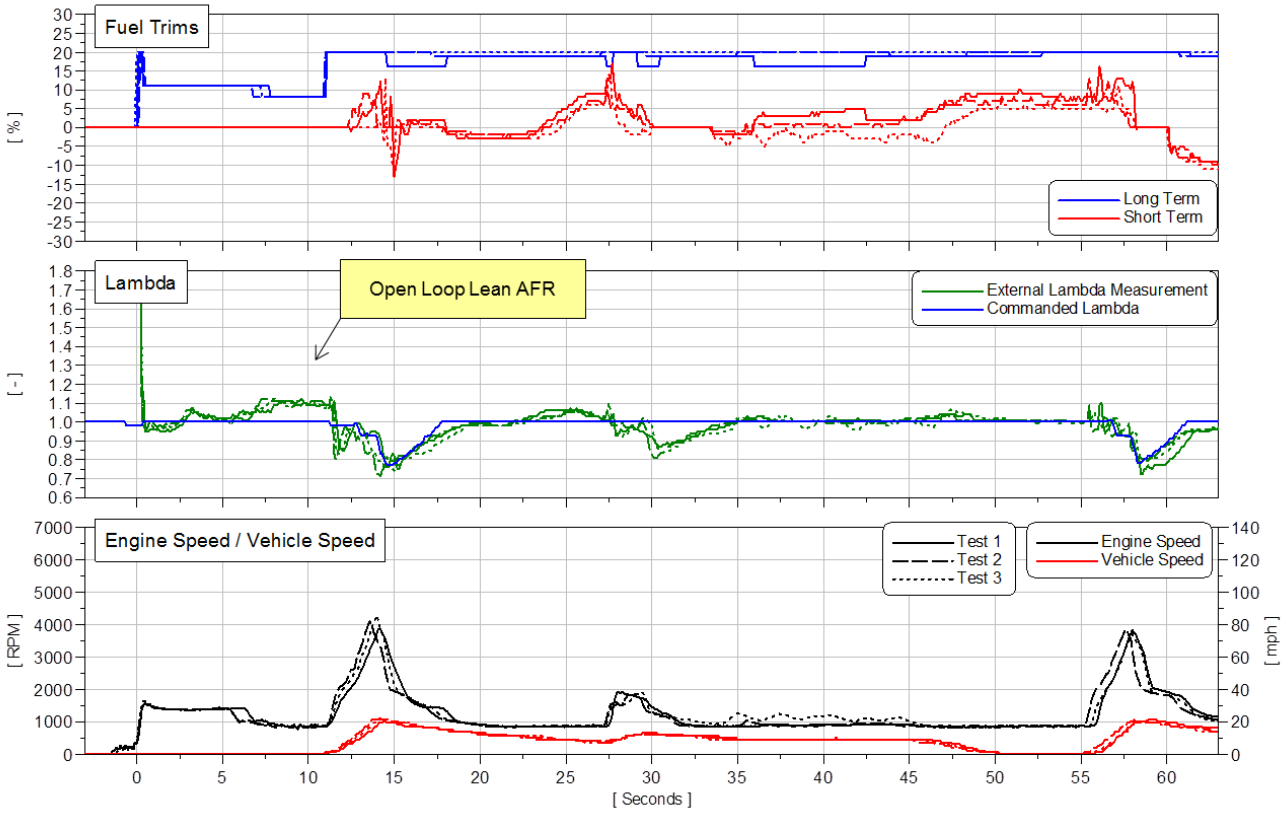


Figure 62. Mazda CX-9 CE30 TR2340A All Tests Open Loop AFR Consistently Lean

Despite open loop fueling being lean, the driveability during vehicle acceleration response was not significantly degraded. Figure 63 and 64 show the driveability on CE30 TR2340A which was not significantly affected with a consistent and smooth response from the engine as indicated by the combustion IMEP in response to pedal input from the driver. The engine start time on CE30 TR2340A was prolonged in comparison to the rest of the test fuels, shown in Table 8.

	Engine Start-Up Comparison (sec)		
	Test 1	Test 2	Test 3
B0	1.3	1.2	0.9
C0	0.9	1.1	1.1
CE15	0.9	1.1	1.3
CE30	1.6	1.2	1.5

	Engine Start (Crank Revolutions)		
	Test 1	Test 2	Test 3
B0	3.5	3.0	2.3
C0	2.8	3.1	3.3
CE15	3.4	3.5	4.0
CE30	4.8	4.0	4.5

Table 8. Mazda CX-9 Engine Startability Metrics

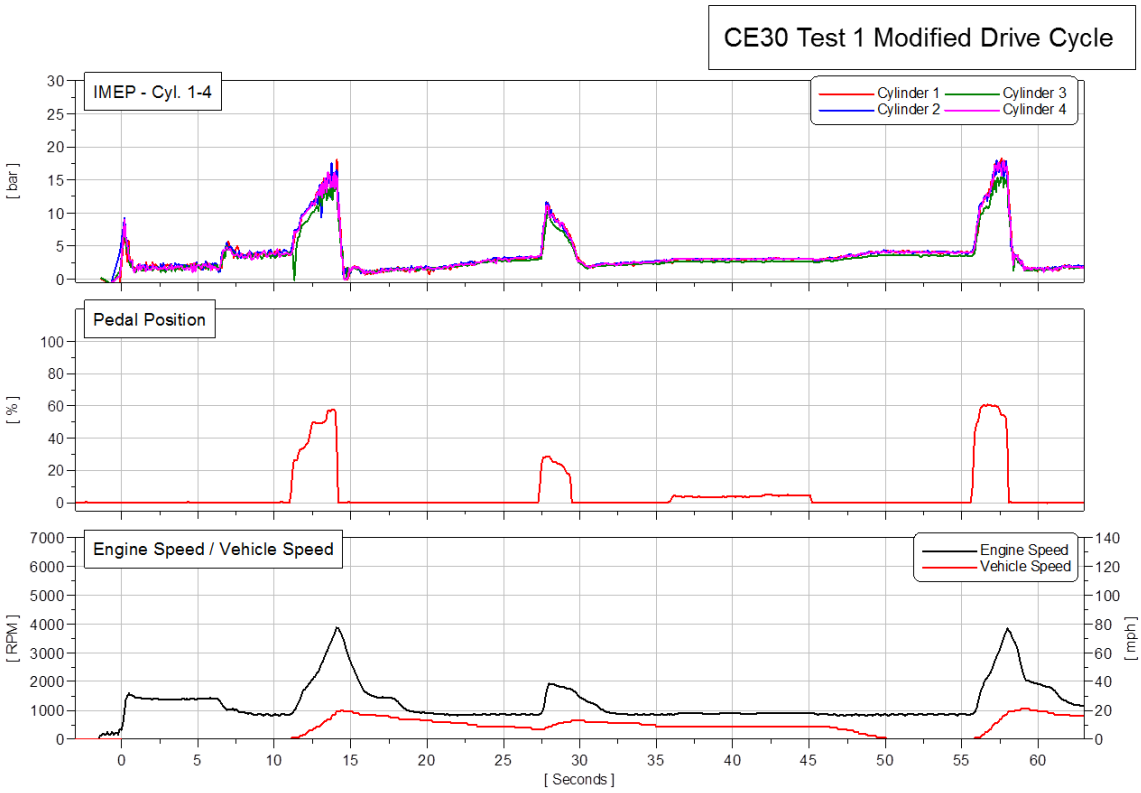


Figure 63. Mazda CX-9 CE30 TR2340A Test 1 Driveability not significantly degraded

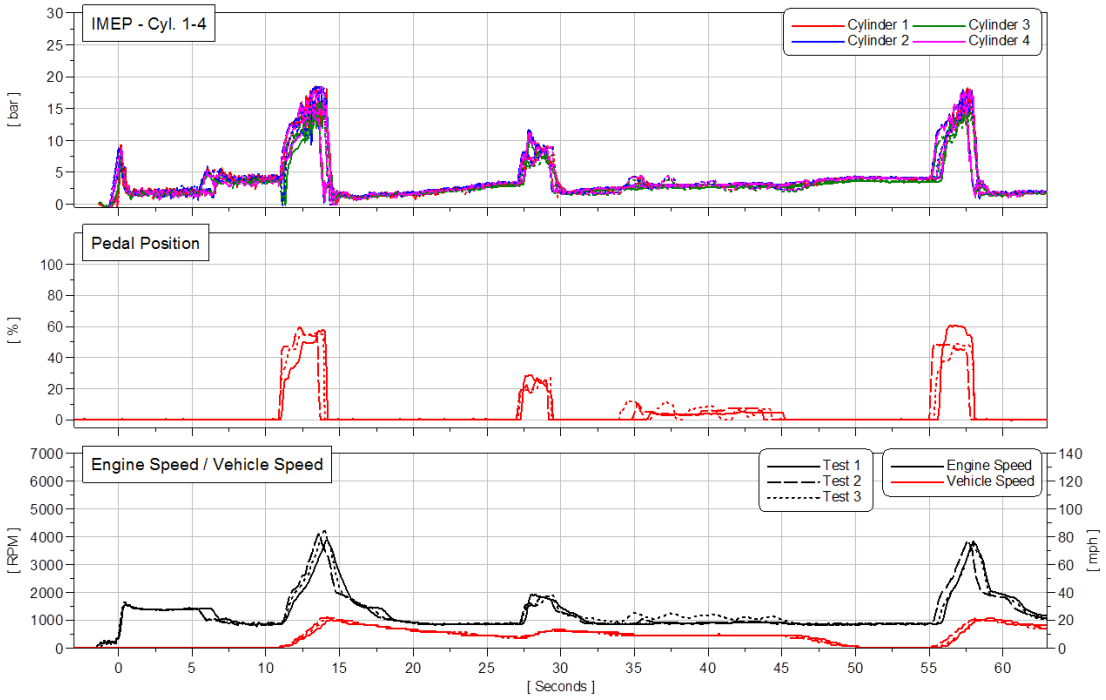


Figure 64. Mazda CX-9 CE30 TR2340A All Tests Showing Consistent Driveability Results

Summary

For this vehicle's testing the ethanol blended fuels exhibited more severe driveability response than the base hydrocarbon fuels, with the most severe fuel being CE15 TR2339A test fuel due to an engine stall event that occurred on the first test and consistent engine hesitation during initial drive away acceleration. It is noted that the CE15 TR2339A fuel had a significant difference in T50 distillation point than the original CE15 TR2339 fuel; this may have contributed to vehicle driveability differences when compared to the previous vehicles tested on CE15 TR2339 fuel. CE30 TR2340A test fuel also had consistent and prolonged engine start times similar to the previous vehicles tested. During the first drive away acceleration, where driveability degradation was present, possible test fuel influence coupled with an ignition retard strategy was the cause for inconsistent combustion IMEP output that triggered driveability performance degradation. The ECM adaptations were also noted to only be effective in improving engine start time on B0 TR2335A test fuel, the rest of the fuels did not show startability improvement on consecutive tests. A consistent single cylinder misfire during the first initial pedal tip-in at drive away (≈10 seconds) was noted across all tests and fuels. This can be due to fuels influence while the vehicle is still in open loop control and combined with poor fueling response by the engine controls, this single cylinder misfire was not noticeable by the driver and not considered a major driveability concern.

The first test on CE15 TR2339A was characterized by an engine stall event, when the vehicle was started and run, again the engine control module was noted to rapidly adapt and switch to a more stable and conservative cold start strategy. Regardless of the change in cold start strategy on the first CE15 TR2339A test, the vehicle still exhibited driveability degradation during the initial drive away acceleration, Figure 57.

In comparison the CE30 TR2340A tests did not stall the engine but did have notable effects on the fueling measurements. Following the CE30 TR2340A fuel testing the vehicle triggered a check engine code due to consistent lean conditions from the high ethanol content fuel; this was the first vehicle in the test program to set a check engine light in response to a test fuel. The first tests are circled in red in the plot of IMEP standard deviation (Figure 65) as they are expected to have the largest IMEP standard deviation due to a lack of fueling adaptation. It is noted that CE30 has a large spread in IMEP standard deviation and the first test has the lowest deviation while the third test has the highest. The broad spread may be explained by the lean conditions caused by the fuel for which the ECM was not able to adapt to and eventually triggered a check engine light. For all tests, driveability degradation was only observed in the first 30 seconds after engine start, indicating that once the combustion chamber warms up the vehicle is able to adequately vaporize and combust the test fuels.

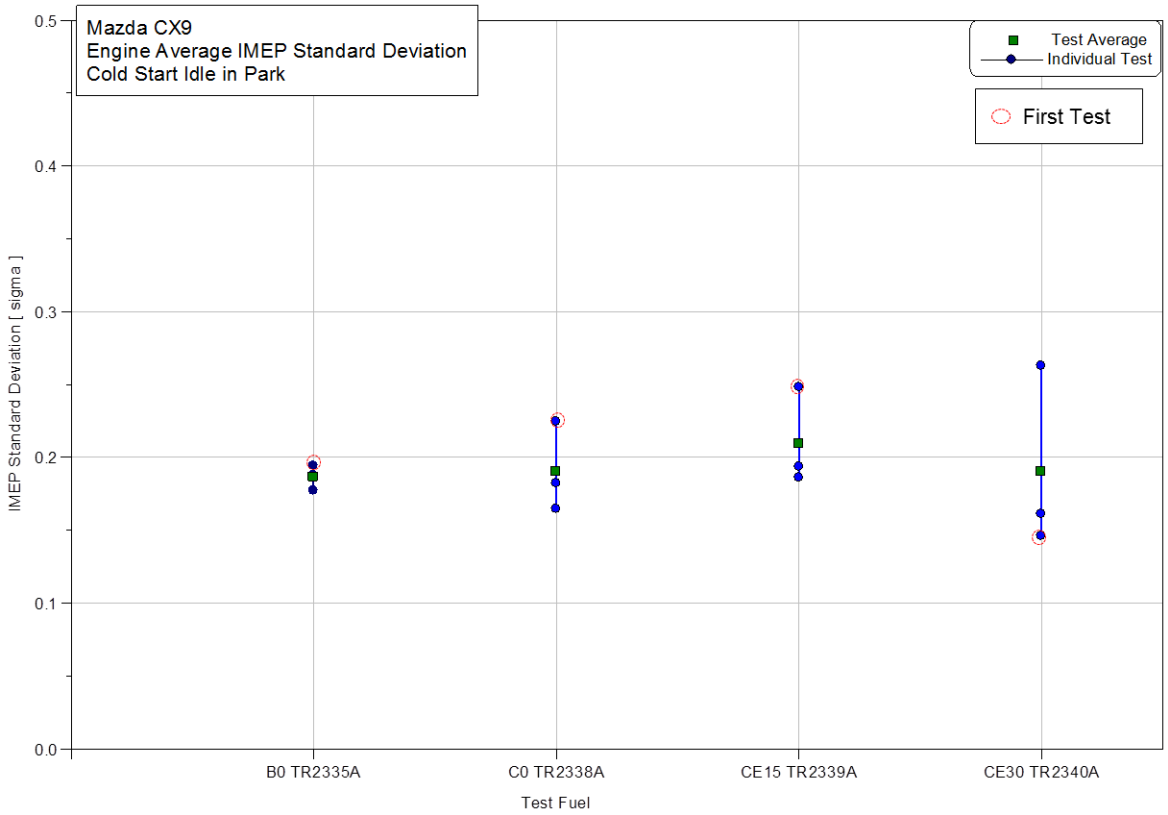


Figure 65. Mazda CX-9 IMEP Standard Deviation Plot

VII. Summary and Conclusions

This test program set out to determine if a climate controlled dynamometer based testing approach can be used to determine how vehicles respond to high DI fuels, ethanol blended fuels and the consequential effects on cold-start driveability performance.

As part of the investigation five questions were posed.

1. Do vehicles still respond adversely to high DI fuels?
2. Can this be detected with instrumentation?
3. How do the vehicles respond to high DI splash blended ethanol fuels?
4. Can the response be quantified with instrumentation?
5. What instrumentation is needed?

The vehicles all responded adversely to the high DI fuels showing that despite advances in engine technology, fuel volatility standards are still relevant and essential for cold-start driveability performance.

Utilizing a climate controlled chassis dyno chamber and instrumented vehicles for testing, the acquired data was able to detect and measure driveability performance in response to the test fuels. Metrics such as engine start up time / number of crankshaft revolutions, IMEP standard deviation, and driver pedal input to engine combustion IMEP output comparisons are able to characterize the effects of the fuels on driveability. It was also possible to gather a more fundamental understanding of the effects the test fuels had on modern combustion and engine management systems.

From initial testing on the Honda Civic it became apparent that engine management system fueling adaptations are a critical factor in vehicle response to differing test fuels, and those adaptations varied across different vehicle manufacturers and engine management systems. The adaptations included fuel trim adjustments, fuel injection duration, cold start enrichment, cold start ignition and injection timing. The time for closed loop AFR control, indicated by STFT activation, varied across vehicles and was also an important factor in how the engine management system responded and corrected fueling conditions. Stored long term fuel trim memory typically leads to driveability improvement in each consecutive test cycle and is considered a critical fueling adaptation to mitigate high DI induced driveability degradation, particularly in open loop AFR conditions. The Honda Civic for example showed increased open loop AFR enrichment following consecutive testing in order to mitigate the effects of high DI fuel while the Ford F-150 did not exhibit open loop AFR adaptation regardless of consecutive testing. This suggests that different engine management systems have varying levels of high DI fuel adaptability.

Consistent with traditional DI modeling of hydrocarbon fuels, C0 TR2338 test fuel produced more driveability degradation than B0 TR2335 fuel on the Honda Civic and Ford F-150, however the same observation is not so clear on the Mazda CX-9. It is to be noted that the CX-9 used the resupplied and re-blended test fuel which had slight differences compared to the original test fuels used on the Honda and Ford. The ethanol blended fuels had variable effects across the vehicles and while they provided good insight into the response from the vehicles a firm conclusion was not reached regarding the effects of splash blended ethanol with high DI fuel. It would be beneficial to continue testing splash blended high DI ethanol fuels on more vehicles using this methodology to continue gathering data and conclusions.

In summary the test fuels that exhibited the most driveability degradation for each one of the vehicles tested are:

- Honda Civic: C0 TR2338 due to repeated engine stalls when shifting into drive.
- Ford F-150: C0 TR2338 and CE30 TR2340 test fuels due to misfires, severe engine hesitation and engine stall events
- Mazda CX-9: CE15 TR2339A due to engine stall event and repeated driveability degradation on the first acceleration.

From the study it is concluded that one of the largest effects the ethanol blended fuels have on vehicles is in open loop fueling control, due to induced lean AFR caused by high DI volatility fuel properties and compounded by ethanol blended oxygenated fuels. None of these vehicles came equipped with ethanol sensors in the fuel system so the change in fuel stoichiometry could only be detected and adjusted via fueling adaptations; in the case of the Mazda, tested with CE30TR2340A fuel an enleanment engine code was set, indicating that the CE30TR2340A fuel was beyond the vehicle's ability to cope with. It is known that engines running lean AFR's with a cold combustion chamber can degrade combustion stability and lead to engine misfires which will be perceived as driveability degradation.

In summary, the main learnings in this project regarding the effect of high DI fuel on vehicle driveability response are:

- Modern vehicles with GTDI engines still respond adversely to high DI fuels showing that despite advances in engine technology, fuel volatility standards are still relevant and essential for cold-start driveability performance.
- Vehicle instrumentation is able to capture and characterize test fuel driveability effects.
- Driver evaluation is able to readily detect several cases of fuel induced driveability effects and instrumented data backs and quantifies driver subjective evaluation.
- Ethanol blended fuels can have an enleanment effect that goes uncorrected until closed loop air fuel control. During the enleaned combustion, the engine is more prone to misfire events, hesitation and subsequently driveability degradation.
- Factors that determine time to closed loop air fuel control vary and can be attributed to O2 sensor heating characteristics, exhaust system packaging and design, and the engine management system.
- Vehicle response and adaptation to poor combustion events caused by the test fuels varied differently across the vehicles tested and can be attributed to engine management system controls, adaptations and calibration differences.

For any future testing to replicate these results the required data acquisition equipment should include:

- Combustion Analysis system with high resolution (1° CA) crankshaft encoder
    - In cylinder pressure transducers for combustion measurement
    - Fuel Injection Measurement (Injection Timing and Duration)
    - Ignition Measurement
- 1/16" K-type thermocouple temperature measurement(s)
    - Ambient Air Temperature
    - Engine Coolant In/Out temperature
    - Engine oil sump temperature
    - Exhaust Turbine Inlet and Catalyst Temperature(s)

- Pressure Measurements(s)
    - Ambient Air Pressure
    - Intake Manifold Pressure
    - Fuel Pressure (Direct Injection Rail and Fuel supply system)
- Exhaust wideband air fuel measurement installed close to OEM oxygen sensor
- OBD-II CAN measurements (10Hz minimum)
    - Pedal Position
    - Throttle position
    - Short/Long Term Fuel Trims
    - Commanded Air Fuel Ratio
    - EVAP Purge Activation
- Analog to Digital Modules and DAQ Battery Setup
- Laptop with data acquisition software
- Special Fuel Drain installed in fuel tank and fuel evacuation points installed on fuel system lines.
- Manufacturer specific scan tool for engine code readings and fuel trim (adaptation) resets.

Out of the equipment listed the most expensive and complex to instrument is the combustion analysis system as special cylinder head machining is required to fit the in-cylinder pressure transducers. The combustion analysis system allows for close monitoring of the combustion quality as well as any crank angle based measurements such as ignition and fuel injection. The use of flush mounted spark plug pressure transducers is of interest due to cost reduction and feasibility but this type of transducer may not have the necessary resolution to distinguish combustion irregularities caused by fuel. Additionally spark plug transducers have been known to cause combustion instability in turbocharged direct injection engines. Due to the high sensitivity of newer combustion systems in vehicles, the slightest inconsistency between the spark plug transducer and the original spark plug, results in misfires at cold start and full load operations. This would ultimately compromise the reliability of the data. A separate investigation is needed to conclude on the option of flush mounted spark plug pressure transducers.

The thermocouple measurements are for boundary condition monitoring of ambient conditions and engine coolant and oil temperatures. The exhaust temperatures help in estimating the cold start combustion temperature and the catalyst temperatures are to monitor any potential catalyst overheating conditions caused by engine misfires.

The pressure measurement of ambient air is for boundary condition monitoring. The intake manifold pressure is for engine load indication as well as for a combustion analysis system reference signal. Another important measurement is the fuel pressure in the direct injection system to observe any changes caused by fueling adaptations.

The exhaust wideband air fuel measurement is for close monitoring of the engine air/fuel ratio during cold start operation and to capture the effects of the test fuels. This equipment is already warmed up and accurately measuring exhaust air/fuel ratios when the engine is started as it is independent of vehicle systems and powered by the DAQ power setup. For this testing the O2 sensor was calibrated in open air only once and that is before the start of any fuels testing during the instrumentation process.

The critical OBD-II measurements needed are pedal position to monitor driver torque request. Fuel trims and commanded air fuel ratio help capture vehicle fueling adaptations and closed loop AFR control. EVAP Purge activation helps in understanding any AFR condition changes caused by EVAP Purge

activation. Monitoring the throttle position allows for understanding of the engine management response as throttle position controls engine loading.

A critical piece of equipment is the manufacturer specific scan tool in order to read engine codes and reset fueling adaptions prior to testing the driveability of test fuels. This was not incorporated during the program but should be done on any subsequent testing in order to capture full effects of fuels and "shock" the vehicle.

The fuel system also needs to be instrumented with special drain points on the tank and along the fuel line system in order to effectively evacuate test fuels. Special fabrication of custom fittings may be needed for this depending on vehicle design and packaging.

VIII. Recommendations

Testing instrumented vehicles in a climate controlled chassis dyno as opposed to the traditional driver subjective evaluations on vehicle fleets allows for a more fundamental understanding of the fuel effects on driveability, combustion and vehicle engine management system. For traditional and novel engine technologies this will have benefits in understanding the effects of fuel properties on the engine cold-start driveability performance. Using a fixed drive cycle, as done in this program, allows for repeatable results and enables different vehicle responses to be more readily compared to each other as opposed to the methodology in previous CRC fleet testing of using intake manifold pressure characteristics of a particular vehicle to define a custom acceleration profile as was done in the original CRC Report 666 drive cycle.

It was initially known and again confirmed in this study that vehicle engines are most sensitive to high DI fuels during the initial cold start as the combustion chamber is warming up to operating temperatures due to the fuel vaporization and air / fuel mixing needed for stable combustion. Driving an aggressive initial acceleration profile is strongly recommended to induce worst case scenario driveability degradation and capture the full effects of the test fuels via instrumented measurements. This will also enhance subjective evaluation as the effects are more readily "felt" by a driver.

One of the aspects of the study was to observe how the engine management system reacted to the test fuels. This study confirmed that different modern engine management systems implement different fueling adaptations and rates of adaption responses to try to mitigate the effects of the fuels. It was learned from this study that in order to fully capture the individual test fuel effects previous fueling adaptations should be baselined to avoid having them carried over into a new test fuel. This study addressed this by conditioning the test vehicles with commercially available pump fuel in-between test fuels in order to reset (baseline) fueling adaptations. It was however noted that after this was done and the vehicle ran a prep cycle at ambient temperatures close to 75°F, the vehicles may have started implementing adaptations with the new test fuels. This likely mitigated some of the full effects of the test fuels during the first test at 40°F but the results from the program are still considered representative and valid. For future testing in order to capture the full effects of the fuels it is recommended to clear fuel trim memory from the test vehicles after prep cycle conditioning and before cold soak storage prior to the first test ran at 40°F. This would erase any learned fueling adaptations during the fuel change over procedure and during the prep cycle conditioning. It is recognized that a fuel trim memory clear using a hand held scan tool following the vehicle prep can be more effective than using pump fuel to reset fueling adaptations and this procedure change is recommended for any future programs.

The driveability metrics used in this study provided good characteristics for the test fuels and allowed for objective driveability measurements. It was noted that the IMEP standard deviation measurements are only feasible during engine steady state operation during the initial cold start idle, in order to characterize idle quality. While it would be valuable to have a metric for the initial vehicle accelerations, carrying out a standard deviation calculation during transient vehicle operation is not accurate due to the combustion IMEP points at different operating points in the engine. A different approach for transient (acceleration) vehicle response is needed in order to quantify the driveability.

IX. Acknowledgements

This program would like to thank the following contributors for all their hard work and participation:

- Joseph Cholag
- Tony Kriegsmann
- Henning Kleeberg
- Frank Richardson
- Aditya Kastury
- Michael Parr
- Coleman Jones
- Mark Winston Galant
- Kelly Davis

X. References

1. Coordinating Research Council, "*2013 CRC Intermediate-Temperature E15 Cold –Start and Warm-up Vehicle Driveability Program"*. Final Report CRC Report No. 666, April 2014.

2. Reddy, Sam, "*Project CM-138-15-1 Development of a Thermodynamics-Based Fundamental Model for Prediction of Gasoline/Ethanol Blend Properties and Vehicle Driveability"*. CRC Report CM-138-15-1. May 2016.

3. Yanowitz,J., McCormick, Robert L., *Review: Fuel Volatility Standards and Spark-Ignition Vehicle Driveability*. SAE Technical Paper 2016-01-9072, 2016, doi: 10.4271/2016-01-9072.

4. Renewable Fuels Foundation (2009), "*Changes in Gasoline IV The Auto Technician's Guide to Spark Ignition Engine Fuel Quality*". Retrieved from: https://ethanolrfa.org/wp-content/uploads/2015/09/ChangesinGasolineManualIV-UpdatedLogo.pdf

5. American Society of Testing and Materials (date unknown). *ASTM D4814-19: Standard Specification for Automotive Spark-Ignition Engine Fuel*. Retrieved from: https://www.astm.org/Standards/D4814.htm

6. Environmental Protection Agency, "*Modification to Fuel Regulations To Provide Flexibility for E15; Modifications to RFS RIN Market Regulations*", Federal Register Vol. 84, No. 111 (Final Rule June 10, 2019) (to be codified at 40 C.F.R. pt. 80).

Definitions/Abbreviations

ABS – Anti Brake System

AFR – Air Fuel Ratio

°CA – Crank Angle Degrees

CAN – Controller Area Network (Communications Protocol)

CRC – Coordinating Research Council

CVT – Continuously Variable Transmission

COV IMEP – Coefficient of Variance IMEP (Combustion Stability Parameter)

DAQ – Data Acquisition

DI – Driveability Index

DVPE – Dry Vapor Pressure Equivalent

Dyno – Chassis Dynamometer

E0 – 0% ethanol blended fuel

E15 – 15% ethanol blended fuel

E30 – 30 % ethanol blended fuel

ECT – Engine Coolant Temperature

ECU – Engine Control Unit

ECM – Engine Control Module

EGR- Exhaust Gas Recirculation

EPA – U.S. Environmental Protection Agency

EVAP – Automotive Evaporative Vehicle Emissions

FTP74 – U.S. Federal Emissions Drive Cycle Segment

FWD – Front Wheel Drive

IMEP – Indicated Mean Effective Pressure (combustion parameter)

GTDI – Gasoline Turbo Direct Injection

HOV – Heat of vaporization

Lambda – Air Fuel Ratio as a function of Stoichiometric Ratio (1.0 = Stoichiometric ratio)

T10 – 10% fuel distillation temperature

T50- 50% fuel distillation temperature

T90 – 90% fuel distillation temperature

LTFT – Long Term Fuel Trims

O2 - Oxygen

OBD – On Board Diagnostic (system)

OEM – Original Equipment Manufacturer

PFI – Port Fuel Injection

RMS – Root Mean Square numerical averaging method

RWD – Rear Wheel Drive

Startability – The capability of a vehicle engine to start during a cold-start procedure

STFT – Short Term Fuel Trims

TDC – Top Dead Center (engine crank angle position)

USCAR– United States Council for Automotive Research

Appendix

Appendix A: Fuel Inspection Sheets

Table A-1
2016-18 CRC Study E0 Original Fuels

Fuel Code			B0 TR2335				
Laboratory			Halterman	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	54.8	54.0	54.6	54.7	54.5
Density @ 15°C			0.7593	0.7625	0.7597	0.7599	
Research Octane Number	D2699	RON	97.6			97.0	97.3
Motor Octane Number	D2700	MON	87.1			88.6	87.9
Antiknock Index, (R+M)/2	D2699/D2700	AKI	92.35			92.8	92.6
Sensitivity			10.5			8.4	
Ethanol Content	D5599	vol %	0	0	0	0	0.0
DVPE Vapor Pressure	D5191	psi	8.9	8.9	8.89	9.0	8.9
Temperature V/L=20 (TVL20)	D5188	°F		142.6		137	139.8
Temperature V/L=20 (TVL20) Calculated	D4814		144.6	142.2	143.5	143.2	
Sulfur Content	D2622/D7039	ppm	4.0				4.0
FIA (uncorrected)	D1319						
Saturates		vol %	52.20		51.2	46.49	50.0
Aromatics		vol %	37.10		38	40.97	38.7
Olefins		vol %	10.70		10.8	12.53	11.3
FIA (corrected for oxygenates)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
Benzene	D3606	vol %	0		0.03	0.03	0.0
D86 Distillation	D86						
Initial Boiling Point		°F	89	83.5	85.8	85.2	85.9
5% Evaporated		°F	115	106.2		111.2	110.8
10% Evaporated		°F	130	121.9	124	125.2	125.3
20% Evaporated		°F	156	149.0	150.9	152.6	152.1
30% Evaporated		°F	187	182.5	185.2	186.3	185.3
40% Evaporated		°F	220	216.4	219.8	220.3	219.1
50% Evaporated		°F	239	235.6	238.3	238.9	238.0
60% Evaporated		°F	254	251.0	253	253.4	252.9
70% Evaporated		°F	274	271.8	273.8	275	273.7
80% Evaporated		°F	316	313.6	316.2	317.5	315.8
90% Evaporated		°F	365	363.3	363.4	364.2	364.0
95% Evaporated		°F	387	383.1		387.2	385.8
Final Boiling Point		°F	408	407.1	411.8	411.4	409.6
Recovered		vol %	97.7	96.7	98	98.4	97.7
Residue		vol %	1	1.1	1.1	1.1	97.7
Loss		vol %	1.3	2.2	0.9	0.5	1.1
Driveability Index Uncorrected	D4814	°F	1278.0	1253.0	1264.3	1269.0	1266.1

Table A-1

2016-18 CRC Study E0 Fuels Resupply Reblended Fuels

Fuel Code			B0 TR2335A				
Laboratory			Gage	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	52.8	51.4	52.3	52.5	52.2
Density @ 15°C			0.7679	0.7735	0.7698	0.7689	0.8
Research Octane Number	D2699	RON	96.6	96.4	96.1	90.9	95.0
Motor Octane Number	D2700	MON	85.2	85.0	84.7	80.7	83.9
Antiknock Index, (R+M)/2	D2699/D2700	AKI	90.90	90.7	90.4	85.80	89.5
Sensitivity							
Ethanol Content	D5599	vol %	0	0	0	0	0.0
DVPE Vapor Pressure	D5191	psi	8.43	8.1	8.25	8.17	8.2
Temperature V/L=20 (TVL20)	D5188	°F				144.8	144.8
Temperature V/L=20 (TVL20) Calculated	D4814						
Sulfur Content	D2622/D7039	ppm		<5			
FIA (uncorrected)	D1319						
Saturates		vol %	50.10	52.80		51.40	51.4
Aromatics		vol %	39.50	36.90		41.00	39.1
Olefins		vol %	10.4	10.00		0	6.8
FIA (corrected for oxygenates)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
Benzene	D3606	vol %					
D86 Distillation	D86						
Initial Boiling Point		°F	91.8	90.3	90.8	90.1	90.8
5% Evaporated		°F	114.5	111.2		112.5	112.7
10% Evaporated		°F	126	124.2	125.4	124.0	124.9
20% Evaporated		°F	144.2	142.9	145.3	143.7	144.0
30% Evaporated		°F	164.5	164.5	165.8	164.4	164.8
40% Evaporated		°F	195.1	195.1	196.6	196.2	195.8
50% Evaporated		°F	240.9	240.8	244	243.6	242.3
60% Evaporated		°F	280.4	280.0	282.8	281.7	281.2
70% Evaporated		°F	305.9	305.3	308	306.3	306.4
80% Evaporated		°F	334.5	333.0	334.2	334.3	334.0
90% Evaporated		°F	364.9	363.7	365	364.3	364.5
95% Evaporated		°F	379.8	379.1	381.5	381.3	380.4
Final Boiling Point		°F	411.7	416.1	415.7	415.9	414.9
Recovered		vol %	97.5	96.7	97.9	97.5	97.4
Residue		vol %	1.1	1.1	0.9	1.1	1.1
Loss		vol %	1.4	2.2	1.2	1.4	1.6
Driveability Index Uncorrected	D4814	°F	1276.7	1272.4	1285.0	1281.1	1278.8

Table A-1 Cont'd.
2016-18 CRC Study E0 Original Fuels

Fuel Code			C0 TR2338				
Laboratory			Halterman	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	55.0	54.0	55	55.0	54.8
Density @ 15°C			0.7585	0.7625	0.7581	0.7584	
Research Octane Number	D2699	RON	96.0			99.4	97.7
Motor Octane Number	D2700	MON	87.1			89.1	88.1
Antiknock Index, (R+M)/2	D2699/D2700	AKI	91.6			94.25	92.9
Sensitivity			8.9			10.3	
Ethanol Content	D5599	vol %	0	0	0	0	0.0
DVPE Vapor Pressure	D5191	psi		8.5	8.78	8.68	8.7
Temperature V/L=20 (TVL20)	D5188	°F				140.4	140.4
Temperature V/L=20 (TVL20) Calculated	D4814		149.7	150.7	148.9	151.2	
Sulfur Content	D2622/D7039	ppm					
FIA (uncorrected)	D1319						
Saturates		vol %	60.00		58.1	53.52	57.2
Aromatics		vol %	31.8		32.9	36.11	33.6
Olefins		vol %	8.20		9	10.37	9.2
FIA (corrected for oxygenates)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
Benzene	D3606	vol %			0.04		0.0
D86 Distillation	D86						
Initial Boiling Point		°F	84	80.8	82.5	84.5	83.0
5% Evaporated		°F	108	106.7		112.1	108.9
10% Evaporated		°F	126	126.2	124.8	129.4	126.6
20% Evaporated		°F	164	164.2	163.9	168.7	165.2
30% Evaporated		°F	211	212.2	212.6	216.7	213.1
40% Evaporated		°F	246	245.6	247.5	249.4	247.1
50% Evaporated		°F	267	266.4	266.5	268.9	267.2
60% Evaporated		°F	285	284.7	285.9	287.2	285.7
70% Evaporated		°F	306	305.4	306.8	308	306.6
80% Evaporated		°F	329	326.8	331.4	333.6.	329.1
90% Evaporated		°F	368	365.2	367.2	365.9	366.6
95% Evaporated		°F	387	385.4		388.7	387.0
Final Boiling Point		°F	409	408.3	409.6	411.2	409.5
Recovered		vol %	97	96.8	97.6	98.6	97.5
Residue		vol %	1.1	1.1	1.1	1.1	1.1
Loss		vol %	1.9	2.1	1.3	0.3	1.4
Driveability Index Uncorrected	D4814	°F	1358.0	1353.7	1353.9	1367.0	1358.2

Table A-1 Cont'd.

2016-18 CRC Study E0 Fuels Resupply Reblended Fuels

Fuel Code			C0 TR2338A				
Laboratory			Gage	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	53.4	52.3	53.2	53.4	53.1
Density @ 15°C			0.7653	0.7700	0.7661	0.7652	0.767
Research Octane Number	D2699	RON	97.0	96.4	95.9	92.8	95.5
Motor Octane Number	D2700	MON	86.3	85.3	85.3	82.1	84.8
Antiknock Index, (R+M)/2	D2699/D2700	AKI	91.70	90.9	90.6	87.40	90.1
Sensitivity							
Ethanol Content	D5599	vol %	0	0	0	0	0.0
DVPE Vapor Pressure	D5191	psi	8.43	8.0	8.24	8.12	8.2
Temperature V/L=20 (TVL20)	D5188	°F		147.1		149.7	148.4
Temperature V/L=20 (TVL20) Calculated	D4814						
Sulfur Content	D2622/D7039	ppm		<5			
FIA (uncorrected)	D1319						
Saturates		vol %	59.00	60.00		55.90	58.3
Aromatics		vol %	34.90	31.90		36.00	34.3
Olefins		vol %	6.1	8.10		3.8	6.0
FIA (corrected for oxygenates)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
Benzene	D3606	vol %					
D86 Distillation	D86						
Initial Boiling Point		°F	91.4	89.4	89.1	87.7	89.4
5% Evaporated		°F	113	109.0		113.0	111.7
10% Evaporated		°F	127.1	124.8	126.2	126.5	126.2
20% Evaporated		°F	150.1	148.2	150.4	150.4	149.8
30% Evaporated		°F	178	176.5	178.1	179.4	178.0
40% Evaporated		°F	219	216.6	220	221.6	219.3
50% Evaporated		°F	265.1	263.9	267.1	268.2	266.1
60% Evaporated		°F	291.3	289.8	293	292.9	291.8
70% Evaporated		°F	313.3	313.0	313.5	315.4	313.8
80% Evaporated		°F	339.7	338.5	339	340.1	339.3
90% Evaporated		°F	370	368.4	369	368.5	369.0
95% Evaporated		°F	382.4	381.8	382.2	382.6	382.3
Final Boiling Point		°F	412.8	411.1	413.2	414.7	413.0
Recovered		vol %	97.3	96.5	98	97.9	97.4
Residue		vol %	1.1	1.1	0.7	1.1	1.0
Loss		vol %	1.6	2.4	1.3	1.0	1.6
Driveability Index Uncorrected	D4814	°F	1356.0	1347.3	1360.0	1362.9	1356.5

Table A-1 Cont'd.
2016-18 CRC Study E15 Original Fuels

Fuel Code			CE15 TR2339				
Laboratory			Halterman	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	54.1	51.3	54	54.0	53.3
Density @ 15°C			0.7621	0.7659	0.7622	0.7625	
Research Octane Number	D2699	RON	100.4			103.8	102.1
Motor Octane Number	D2700	MON	88.7			90.1	89.4
Antiknock Index, (R+M)/2	D2699/D2700	AKI	94.55			96.95	95.8
Sensitivity			11.7			13.7	
Ethanol Content	D5599	vol %	15	15.2	15.18	15.4	15.2
DVPE Vapor Pressure	D5191	psi	9.7	9.3	9.57	9.64	9.6
Temperature V/L=20 (TVL20)	D5188	°F				126.3	126.3
Temperature V/L=20 (TVL20) Calculated	D4814		136.7	138.3	137.6	137.8	
Sulfur Content	D2622/D7039	ppm					
FIA (uncorrected)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
FIA (corrected for oxygenates)	D1319						
Saturates		vol %			49.5	52.30	50.9
Aromatics		vol %			28	28.2	28.1
Olefins		vol %			7.4	3.00	5.2
Benzene	D3606	vol %			0.03		0.0
D86 Distillation	D86						
Initial Boiling Point		°F	91.9	86.3	86.6	90	88.7
5% Evaporated		°F	117.8	117.4		118.9	118.0
10% Evaporated		°F	129.5	129.5	129.7	130.9	129.9
20% Evaporated		°F	148.3	147.6	149.4	149.8	148.8
30% Evaporated		°F	160.2	159.5	161.4	161.2	160.6
40% Evaporated		°F	167.3	166.2		167.1	166.9
50% Evaporated		°F	239.1	244.2	241.4	245	242.4
60% Evaporated		°F	269.7	268.8		273.7	270.7
70% Evaporated		°F	294.8	296.2	295.6	297.4	296.0
80% Evaporated		°F	317.1	321.6		321.5	320.1
90% Evaporated		°F	360.9	359.9	358	362.3	360.3
95% Evaporated		°F	384	382.9		384.5	383.8
Final Boiling Point		°F	406.1	411.4	406.7	406.8	407.8
Recovered		vol %	97.2	97.8	97.7	98.2	97.7
Residue		vol %	1.1	1.1	1.1	1.1	1.1
Loss		vol %	1.7	1.2	1.2	0.7	1.2
Driveability Index Uncorrected	D4814	°F	1272.0	1286.8	1276.8	1294.0	1282.4

Table A-1 Cont'd.

2016-18 CRC Study E15 Resupply Reblended Fuels

Fuel Code			CE15 TR2339A				
Laboratory			Gage	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	52.3	51.3	52.4	52.6	52.1
Density @ 15°C			0.7698	0.7739	0.7694	0.7684	0.7704
Research Octane Number	D2699	RON	100.6	100.4	100.5	97.9	99.9
Motor Octane Number	D2700	MON	87.6	87.7	87.6	84.2	86.8
Antiknock Index, (R+M)/2	D2699/D2700	AKI	94.10	94.1	94	91.00	93.3
Sensitivity							
Ethanol Content	D5599	vol %	15.08	15.28	14.1	15.2	14.9
DVPE Vapor Pressure	D5191	psi	9.17	9.0	9.13	9.15	9.1
Temperature V/L=20 (TVL20)	D5188	°F		131.8		132.2	132.0
Temperature V/L=20 (TVL20) Calculated	D4814			134.8			134.8
Sulfur Content	D2622/D7039	ppm		<5			
FIA (uncorrected)	D1319						
Saturates		vol %		51.50		30.90	41.2
Aromatics		vol %		26.30		1.30	13.8
Olefins		vol %		6.50		49.2	27.9
FIA (corrected for oxygenates)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
Benzene	D3606	vol %					
D86 Distillation	D86						
Initial Boiling Point		°F	95	93.2	93.6	90.3	93.0
5% Evaporated		°F	118.3	115.8		118.8	117.6
10% Evaporated		°F	128.3	125.8	128.7	128.8	127.9
20% Evaporated		°F	140.8	138.6	142.2	141.9	140.9
30% Evaporated		°F	150.8	149.5	152.2	152.0	151.1
40% Evaporated		°F	159.6	159.7	160.8	160.7	160.2
50% Evaporated		°F	182	176.1	179.1	187.6	181.2
60% Evaporated		°F	275.3	270.2	275.5	276.4	274.4
70% Evaporated		°F	302.1	303.4	303.1	303.4	303.0
80% Evaporated		°F	329.7	329.4	331	330.8	330.2
90% Evaporated		°F	363.1	363.9	364.5	364.6	364.0
95% Evaporated		°F	363.1	380.0	381.4	380.6	376.3
Final Boiling Point		°F	406.4	410.0	409.4	410.7	409.1
Recovered		vol %	97.2	96.8	97.9	98.0	97.5
Residue		vol %	1.1	1.1	0.8	1.1	1.0
Loss		vol %	1.7	2.1	1.3	0.9	1.5
Driveability Index Uncorrected	D4814	°F	1101.6	1080.9	1094.9	1120.6	1099.5

Table A-1 Cont'd.
2016-18 CRC Study E30 Original Fuels

Fuel Code			CE30 TR2340				
Laboratory			Halterman	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	52.6	51.7	52.6	52.7	52.4
Density @ 15°C			0.768	0.772	0.768	0.768	
Research Octane Number	D2699	RON	103.0			106.3	104.7
Motor Octane Number	D2700	MON	88.7			89.9	89.3
Antiknock Index, (R+M)/2	D2699/D2700	AKI	95.9			98.1	97.0
Sensitivity			14.3			16.4	
Ethanol Content	D5599	vol %	30.2	32.3	30.4	30.3	30.8
DVPE Vapor Pressure	D5191	psi	9.0	8.8	9.1	9.1	9.0
Temperature V/L=20 (TVL20)	D5188	°F				130.8	130.8
Temperature V/L=20 (TVL20) Calculated	D4814		133.8	134.8	133.9	133.6	
Sulfur Content	D2622/D7039	ppm					
FIA (uncorrected)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
FIA (corrected for oxygenates)	D1319						
Saturates		vol %			41.3	48.6	45.0
Aromatics		vol %			21.7	24.3	23.0
Olefins		vol %			6.6	0.0	3.3
Benzene	D3606	vol %			0.0		0.0
D86 Distillation	D86						
Initial Boiling Point		°F	88.8	90.6	90.3	93.0	90.7
5% Evaporated		°F	122.6	124.7		124.4	123.9
10% Evaporated		°F	136.9	138.5	138.1	138.1	137.9
20% Evaporated		°F	155.9	156.6	156.9	156.5	156.5
30% Evaporated		°F	164.9	164.7	165.5	165.2	165.1
40% Evaporated		°F	168.7	168.6		168.8	168.7
50% Evaporated		°F	171.2	170.1	171.4	170.9	170.9
60% Evaporated		°F	173.8	171.7		172.8	172.8
70% Evaporated		°F	270.9	272.7	270.4	274.1	272.0
80% Evaporated		°F	306.5	303.1		307.2	305.6
90% Evaporated		°F	347.5	344.0	349.7	346.8	347.0
95% Evaporated		°F	378.4	374.8		376.1	376.4
Final Boiling Point		°F	403.0	402.8	404.9	394.0	401.2
Recovered		vol %	97.4	97.9	97.7	97.7	97.7
Residue		vol %	1.0	1.0	1.1	1.1	1.1
Loss		vol %	1.6	1.1	1.2	1.2	1.3
Driveability Index Uncorrected	D4814	°F	1066.0	1062.1	1071.1	1067.0	1066.5

Table A-1 Cont'd.

2016-18 CRC Study E30 Resupply Reblended Fuels

Fuel Code			CE30 TR2340A				
Laboratory			Gage	Chevron	MPC	BP	Average
Property	ASTM Test Method	Units					
API Gravity@60°F	D1298/D287	API	50.8	50.8	51.6	51.7	51.2
Density @ 15°C			0.776	0.776	0.773	0.772	0.7743
Research Octane Number	D2699	RON		102.8	102.3	101.1	102.1
Motor Octane Number	D2700	MON		88.4	89.2	84.4	87.3
Antiknock Index, (R+M)/2	D2699/D2700	AKI		95.6	95.8	92.7	94.7
Sensitivity							
Ethanol Content	D5599	vol %	30.3	28.8	26.7	33.0	29.7
DVPE Vapor Pressure	D5191	psi	8.8	8.3	8.9	8.8	8.7
Temperature V/L=20 (TVL20)	D5188	°F		133.5		134.0	133.8
Temperature V/L=20 (TVL20) Calculated	D4814						
Sulfur Content	D2622/D7039	ppm					
FIA (uncorrected)	D1319						
Saturates		vol %		43.6		45.4	44.5
Aromatics		vol %		21.4		27.4	24.4
Olefins		vol %		5.6		0.0	2.8
FIA (corrected for oxygenates)	D1319						
Saturates		vol %					
Aromatics		vol %					
Olefins		vol %					
Benzene	D3606	vol %				0.0	0.0
D86 Distillation	D86						
Initial Boiling Point		°F	96.8		96.1	94.6	95.8
5% Evaporated		°F	125.1			123.5	124.3
10% Evaporated		°F	134.8		133.3	134.1	134.1
20% Evaporated		°F	147.7		147.9	148.0	147.9
30% Evaporated		°F	157.6		158.2	158.1	158.0
40% Evaporated		°F	164.9		165.5	165.4	165.3
50% Evaporated		°F	169.3		169.8	169.5	169.5
60% Evaporated		°F	172.5		174.0	173.3	173.3
70% Evaporated		°F	281.3		282.0	282.0	281.8
80% Evaporated		°F	317.9		316.2	319.3	317.8
90% Evaporated		°F	357.2		356.6	357.3	357.0
95% Evaporated		°F	376.8		377.8	376.7	377.1
Final Boiling Point		°F	403.0		406.7	406.4	405.4
Recovered		vol %	97.7		97.9	98.1	97.9
Residue		vol %	1.1		0.9	1.1	1.0
Loss		vol %	1.2		1.2	0.8	1.1
Driveability Index Uncorrected	D4814	°F	1067.3		1066.0	1067.0	1066.7

Appendix B: Average Fuel Inspection Properties Original and Reblend Comparison Table

Appendix B
CRC 2016-2018 CM-138-15-2 Fuel Inspection Averages Comparison Table

Fuel Code			B0 TR2335	B0 TR2335A	C0 TR2338	C0 TR2338A	CE15 TR2339	CE15 TR2339A	CE30 TR2340	CE30 TR2340A
Property	ASTM Test Method	Units								
API Gravity@60°F	D1298/D287	API	54.5	52.2	54.8	53.1	53.3	52.1	52.4	51.2
Density @ 15°C	D1298/D287	kg/L	0.7604	0.7692	0.7595	0.767	0.7633	0.7704	0.7692	0.7743
Ethanol Content	D5599	vol %	0.0	0.0	0.0	0.0	15.2	14.9	30.8	29.7
DVPE Vapor Pressure	D5191	psi	8.9	8.2	8.7	8.2	9.6	9.1	9.0	8.7
Temperature V/L=20 (TVL20)	D5188	°F	137.0	144.8	140.4	148.4	126.3	132.0	130.8	133.8
Temperature V/L=20 (TVL20) Calculated	D4814		143.3	147.0	150.2		137.6	134.8	134.0	
Driveability Index Uncorrected	D4814	°F	1266.1	1278.8	1358.2	1356.5	1282.4	1099.5	1066.5	1066.7
D86 Distillation	D86									
Initial Boiling Point		°F	85.9	90.8	83.0	89.4	88.7	93.0	90.7	95.8
5% Evaporated		°F	110.8	112.7	108.9	111.7	118.0	117.6	123.9	124.3
10% Evaporated		°F	125.3	124.9	126.6	126.2	129.9	127.9	137.9	134.1
20% Evaporated		°F	152.1	144.0	165.2	149.8	148.8	140.9	156.5	147.9
30% Evaporated		°F	185.3	164.8	213.1	178.0	160.6	151.1	165.1	158.0
40% Evaporated		°F	219.1	195.8	247.1	219.3	166.9	160.2	168.7	165.3
50% Evaporated		°F	238.0	242.3	267.2	266.1	242.4	181.2	170.9	169.5
60% Evaporated		°F	252.9	281.2	285.7	291.8	270.7	274.4	172.8	173.3
70% Evaporated		°F	273.7	306.4	306.6	313.8	296.0	303.0	272.0	281.8
80% Evaporated		°F	315.8	334.0	329.1	339.3	320.1	330.2	305.6	317.8
90% Evaporated		°F	364.0	364.5	366.6	369.0	360.3	364.0	347.0	357.0
95% Evaporated		°F	385.8	380.4	387.0	382.3	383.8	376.3	376.4	377.1
Final Boiling Point		°F	409.6	414.9	409.5	413.0	407.8	409.1	401.2	405.4
Recovered		vol %	97.7	97.4	97.5	97.4	97.7	97.5	97.7	97.9
Residue		vol %	97.7	1.1	1.1	1.0	1.1	1.0	1.1	1.0
Loss		vol %	1.1	1.6	1.4	1.6	1.2	1.5	1.3	1.1
FIA/DHA (uncorrected)	D1319/D6849									
Saturates		vol %	50.0	51.4	57.2	58.3				
Aromatics		vol %	38.7	39.1	33.6	34.3				
Olefins		vol %	11.3	6.8	9.2	6.0				
FIA (corrected for oxygenates)/DHA	D1319/D6849									
Saturates		vol %	50.0	51.4	57.2	58.3	49.5	50.4	45.0	44.5
Aromatics		vol %	38.7	39.1	33.6	34.3	28.0	28.6	23.0	24.4
Olefins		vol %	11.3	6.8	9.2	6.0	7.4	3.9	3.3	2.8
Benzene	D3606	vol %	0.0		0.0		0.0		0.0	0.0
Research Octane Number	D2699	RON	97.3	95.0	97.7	95.5	102.1	99.9	104.7	102.1
Motor Octane Number	D2700	MON	87.9	83.9	88.1	84.8	89.4	86.8	89.3	87.3
Antiknock Index, (R+M)/2	D2699/D2700	AKI	92.6	89.5	92.9	90.1	95.8	93.3	97.0	94.7
Sensitivity	D2699/D2700		9.5		9.6		12.7		15.4	
Sulfur Content	D2622/D7039	ppm	4.0							

Appendix C: CRC Report 666 Cold-Start and Warm-Up Driveability Procedure

REVISED CRC COLD-START AND WARMUP DRIVEABILITY PROCEDURE

A. Record all necessary test information at the top of the data sheet.

B. Turn key on for 2 seconds before cranking to pressurize fuel system. Make sure defrost is on and fan is in "low" position. Start engine per Owner's Manual Procedure. Record start time.

C. There may be a total of three starting attempts recorded. If the engine fails to start within 5 seconds on any of these attempts, stop cranking at 5 seconds and record "NS" (no start) in the appropriate starting time box on the data sheet. After the first and second unsuccessful attempts to start, turn the key to the "off" position before attempting to restart per the Owner's Manual procedure. If the engine fails to start after 5 seconds during the third attempt, record a "NS" in the Restart box, then start the engine any way possible and proceed as quickly as possible to Step D without recording any further start times.

Once the engine starts on any of the first three attempts, idle in park for 5 seconds and record the idle quality. If the engine stalls during this 5-second idle, record a stall in the Idle Park "Stls" box, then restart per the above paragraph, subject to a combined maximum (in any order) of

three no-starts and Idle Park stalls. After all the start-time boxes are filled, no further starts should be recorded.

D. Apply brakes (right foot), shift to "Drive" ("Overdrive" if available) for 5-second idle, and record idle quality. If engine stalls, restart immediately. Do not record restart time. Record number of stalls.

A maximum of three Idle Drive stalls may be recorded; however, only one stall contributes to demerits. If the engine stalls a fourth time, restart and proceed to the next maneuver as quickly as possible. It is important to complete the start-up procedure as quickly as possible to prevent undue warmup before the driving maneuvers and to maintain vehicle spacing on the test track.

E. After idling 5 seconds (Step D), make a brief 0-15 mph light-throttle acceleration. Light-throttle accelerations will be made at a constant throttle opening beginning at a predetermined manifold vacuum. This and all subsequent accelerations throughout the procedure should be "snap" maneuvers: the throttle should be depressed immediately to the position that achieves the pre-set manifold vacuum, rather than easing into the acceleration. Once the throttle is depressed, no adjustment should be made, even if the pre-set vacuum is not achieved. Use moderate braking to stop. Idle for approximately 3 seconds without rating it. Make a brief 0-15 mph light-throttle acceleration. Both accelerations together should be made within 0.1-mile. If both accelerations are completed before the 0.1-mile marker, cruise at 15 mph to the 0.1-mile marker. Use moderate braking to stop; idle for approximately 3 seconds without rating it.

F. Make a 0-20 mph wide-open-throttle (WOT) acceleration beginning at the 0.1-mile marker. Use moderate braking to achieve 10 mph and hold 10 mph until the 0.2-mile marker (approximately 5 seconds). Use moderate braking to stop; idle for approximately 3 seconds without rating it.

G. At the 0.2-mile marker, make a brief 0-15 mph light-throttle acceleration. Use moderate braking to stop. Idle for approximately 3 seconds without rating it. Make a brief 0-15 mph light-throttle acceleration. If accelerations are completed before the 0-3-mile marker, cruise at 10 mph to the 0.3-mile marker.

H. At the 0.3-mile marker, make a light-throttle acceleration from 10-20 mph. Use moderate braking to make a complete stop at the 0.4-mile marker in anticipation of the next maneuver. Idle for approximately 3 seconds at the 0.4-mile marker without rating the idle.

I. Make a 0-20 mph moderate acceleration beginning at the 0.4-mile marker.

J. At the 0.5-mile marker, brake moderately and pull to the right side of the roadway. Idle in "Drive" for 5 seconds and record idle quality. Slowly make a U-turn.

K. Repeat Steps E through J. At the 0.0-mile marker, brake moderately and slowly make a U-turn.

NOTE: Items L-N may be useful only at colder temperatures.

L. Make a crowd acceleration (constant predetermined vacuum) from 0-45 mph. Four-tenths of a mile is provided for this maneuver. Decelerate from 45 to 25 mph before the 0.4-mile marker.

M. At the 0.4-mile marker, make a 25-35 mph detent position acceleration.

N. At the 0.5-mile marker, brake moderately. Idle for 30 seconds in "Drive," recording idle quality after 5 seconds and after 30 seconds, and record any stalls that occur. This ends the driving schedule. Proceed to the staging area.

Definitions of light-throttle, detent, and WOT accelerations are attached. During the above maneuvers, observe and record the severity of any of the following malfunctions (see attached definitions):

1. Hesitation

2. Stumble

3. Surge

4. Stall

5. Backfire

It is possible that during a maneuver, more than one malfunction may occur. Record all deficiencies observed. Do not record the number of occurrences. If no malfunctions occur during a maneuver, draw a horizontal line through all boxes for that maneuver. Also, in recording subjective ratings (T, M, or H), be sure the entry is legible. At times, M and H recordings cannot be distinguished from each other.

Record maneuvering stalls on the data sheet in the appropriate column: accelerating or decelerating. If the vehicle should stall before completing the maneuver, record the stall and restart the car as quickly as possible. Bring the vehicle up to the intended final speed of the maneuver. Any additional stalls observed will not add to the demerit total for the maneuver, and it is important to maintain the driving schedule as closely as possible.

DEFINITIONS AND EXPLANATIONS

Test Run

Operation of a car throughout the prescribed sequence of operating conditions and/or maneuvers for a single test fuel.

Maneuver

A specified single vehicle operation or change of operating conditions (such as idle, acceleration, or cruise) that constitutes one segment of the driveability driving schedule.

Cruise

Operation at a prescribed constant vehicle speed with a fixed throttle position on a level road.

Wide Open Throttle (WOT) Acceleration

"Floorboard" acceleration through the gears from prescribed starting speed. Rate at which throttle is depressed is to be as fast as possible without producing tire squeal or appreciable slippage.

Part-Throttle (PT) Acceleration

An acceleration made at any defined throttle position, or consistent change in throttle position, less than WOT. Several PT accelerations are used. They are:

1. Light Throttle (Lt. Th) - All light-throttle accelerations are begun by opening the throttle to an initial manifold vacuum and maintaining constant throttle position throughout the remainder of the acceleration. The vacuum selected is the vacuum setting necessary to reach 25 mph in 9 seconds. The vacuum setting should be determined when the vehicle is cold. The vacuum setting is posted in each vehicle.

2. Moderate Throttle (Md. Th) - Moderate-throttle accelerations are begun by immediately depressing the throttle to the position that gives the pre-specified vacuum and maintaining a constant throttle position throughout the acceleration. The moderate-throttle vacuum setting is determined by taking the mean of the vacuum observed during WOT acceleration and the vacuum prescribed for light-throttle acceleration. This setting is to be posted in the vehicle.

3. Crowd - An acceleration made at a constant intake manifold vacuum. To maintain constant vacuum, the throttle-opening must be continually increased with increasing engine speed. Crowd accelerations are performed at the same vacuum prescribed for the light-throttle acceleration.

4. Detent - All detent accelerations are begun by opening the throttle to just above the downshift position as indicated by transmission shift characteristic curves. Manifold vacuum corresponding to this point at 25 mph is posted in each vehicle. Constant throttle position is maintained to 35 mph in this maneuver.

Malfunctions

1. Stall

Any occasion during a test when the engine stops with the ignition on. Three types of stall, indicated by location on the data sheet, are:

a. Stall; idle - Any stall experienced when the vehicle is not in motion, or when a maneuver is not being attempted.

b. Stall; maneuvering - Any stall which occurs during a prescribed maneuver or attempt to maneuver.

c. Stall; decelerating - Any stall which occurs while decelerating between maneuvers.

2. Idle Roughness

An evaluation of the idle quality or degree of smoothness while the engine is idling. Idle quality may be rated using any means available to the lay customer. The rating should be determined by the worst idle quality experienced during the idle period.

3. Backfire

An explosion in the induction or exhaust system.

4. Hesitation

A temporary lack of vehicle response to opening of the throttle.

5. Stumble

A short, sharp reduction in acceleration after the vehicle is in motion.

6. Surge

Cyclic power fluctuations.

Malfunction Severity Ratings

The number of stalls encountered during any maneuver are to be listed in the appropriate data sheet column. Each of the other malfunctions must be rated by severity and the letter designation entered on the data sheet. The following definitions of severity are to be applied in making such ratings.

1. Trace (T) - A level of malfunction severity that is just discernible to a test driver but not to most laymen.

2. Moderate (M) - A level of malfunction severity that is probably noticeable to the average laymen.

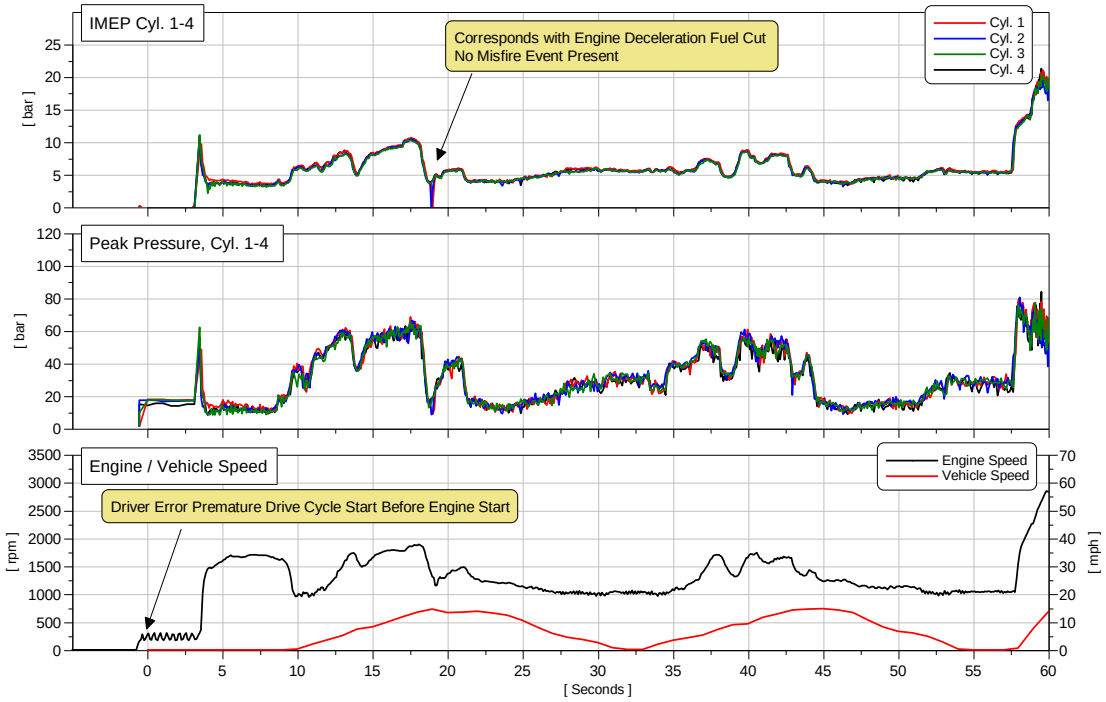
3. Heavy (H) - A level of malfunction severity that is pronounced and obvious to both test driver and layman.

4. Extreme (E) - A level of malfunction severity more severe than "Heavy" at which the lay driver would not have continued the maneuver, but taken some other action.

Enter a T, M, H, or E in the appropriate data block to indicate both the occurrence of the malfunction and its severity. More than one type of malfunction may be recorded on each line. If no malfunctions occur, enter a dash (-) to indicated that the maneuver was performed and operation was satisfactory during the maneuver.

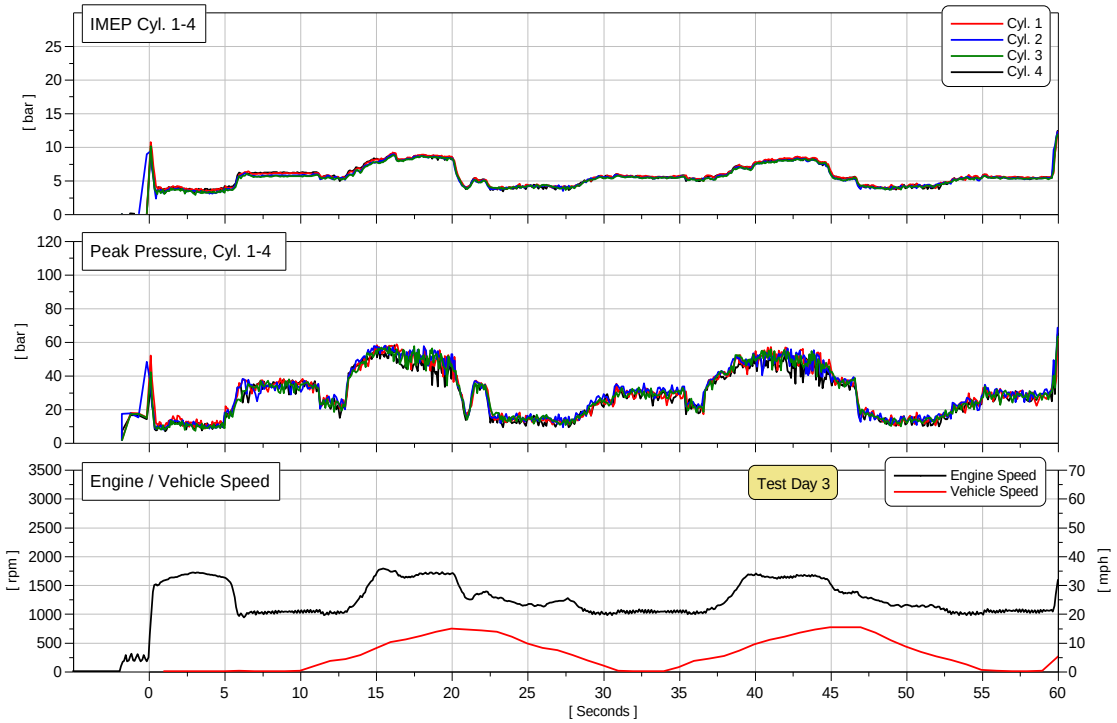
Appendix D: Honda Civic and Ford F-150 Original Drive Cycle IMEP Measurements

Honda Civic B0 TR2335 Test 1 Original Drive Cycle

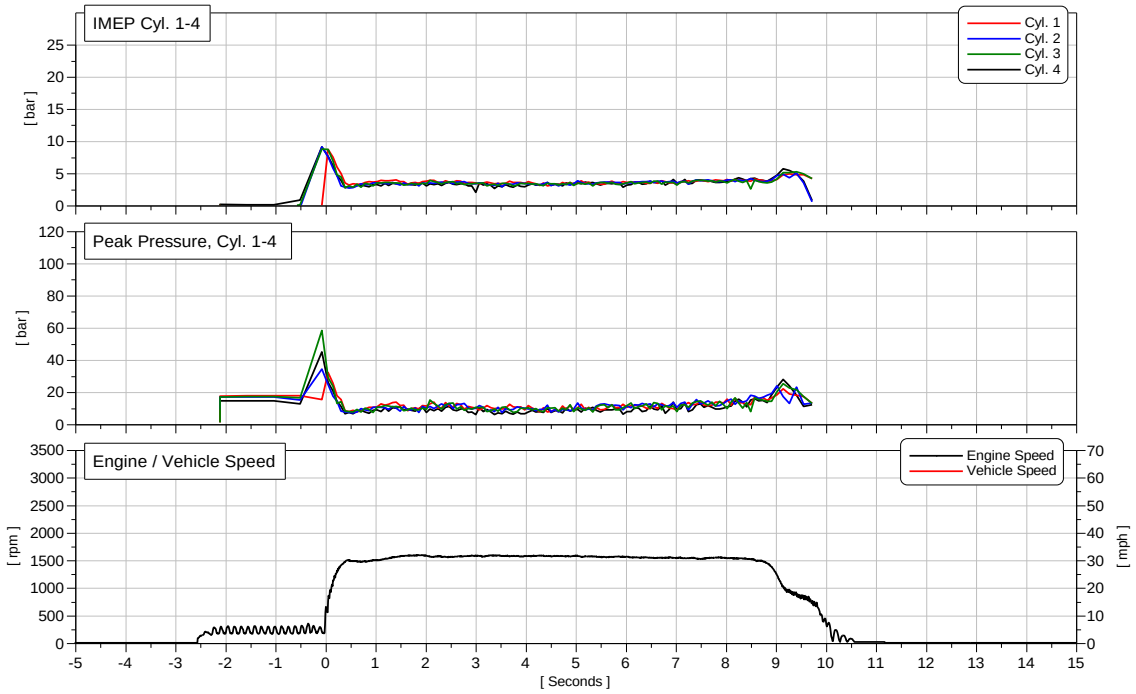


Honda Civic B0 TR2335 Test 2 Original Drive Cycle

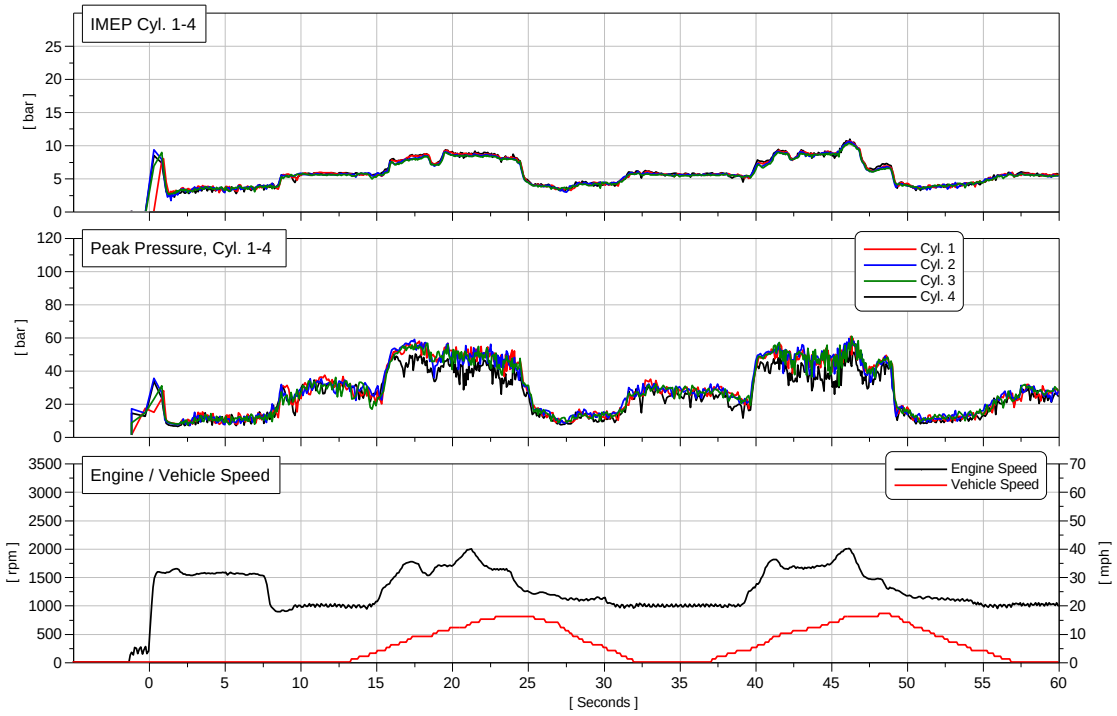
Honda Civic B0 TR2335 Test 3 Original Drive Cycle



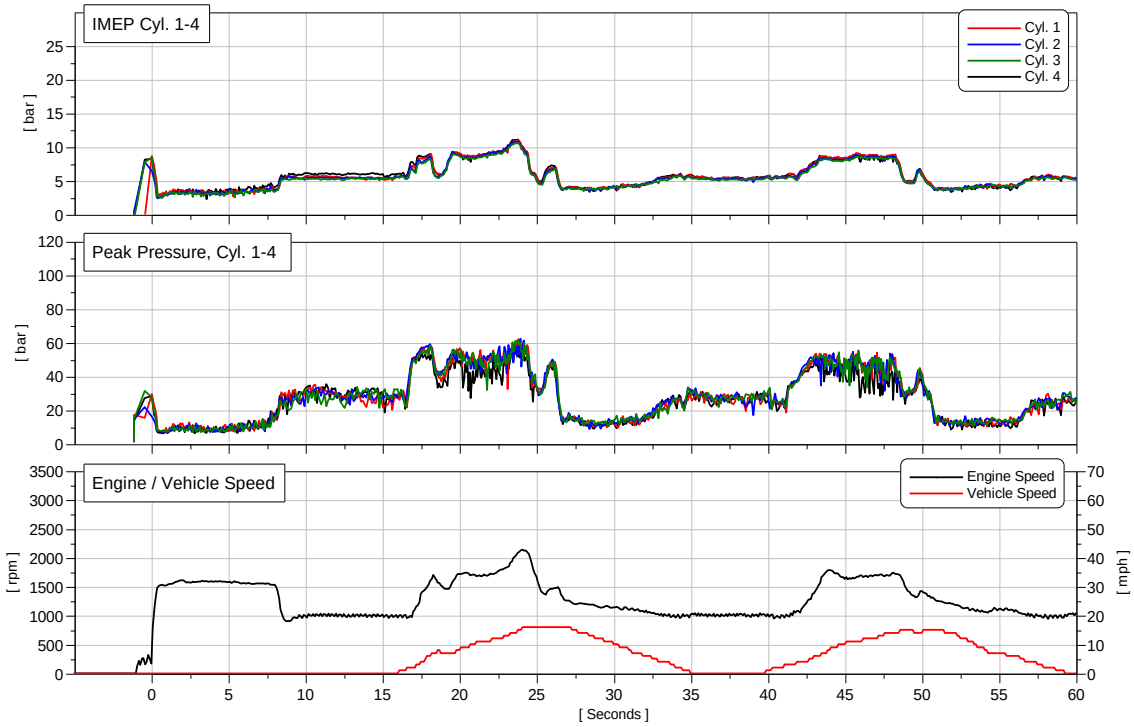
Honda Civic C0 TR2338 Test 1 Original Drive Cycle



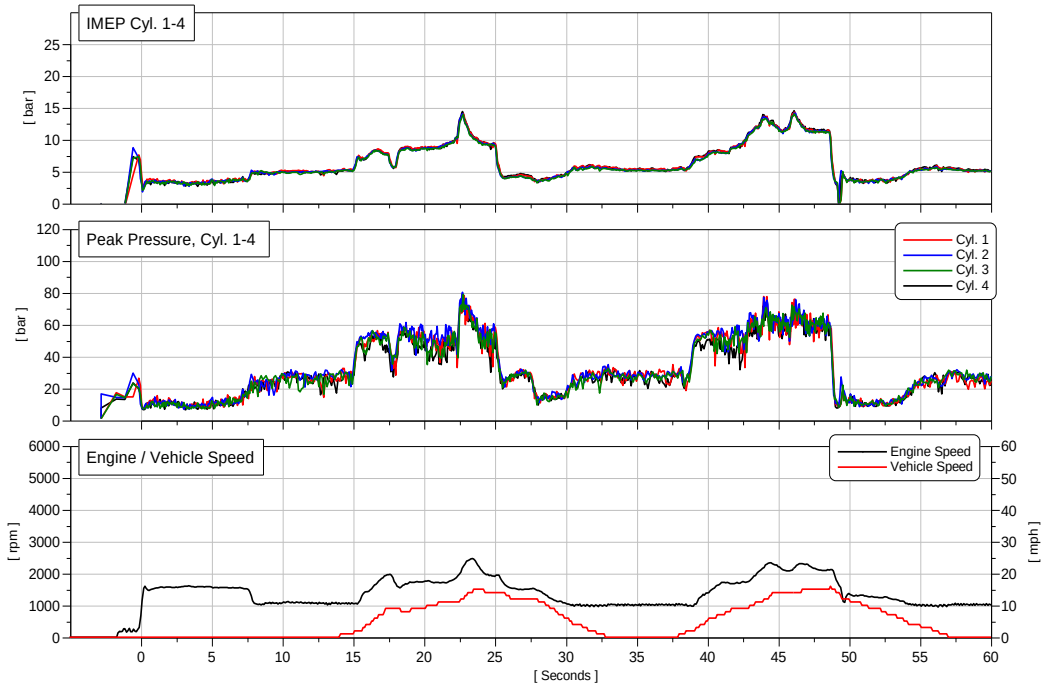
Honda Civic C0 TR2338 Test 2 Original Drive Cycle



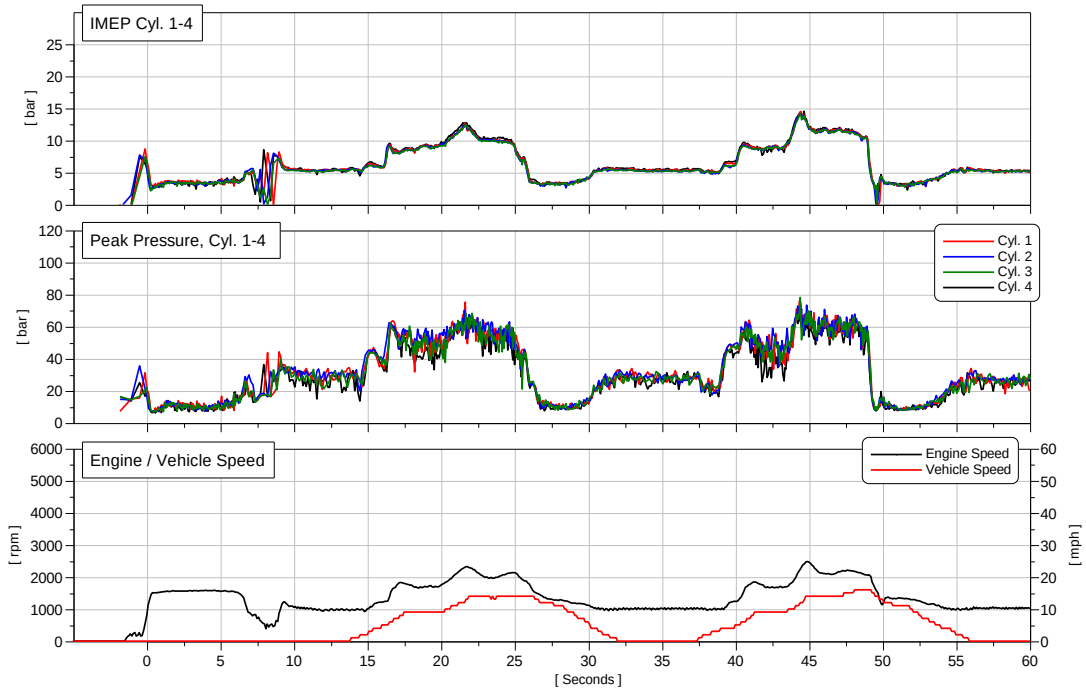
Honda Civic C0 TR2338 Test 3 Original Drive Cycle



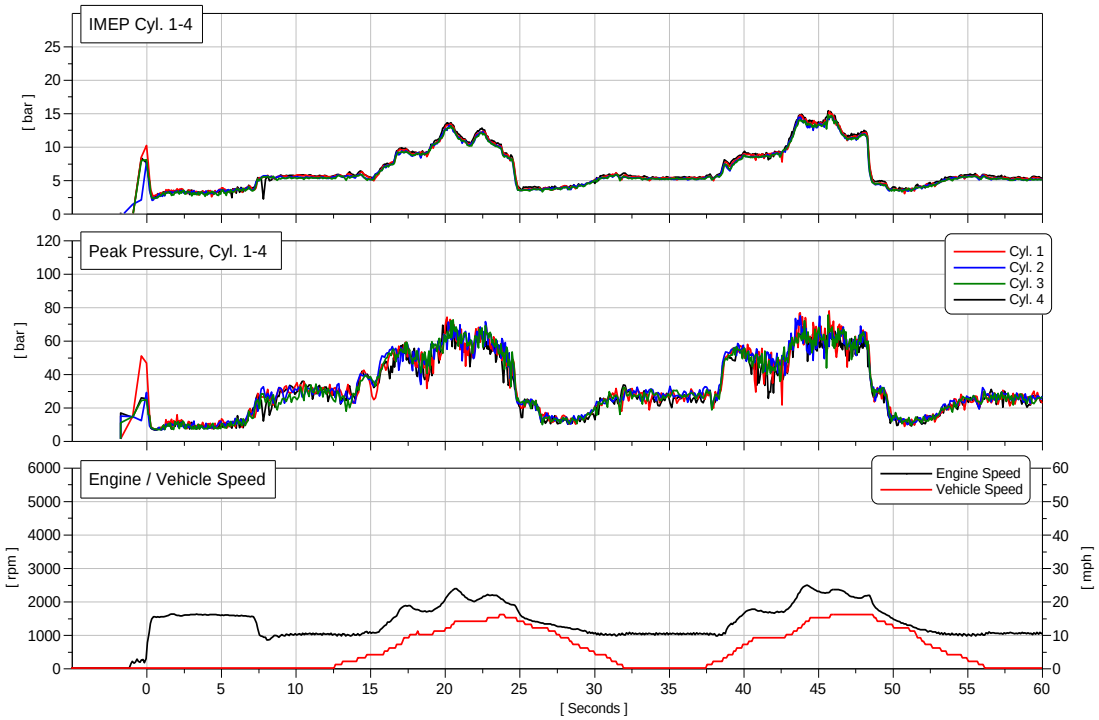
Honda Civic CE15 TR2339 Test 1 Original Drive Cycle



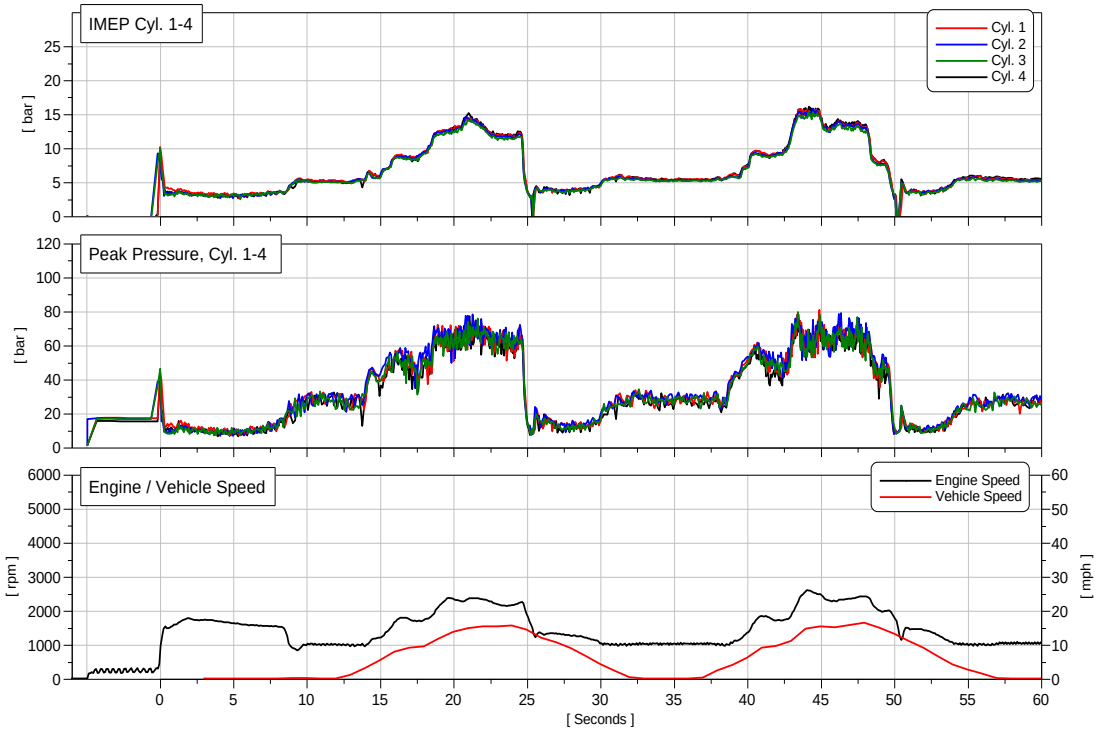
Honda Civic CE15 TR2339 Test 2 Original Drive Cycle



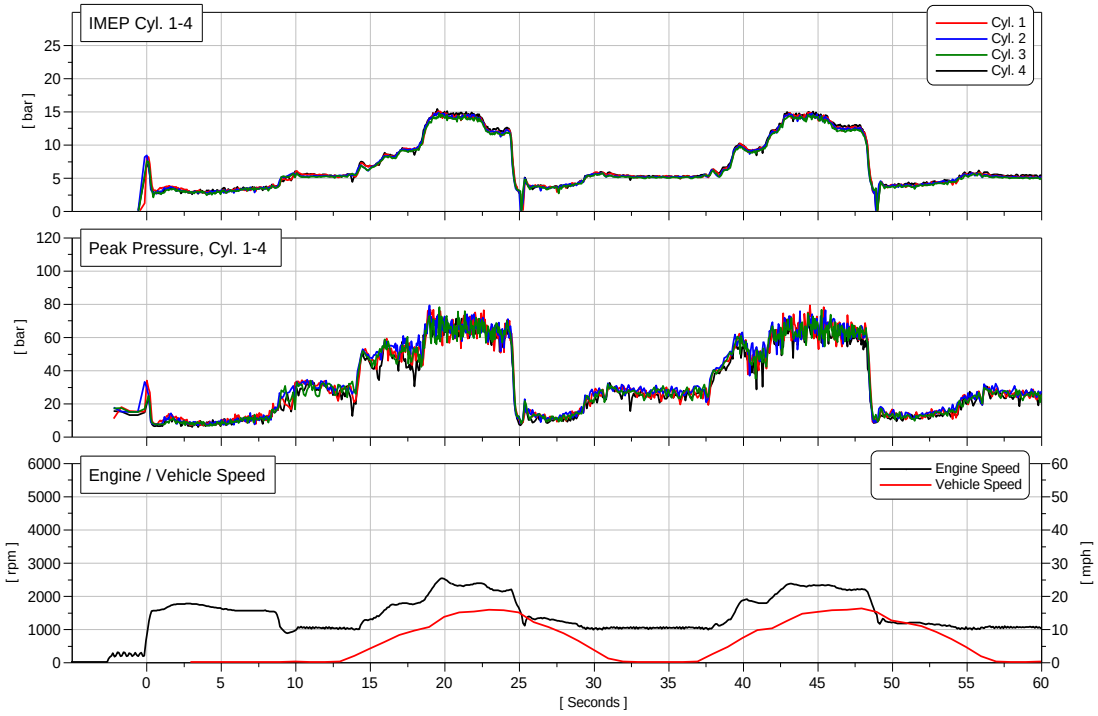
Honda Civic CE15 TR2339 Test 3 Original Drive Cycle



Honda Civic CE30 TR2340 Test 1 Original Drive Cycle

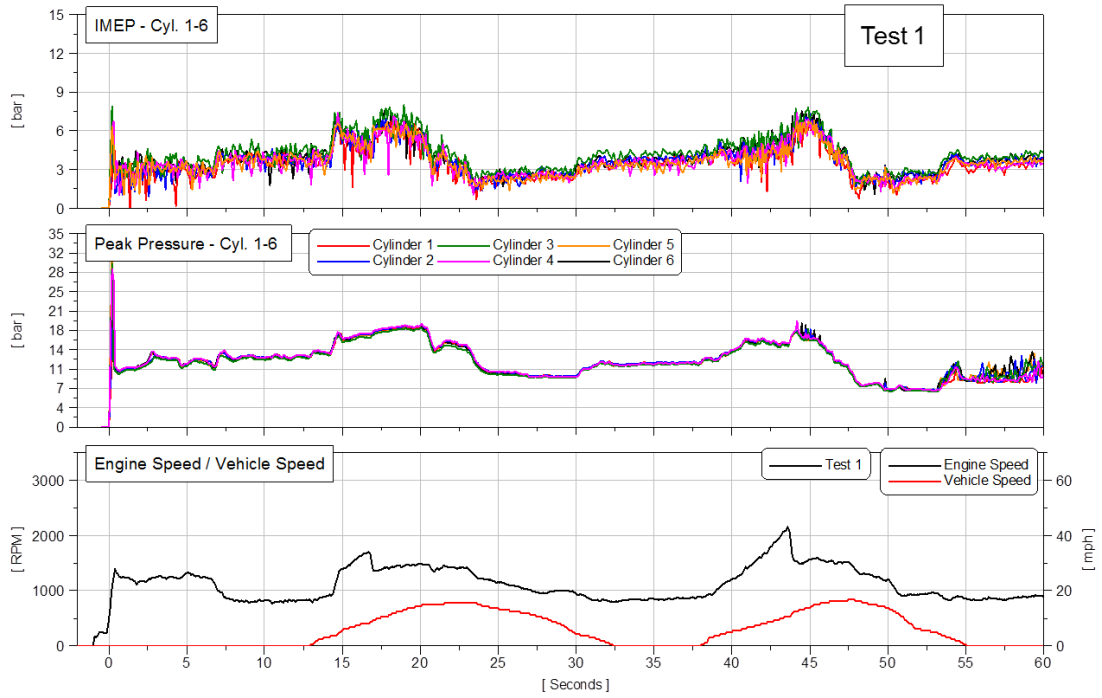


Honda Civic CE30 TR2340 Test 2 Original Drive Cycle

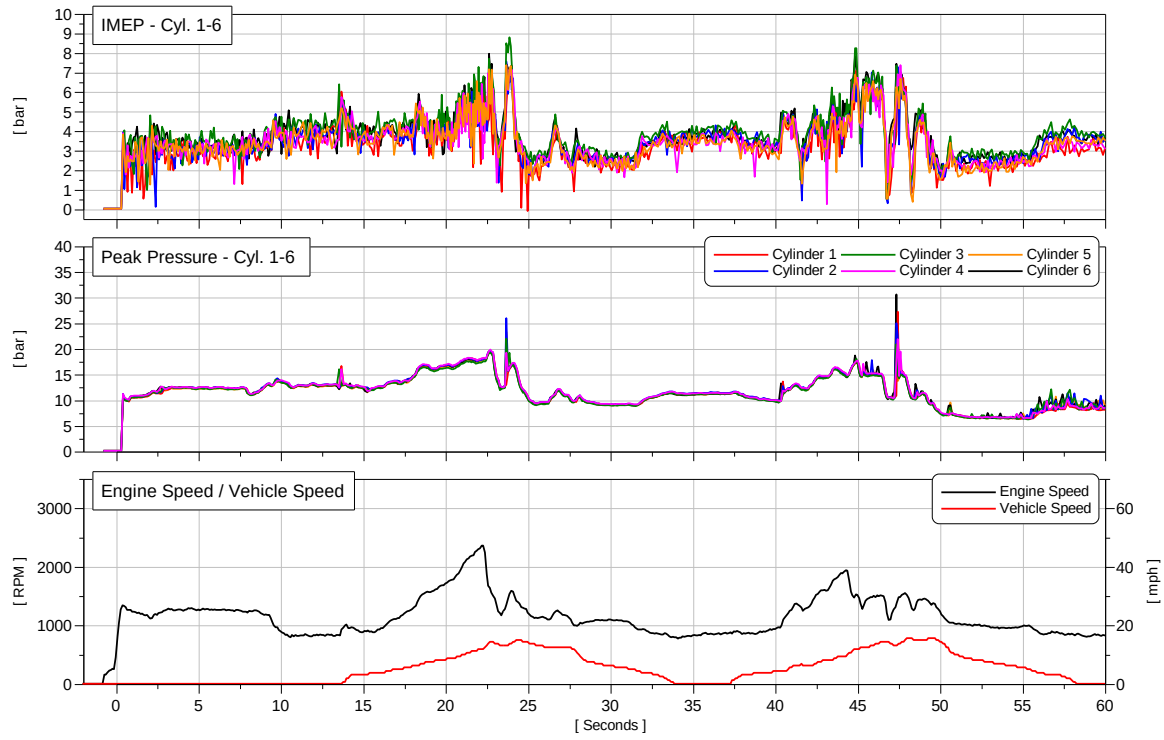


Honda Civic CE30 TR2340 Test 3 Original Drive Cycle

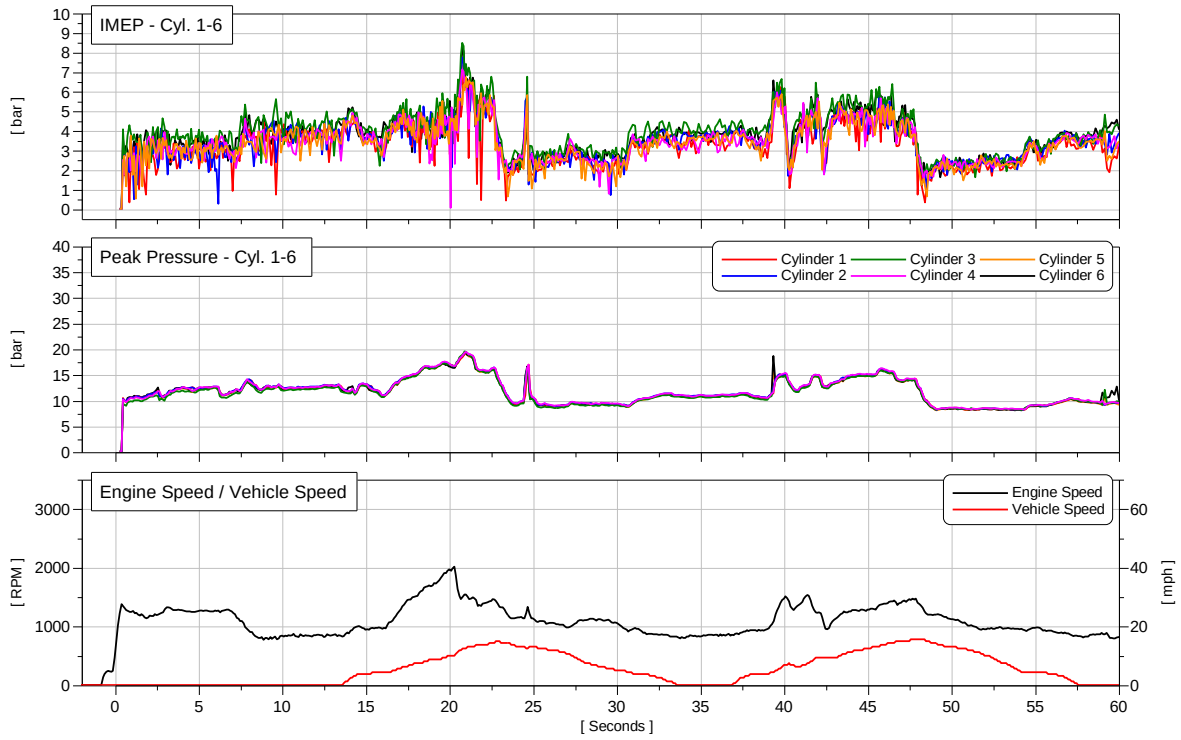
Ford F-150 B0 TR2335 Test 1 Original Drive Cycle



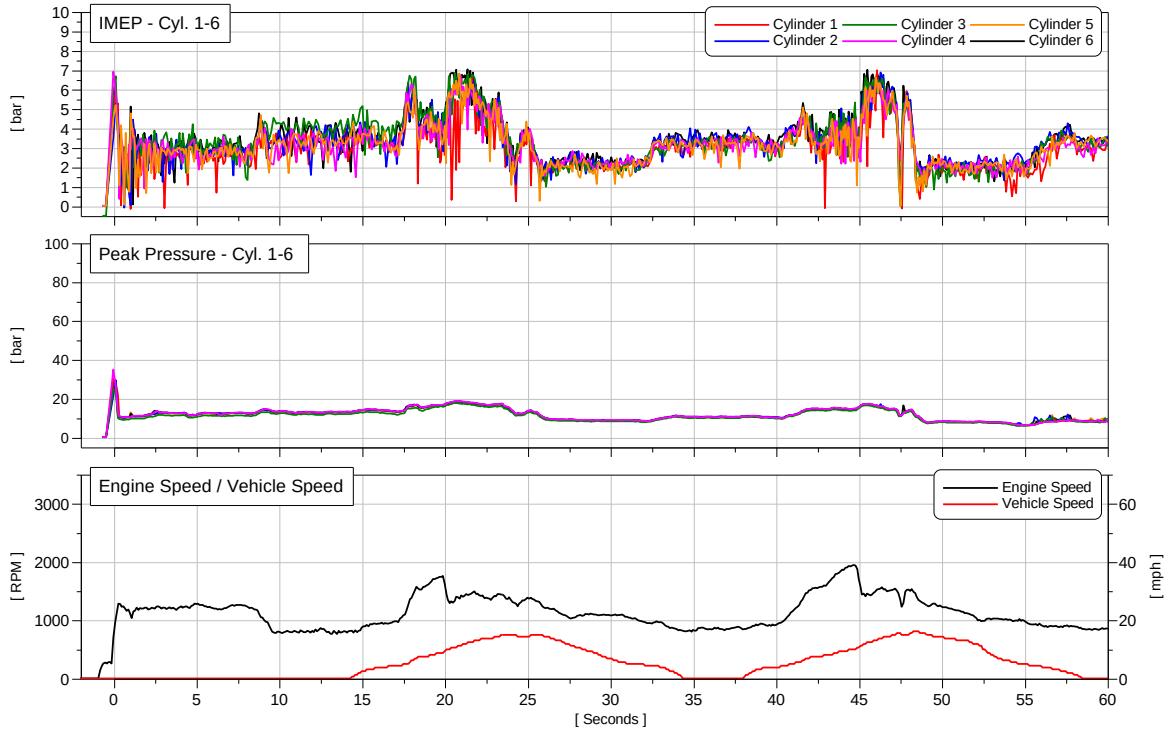
Ford F-150 B0 TR2335 Test 2 Original Drive Cycle



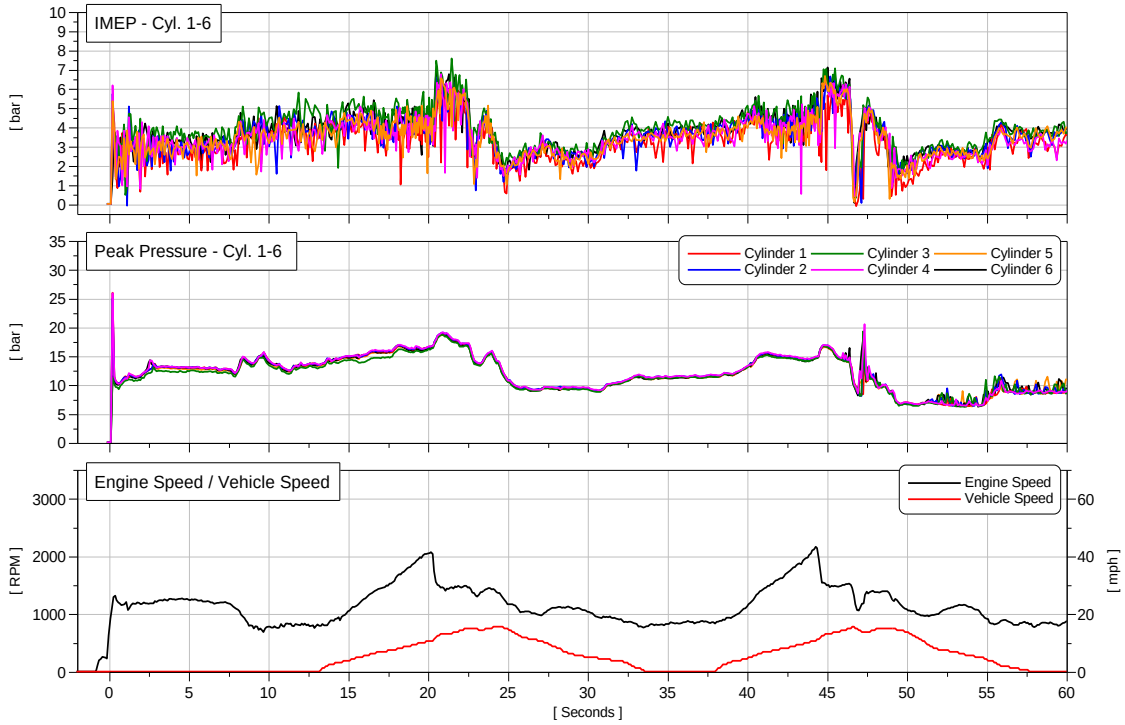
Ford F-150 B0 TR2335 Test 3 Original Drive Cycle



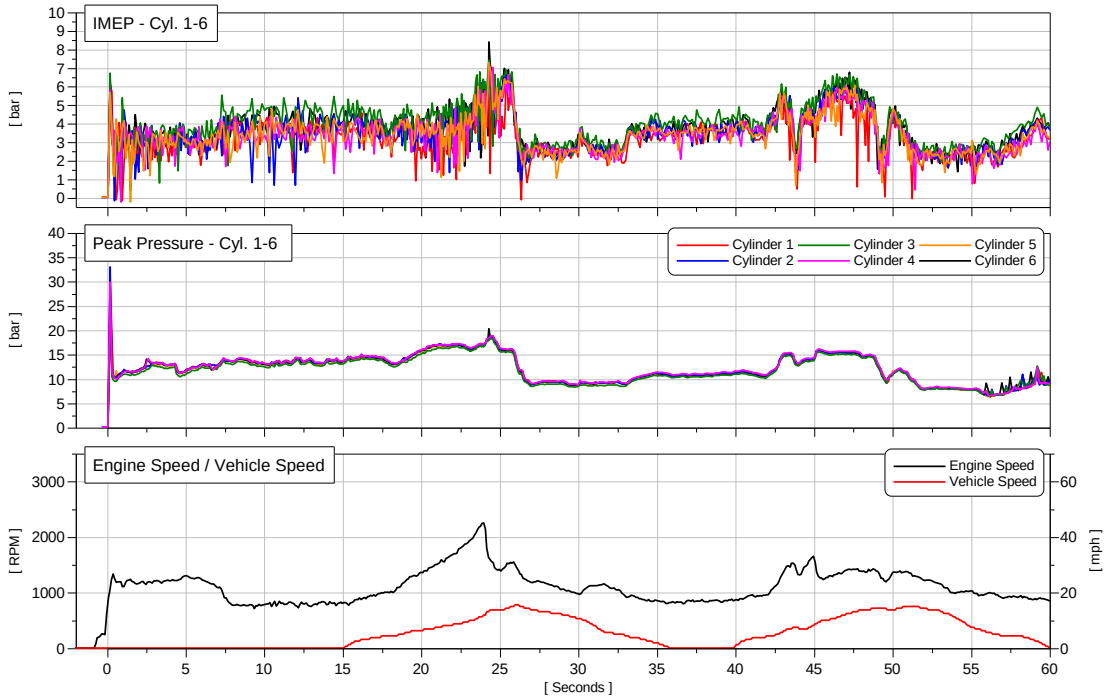
Ford F-150 C0 TR2338 Test 1 Original Drive Cycle



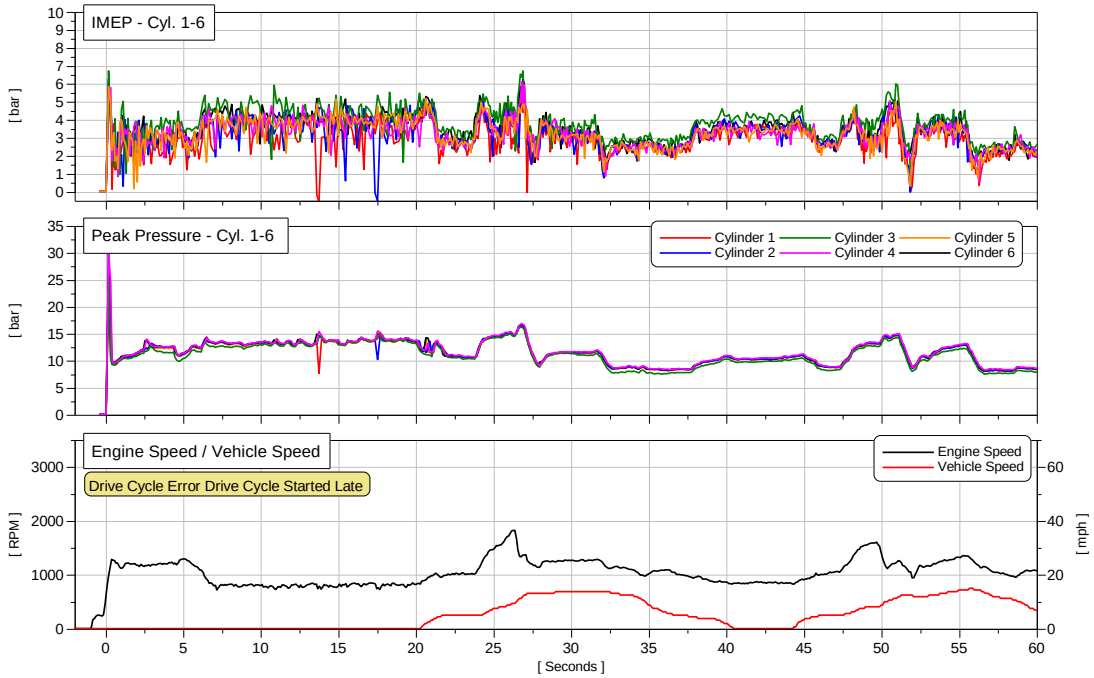
Ford F-150 C0 TR2338 Test 2 Original Drive Cycle



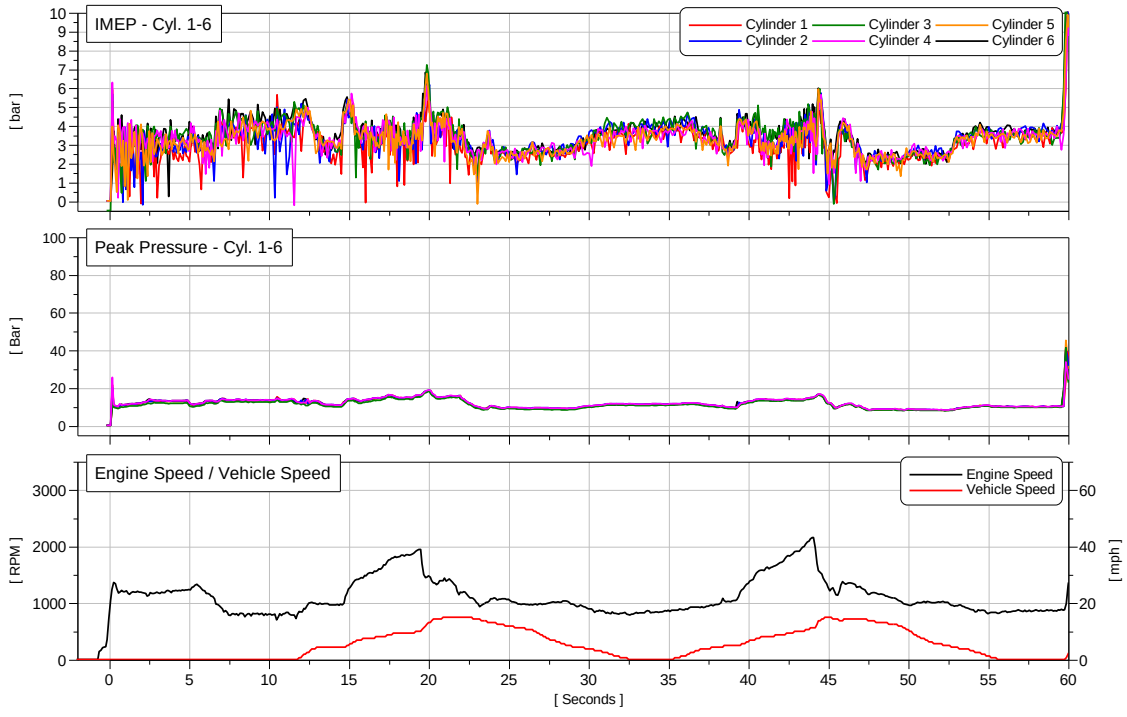
Ford F-150 C0 TR2338 Test 3 Original Drive Cycle



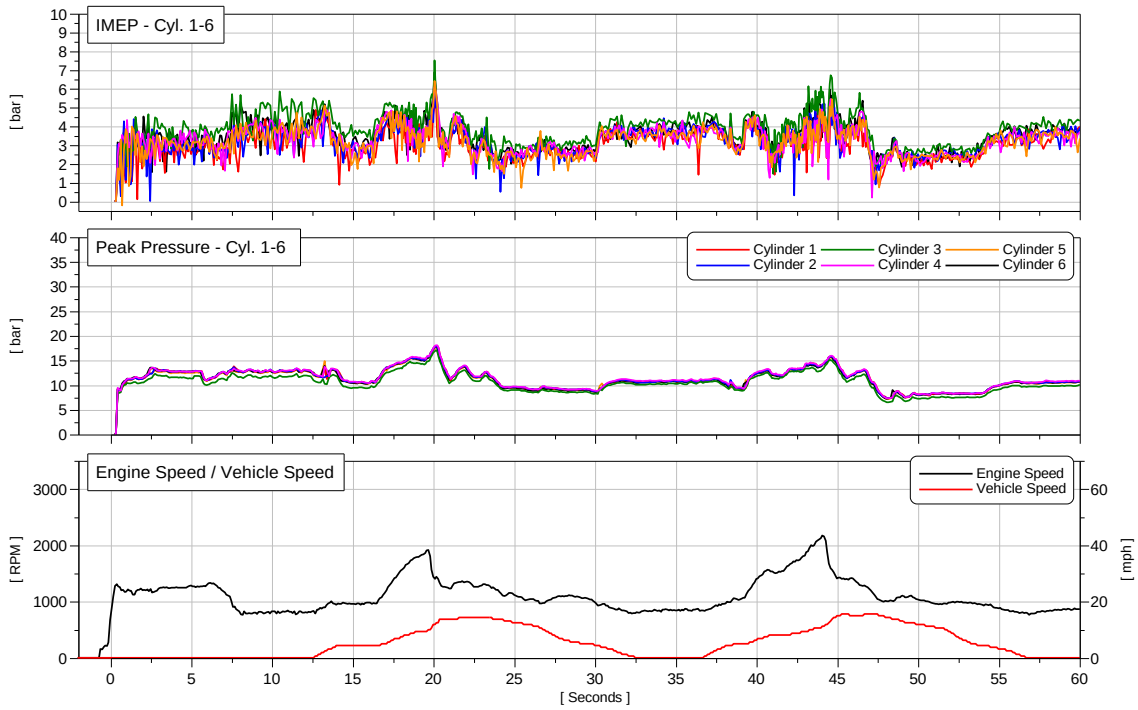
Ford F-150 CE15 TR2339 Test 1 Original Drive Cycle



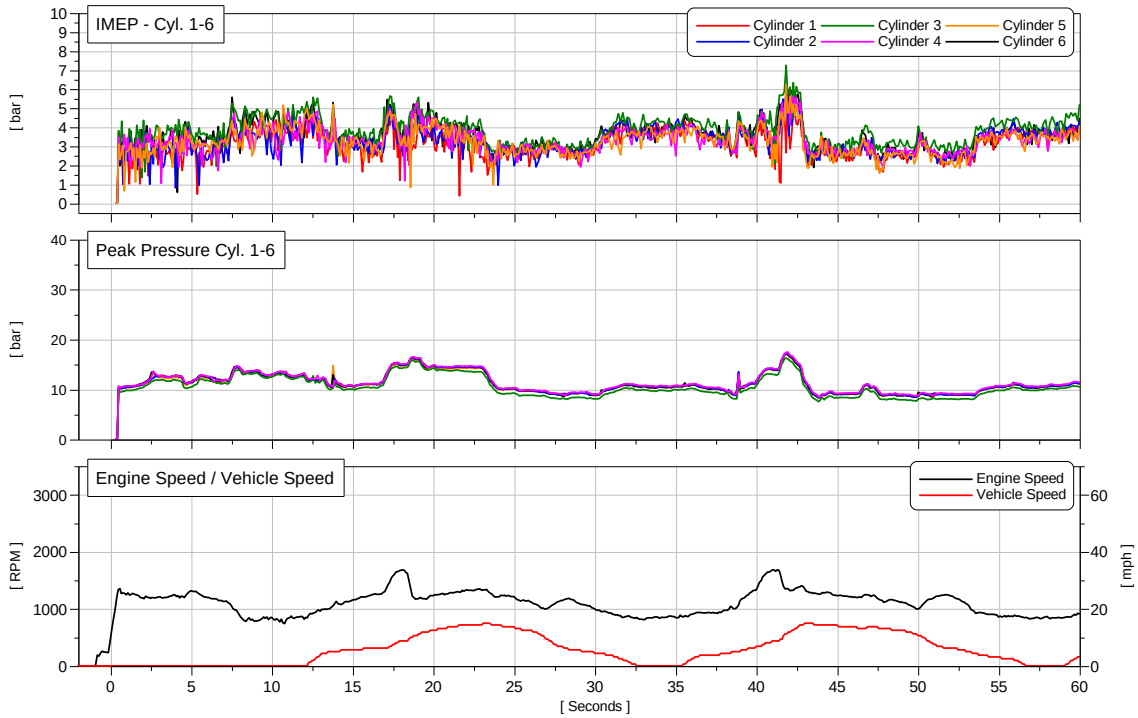
Ford F-150 CE15 TR2339 Test 2 Original Drive Cycle



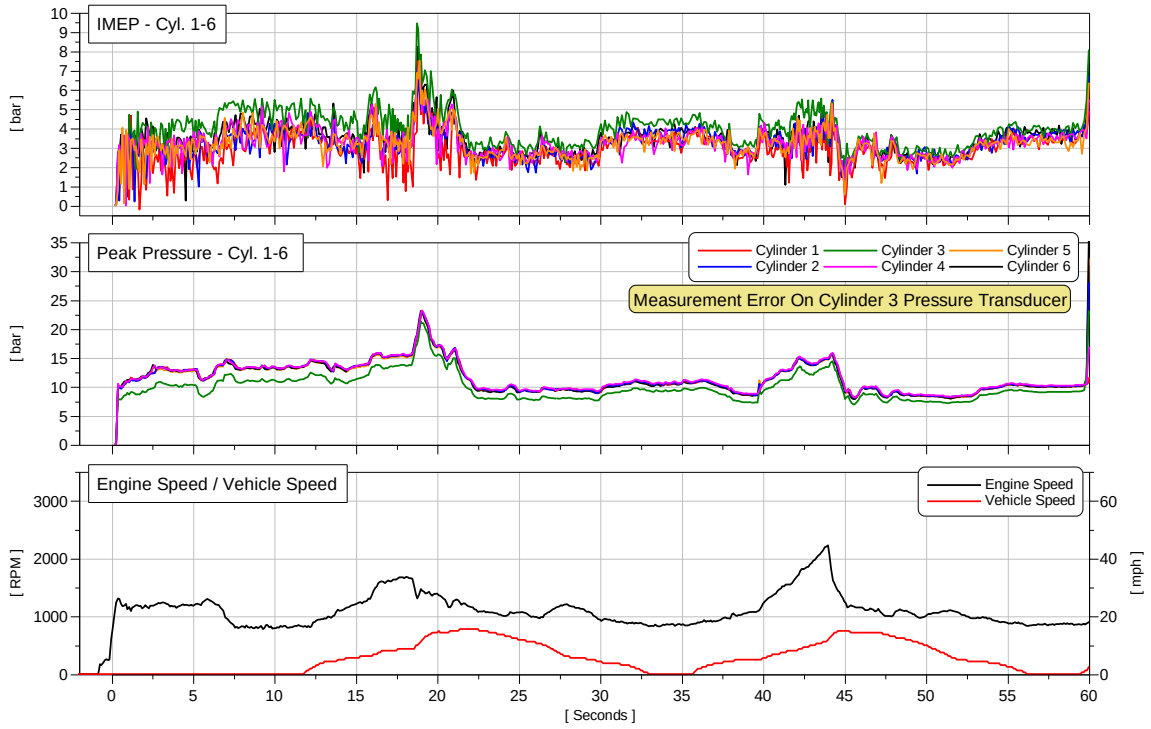
Ford F-150 CE15 TR2339 Test 3 Original Drive Cycle



Ford F-150 CE30 TR2340 Test 1 Original Drive Cycle



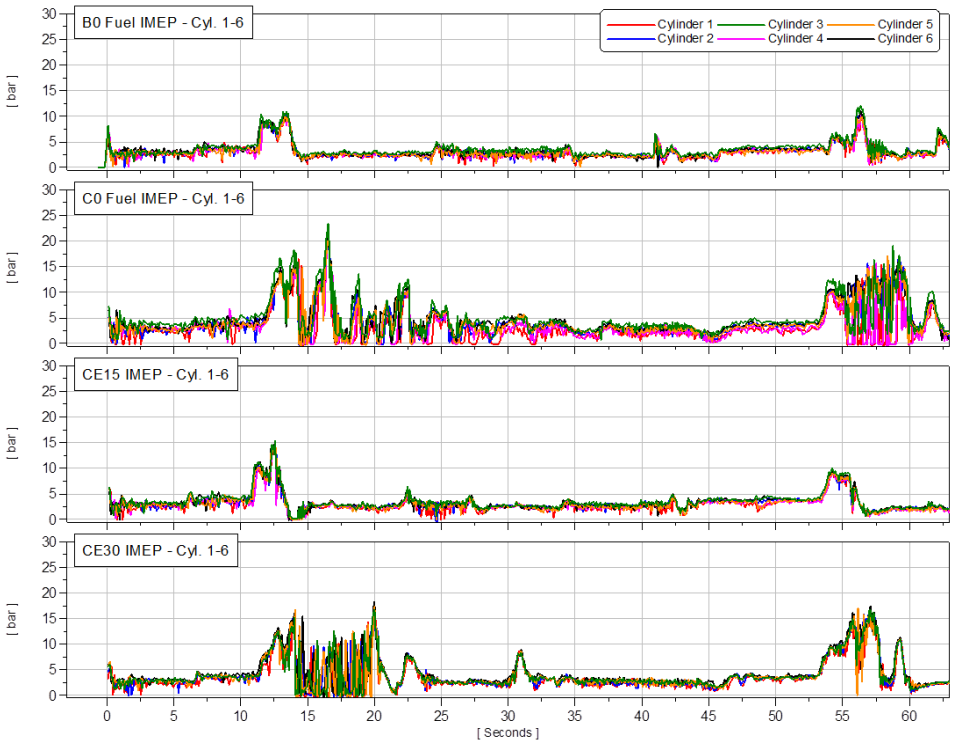
Ford F-150 CE30 TR2340 Test 2 Original Drive Cycle



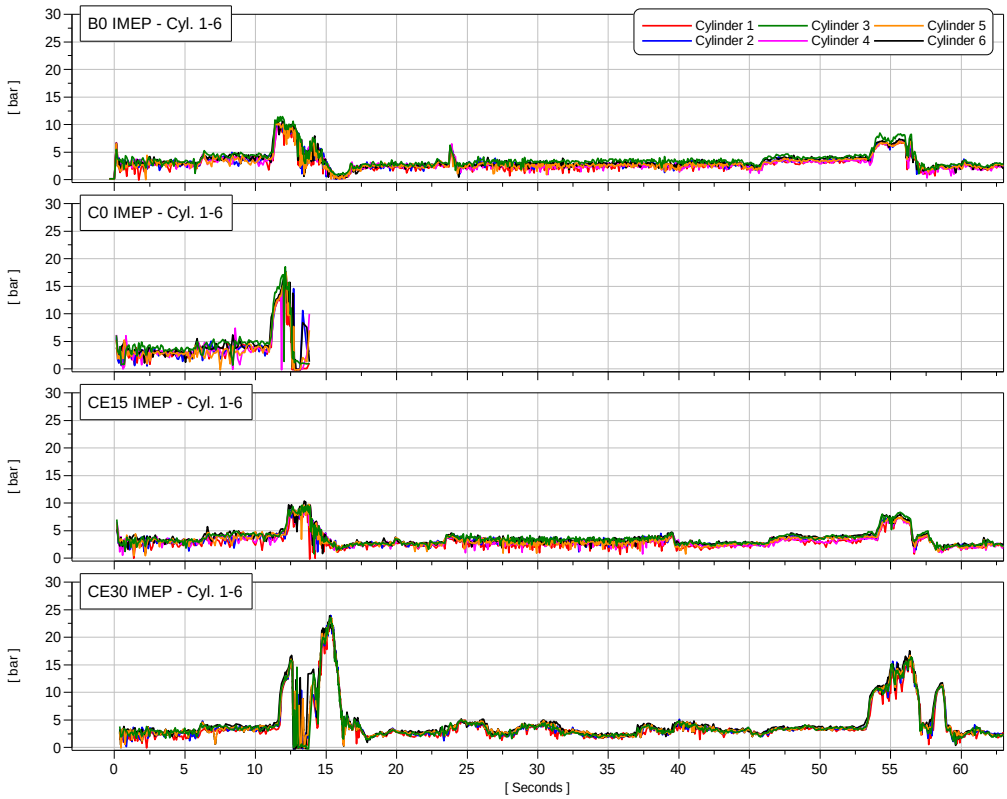
Ford F-150 CE30 TR2340 Test 3 Original Drive Cycle

Appendix E: Ford F-150 and Mazda CX-9 Modified Drive Cycle IMEP Measurements

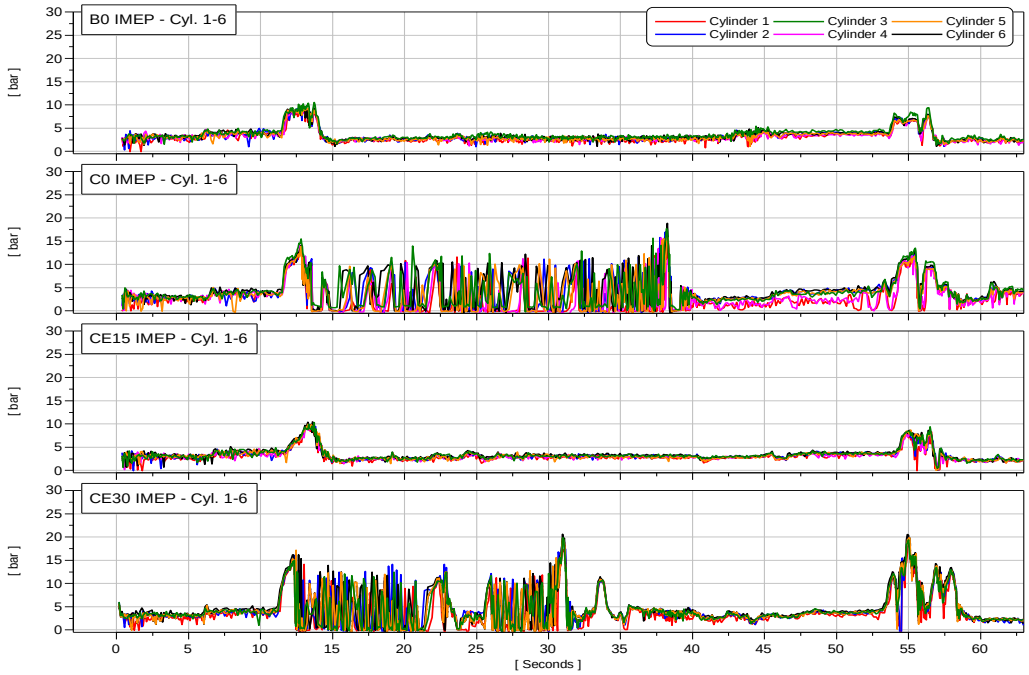
Ford F-150 Test 1



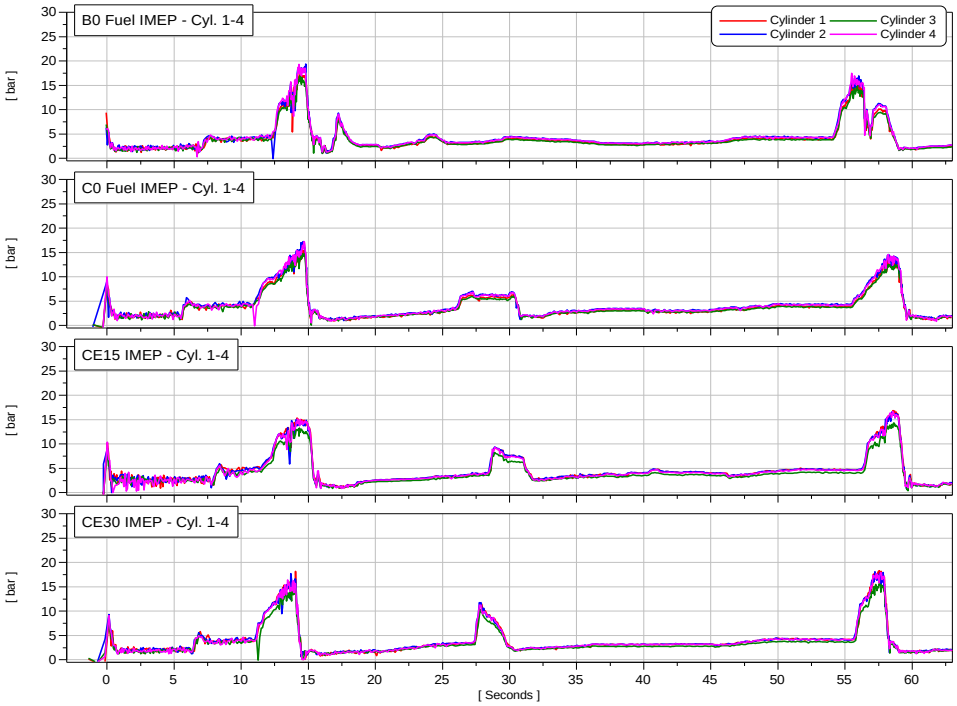
Ford F-150 Test 2



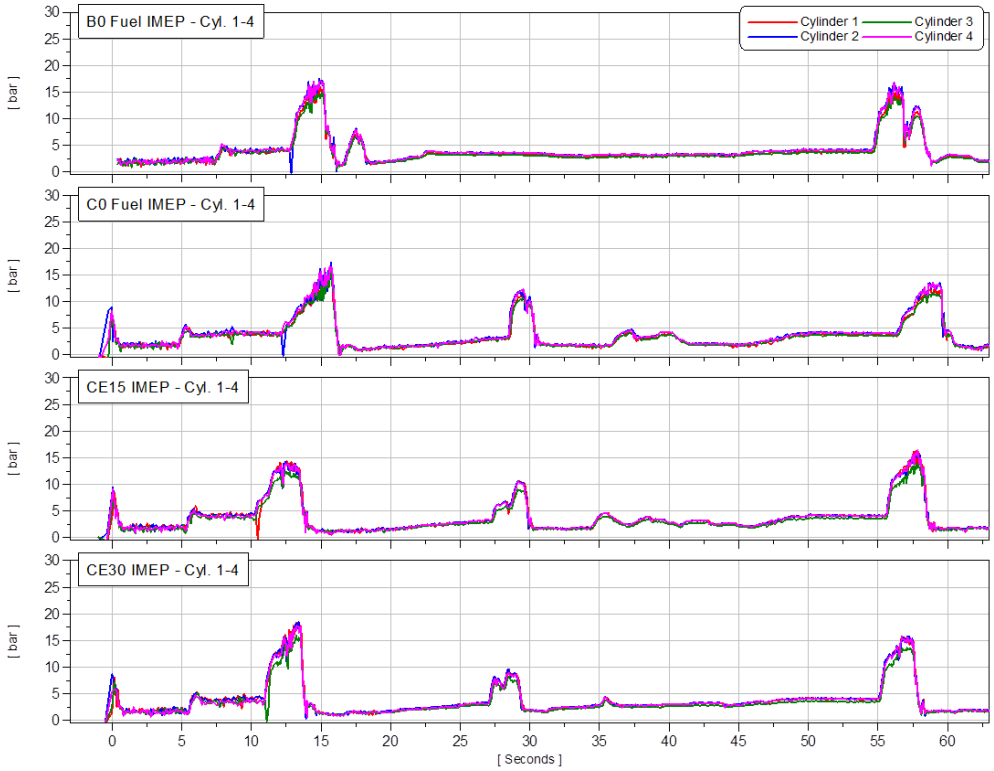
Ford F-150 Test 3



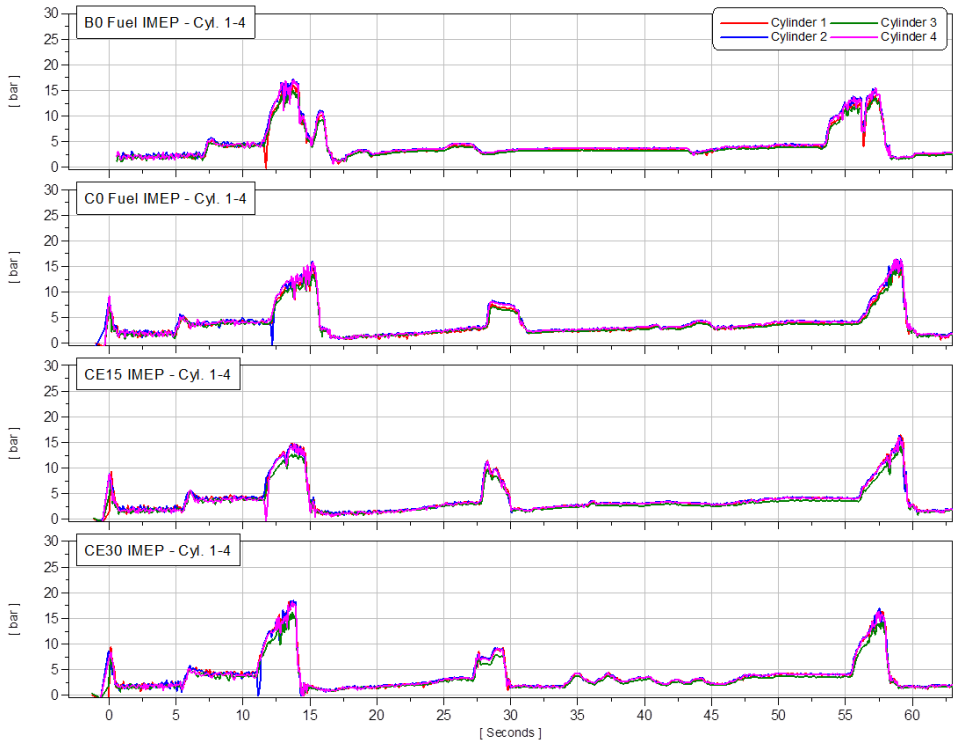
Mazda CX-9 Test 1



Mazda CX-9 Test 2



Mazda CX-9 Test 3



Appendix F: Vehicle Test Sequence and Test Modifications

1) 2016 Honda Civic Testing, all four fuels (B0 TR2335, C0 TR2338, CE15 TR2339, CE30 TR2340), 3 tests each fuel, original drive cycle, original spark plugs.

2) 2017 Ford F-150, all four fuels (B0 TR2335, C0 TR2338, CE15 TR2339, CE30 TR2340), 3 tests each fuel, original drive cycle, original spark plugs.

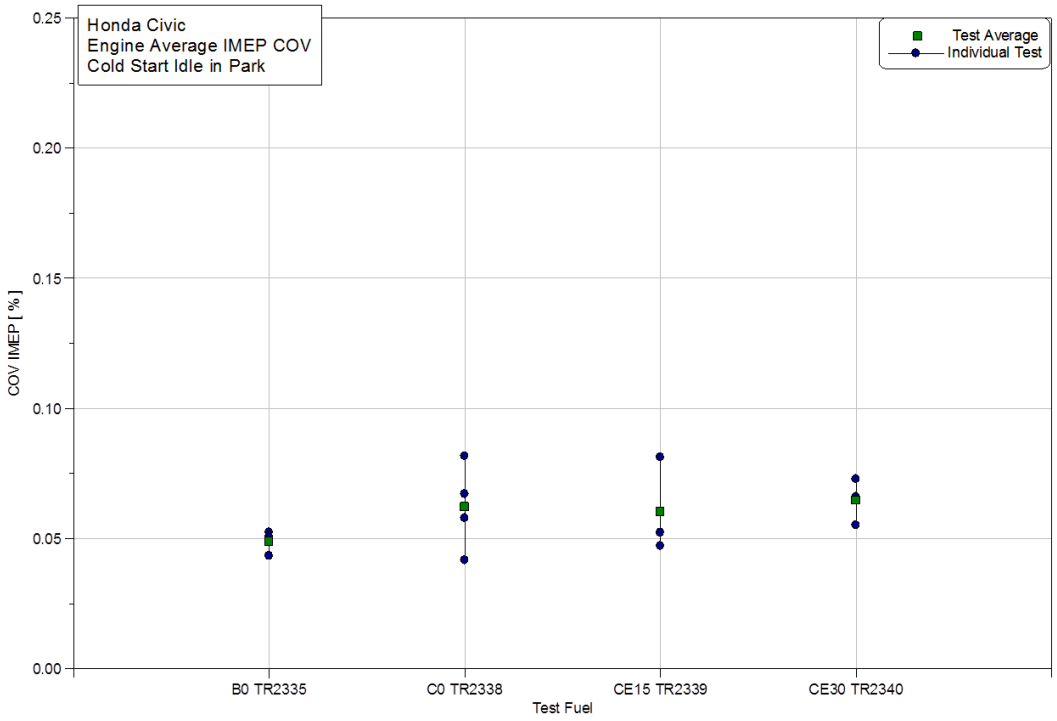
3) 2017 Ford F-150, fuel B0 TR2335 and C0 TR2338, 3 tests each fuel, modified aggressive drive cycle, original spark plugs

4) 2017 Ford F-150, fuel CE15 TR2339 and CE30 TR2340, 3 tests each fuel, modified aggressive cycle, new spark plugs before each of the 3 tests on each fuel

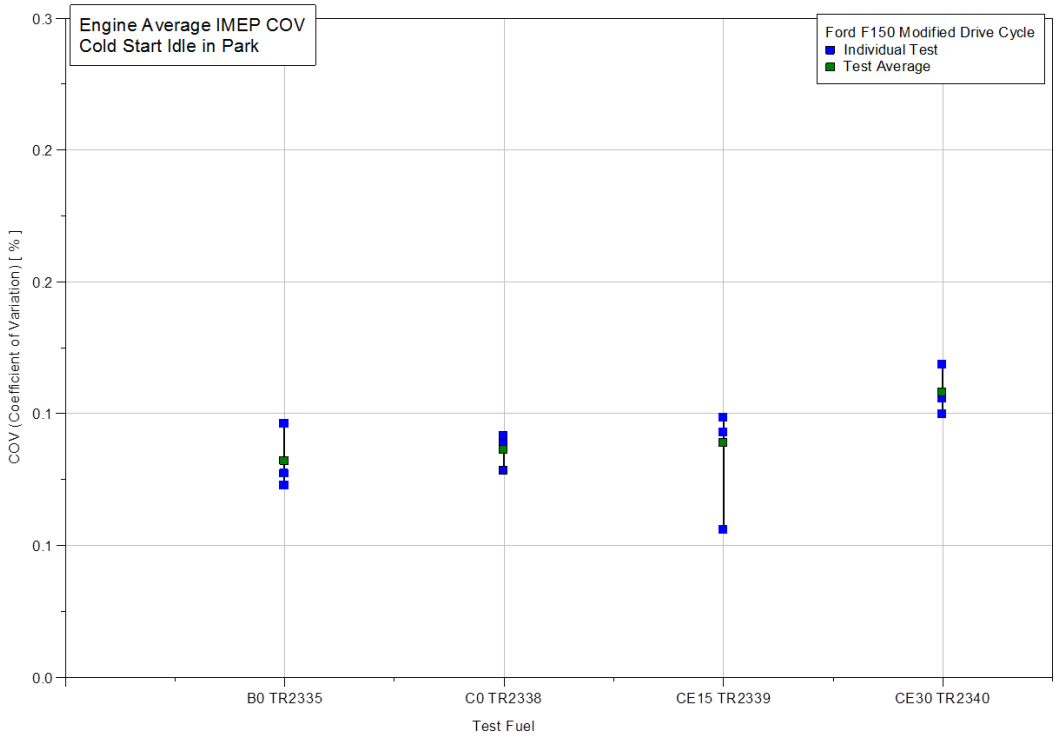
5) 2016 Mazda CX-9, all four resupply re-blended fuels (B0 TR2335A, C0 TR2338A, CE15 TR2339A, CE30 TR2340A). 3 tests each fuel, modified aggressive cycle, new spark plugs before each individual test.

Appendix G: IMEP COV (Coefficient of Variance) Plots

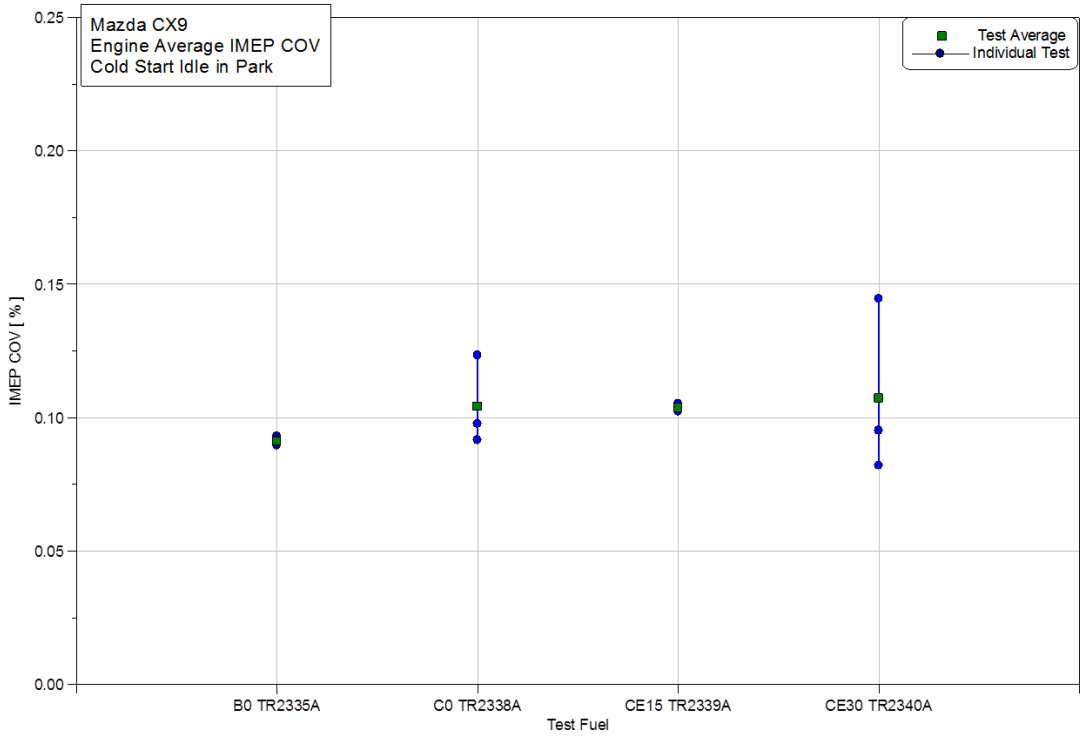
1.) Honda Civic Cold Start IMEP COV



2.) Ford F-150 Cold Start IMEP COV Modified Drive Cycle



3.) Mazda CX-9 Cold Start IMEP COV



Appendix H: Resupply Reblend Fuel Detailed Hydrocarbon Analysis

1.) B0 TR2335A

TIME	CASNO	RI	GROUP	CARBON#
8.223	75-28-5	371.24	I-Paraffins	4
9.17	106-97-8	400	Paraffin	4
12.745	78-78-4	478.63	I-Paraffins	5
12.827		479.79	Unidentified	0
14.447	109-66-0	500	Paraffin	5
16.993	75-83-2	540.93	I-Paraffins	6
18.71	691-37-2	563.06	Iso-Olefins	6
19.137	287-92-3	568.06	Mono-Naphthenes	5
19.27	79-29-8	569.59	I-Paraffins	6
19.643	107-83-5	573.78	I-Paraffins	6
20.18		579.6	Unidentified	0
20.758	96-14-0	585.61	I-Paraffins	6
21.383	592-41-6	591.83	n-Olefins	6
22.247	110-54-3	600	Paraffin	6
22.48	13269-52-8	602.85	n-Olefins	6
22.7	4050-45-7	605.5	n-Olefins	6
22.902	625-27-4	607.9	Iso-Olefins	6
23.143	922-62-3	610.73	Iso-Olefins	6
23.502	7688-21-3	614.85	n-Olefins	6
24.062	922-61-2	621.12	Iso-Olefins	6
24.34	590-35-2	624.16	I-Paraffins	7
24.557	96-37-7	626.49	Mono-Naphthenes	6
24.942	108-08-7	630.57	I-Paraffins	7
25.387	464-06-2	635.17	I-Paraffins	7
26.842	693-89-0	649.49	Naphtheno-Olefins	6
27.405	625-65-0	654.76	Iso-Olefins	7
27.848	110-82-7	658.8	Mono-Naphthenes	6
28.848	591-76-4	667.62	I-Paraffins	7
29.018	565-59-3	669.07	I-Paraffins	7
29.352	1638-26-2	671.9	Mono-Naphthenes	7
29.845	589-34-4	676.01	I-Paraffins	7
30.618	1759-58-6	682.28	Mono-Naphthenes	7
30.962	2532-58-3	685	Mono-Naphthenes	7
31.095	617-78-7	686.04	I-Paraffins	7
31.31	822-50-4	687.72	Mono-Naphthenes	7
31.425	540-84-1	688.6	I-Paraffins	8
32.948	142-82-5	700	Paraffin	7
35.902	108-87-2	718.83	Mono-Naphthenes	7
36.323	4516-69-2	721.36	Mono-Naphthenes	8
37.85	1640-89-7	730.23	Mono-Naphthenes	7

38.062	564-02-3	731.42	I-Paraffins	8
38.18	589-43-5	732.09	I-Paraffins	8
39.21	16883-48-0	737.77	Mono-Naphthenes	8
40.562	15890-40-1	744.95	Mono-Naphthenes	8
41.087	565-75-3	747.67	I-Paraffins	8
41.473	2146-38-5	749.64	Naphtheno-Olefins	7
41.937	560-21-4	751.97	I-Paraffins	8
42.368	108-88-3	754.12	Mono-Aromatics	7
42.628	1515-79-3	755.4	Di-Olefins	8
43.25	584-94-1	758.43	I-Paraffins	8
43.488	609-26-7	759.57	I-Paraffins	8
44.492	592-27-8	764.32	I-Paraffins	8
44.82	589-53-7	765.84	I-Paraffins	8
45.09	16747-28-7	767.09	I-Paraffins	9
45.21	583-48-2	767.64	I-Paraffins	8
46.17	2815-58-9	771.98	Mono-Naphthenes	8
46.6	619-99-8	773.89	I-Paraffins	8
47.03	638-04-0	775.78	Mono-Naphthenes	8
48.363	590-66-9	781.51	Mono-Naphthenes	8
48.79	3522-94-9	783.3	I-Paraffins	9
49.218	2613-66-3	785.09	Mono-Naphthenes	8
49.763	3726-47-4	787.33	Mono-Naphthenes	8
50.085	624-29-3	788.64	Mono-Naphthenes	8
50.432		790.05	Unidentified	0
51.362		793.75	Naphtheno-Olefins	8
52.973	111-65-9	800	Paraffin	8
53.357	589-90-2	801.53	Mono-Naphthenes	8
54.883	473-91-6	807.48	Naphtheno-Olefins	8
55.297	3404-79-3	809.06	Iso-Olefins	8
57.357	4784-86-5	816.73	Naphtheno-Olefins	7
57.8	1462-07-3	818.34	Naphtheno-Olefins	8
58.485	3726-46-3	820.8	Mono-Naphthenes	8
58.922		822.35	Iso-Olefins	8
60.35		827.34	I-Paraffins	9
60.35		827.34	Naphtheno-Olefins	8
62.175	1678-91-7	833.52	Mono-Naphthenes	8
62.602	1072-05-5	834.93	I-Paraffins	9
63.257	1068-19-5	837.09	Naphtheno-Olefins	9
64.008		839.53	Naphtheno-Olefins	8
64.985	2216-30-0	842.65	I-Paraffins	9
65.437	4032-86-4	844.07	I-Paraffins	9
65.883	7094-27-1	845.47	Mono-Naphthenes	9
66.368		846.98	Mono-Naphthenes	9
66.865		848.51	Unidentified	0
66.977		848.85	Mono-Naphthenes	9
68.572		853.68	Unidentified	0

69.523	100-41-4	856.5	Mono-Aromatics	8
69.787	7667-60-9	857.27	Mono-Naphthenes	9
70.61		859.66	Mono-Naphthenes	9
71.318	1795-27-3	861.7	Mono-Naphthenes	9
72.975	108-38-3	866.38	Mono-Aromatics	8
73.282	106-42-3	867.23	Mono-Aromatics	8
73.64	926-82-9	868.22	I-Paraffins	9
73.955	13151-04-7	869.09	Iso-Olefins	8
74.08		869.43	Unidentified	0
74.467		870.49	Mono-Naphthenes	9
74.785	2216-32-2	871.35	I-Paraffins	9
74.862	75873-00-6	871.56	Naphtheno-Olefins	10
75.832	2216-34-4	874.17	I-Paraffins	9
76.172	3221-61-2	875.07	I-Paraffins	9
76.85	7145-23-5	876.87	Iso-Olefins	8
77.647	15869-80-4	878.95	I-Paraffins	9
78.208	2216-33-3	880.41	I-Paraffins	9
78.638	61228-10-2	881.52	Iso-Olefins	10
78.985	3074-78-0	882.4	Iso-Olefins	9
79.49		883.69	Unidentified	0
79.992	95-47-6	884.96	Mono-Aromatics	8
80.335		885.82	Iso-Olefins	9
80.605	14720-74-2	886.5	I-Paraffins	10
81.375	3728-57-2	888.41	Mono-Naphthenes	9
81.48		888.67	Unidentified	0
81.615	3728-56-1	889	Mono-Naphthenes	9
82.22	19489-10-2	890.49	Mono-Naphthenes	9
82.478	4110-44-5	891.12	I-Paraffins	10
83.05	20063-92-7	892.51	n-Olefins	9
83.312	932-40-1	893.14	Mono-Naphthenes	9
83.463	4923-77-7	893.5	Mono-Naphthenes	9
83.558	16580-26-0	893.73	Mono-Naphthenes	10
84.815		896.72	Iso-Olefins	10
85.502	16993-86-5	898.34	Iso-Olefins	9
85.743	7154-80-5	898.91	I-Paraffins	10
86.213	111-84-2	900	Paraffin	9
86.64	4926-90-3	902.32	Mono-Naphthenes	9
87.205	1678-98-4	905.36	Mono-Naphthenes	10
87.4	6236-88-0	906.41	Mono-Naphthenes	9
88.833	98-82-8	914.03	Mono-Aromatics	9
89.203		915.97	Mono-Naphthenes	9
89.747	1678-92-8	918.81	Mono-Naphthenes	9
90.272	20278-85-7	921.54	I-Paraffins	10
90.68		923.65	I-Paraffins	10
90.83	2613-61-8	924.42	I-Paraffins	10
91.232	68702-25-0	926.48	Iso-Olefins	10

91.778		929.27	Mono-Naphthenes	9
92.288		931.85	Unidentified	0
93.313	4032-93-3	937	I-Paraffins	10
93.617	1072-16-8	938.52	I-Paraffins	10
94.412	2051-30-1	942.46	I-Paraffins	10
95.552	103-65-1	948.04	Mono-Aromatics	9
95.913	13475-78-0	949.8	I-Paraffins	10
96.402	32281-85-9	952.16	Mono-Naphthenes	10
97.295	620-14-4	956.45	Mono-Aromatics	9
97.638	622-96-8	958.08	Mono-Aromatics	9
98.547		962.38	Unidentified	0
98.813	108-67-8	963.64	Mono-Aromatics	9
99.763	15869-85-9	968.08	I-Paraffins	10
100.09	62016-37-9	969.59	I-Paraffins	11
100.637	611-14-3	972.12	Mono-Aromatics	9
101.182	5881-17-4	974.62	I-Paraffins	10
101.797	1465084	977.43	I-Paraffins	10
103.598	95-63-6	985.54	Mono-Aromatics	9
104.89		991.27	Mono-Naphthenes	9
106.202	538-93-2	997.01	Mono-Aromatics	10
106.67	135-98-8	999.04	Mono-Aromatics	10
106.892	124-18-5	1000	Paraffin	10
108.23	526-73-8	1009.5	Mono-Aromatics	9
108.535	535-77-3	1011.65	Mono-Aromatics	10
109.03	99-87-6	1015.12	Mono-Aromatics	10
109.372		1017.51	I-Paraffins	11
109.523		1018.56	I-Paraffins	11
110.065	496-11-7	1022.33	Indanes	9
110.388		1024.56	I-Paraffins	11
110.838		1027.66	I-Paraffins	11
111.135	95-13-6	1029.7	Indenes	9
111.642		1033.17	I-Paraffins	11
112.302	62199-06-8	1037.65	I-Paraffins	12
112.657	7045-71-8	1040.06	I-Paraffins	12
112.9	141-93-5	1041.7	Mono-Aromatics	10
113.298	1074-43-7	1044.38	Mono-Aromatics	10
113.863	1074-55-1	1048.16	Mono-Aromatics	10
114.022	105-05-5	1049.22	Mono-Aromatics	10
114.357	934-74-7	1051.45	Mono-Aromatics	10
114.688	135-01-3	1053.66	Mono-Aromatics	10
114.898		1055.05	Mono-Aromatics	10
115.605	1074-17-5	1059.71	Mono-Aromatics	10
116.028	13151-35-4	1062.48	I-Paraffins	11
116.4		1064.91	Iso-Olefins	11
116.485	2847-72-5	1065.47	I-Paraffins	11
117.147	1758-88-9	1069.77	Mono-Aromatics	10

117.4	768-49-0	1071.41	Mono-Aromatics	10
117.917	13151-34-3	1074.75	I-Paraffins	11
118.297	934-80-5	1077.19	Mono-Aromatics	10
118.528	767-58-8	1078.67	Indanes	10
118.757		1080.13	Unidentified	0
119.137	98-51-1	1082.56	Mono-Aromatics	11
119.658		1085.87	Unidentified	0
119.828	62238-04-4	1086.95	Mono-Naphthenes	10
120.212	13151-10-5	1089.37	Iso-Olefins	9
120.472		1091.01	Iso-Olefins	9
120.823	20024-91-3	1093.22	Mono-Aromatics	11
121.12	933-98-2	1095.07	Mono-Aromatics	10
121.677		1098.55	Unidentified	0
121.91	1120-21-4	1100	Paraffin	11
122.788	4218-48-8	1107.51	Mono-Aromatics	11
123.305	95-93-2	1111.89	Mono-Aromatics	10
123.597		1114.36	Mono-Aromatics	11
123.893		1116.87	Unidentified	0
124.113	20836-11-7	1118.72	Indanes	11
124.408		1121.2	I-Paraffins	11
125.115		1127.12	I-Paraffins	12
125.14		1127.33	I-Paraffins	12
125.517	824-22-6	1130.46	Indanes	10
125.875		1133.44	Mono-Naphthenes	11
126.16	2050-24-0	1135.8	Mono-Aromatics	11
126.325		1137.16	Mono-Aromatics	11
126.505	1075-38-3	1138.65	Mono-Aromatics	11
126.687	767-59-9	1140.15	Indenes	10
126.883	824-63-5	1141.77	Indanes	10
127.393	354381	1145.95	Mono-Aromatics	10
127.732		1148.72	Mono-Naphthenes	11
127.953	4132-72-3	1150.53	Mono-Aromatics	11
128.135	538-68-1	1152.01	Mono-Aromatics	11
128.532	13632-94-5	1155.23	Mono-Aromatics	11
128.663	4920-99-4	1156.3	Mono-Aromatics	11
128.907		1158.27	I-Paraffins	10
129.087	2049-95-8	1159.72	Mono-Aromatics	11
129.335	1758-85-6	1161.72	Mono-Aromatics	11
129.537	1636-44-8	1163.35	I-Paraffins	12
129.857		1165.92	Mono-Aromatics	11
130.042	17301-24-5	1167.4	I-Paraffins	13
130.183	1595-16-0	1168.54	Mono-Aromatics	11
130.648	91-20-3	1172.25	Naphthalenes	10
130.835	98-19-1	1173.74	Mono-Aromatics	12
131.158	4175-53-5	1176.31	Indanes	11
131.38		1178.07	Unidentified	0

131.707	6682-71-9	1180.65	Indanes	11
131.913	4912-92-9	1182.28	Indanes	11
132.363	7364-19-4	1185.83	Mono-Aromatics	12
132.99	99-62-7	1190.75	Mono-Aromatics	12
133.207	4706-90-5	1192.44	Mono-Aromatics	11
133.65		1195.9	Mono-Aromatics	11
134.178	112-40-3	1200	Paraffin	12
134.602	17314-92-0	1204.08	Mono-Aromatics	12
135.167	4706-89-2	1209.51	Mono-Aromatics	11
135.363	60584-82-9	1211.4	Indanes	12
135.622		1213.87	Mono-Aromatics	11
135.942		1216.92	Mono-Aromatics	11
136.227	4/2/4810	1219.63	Mono-Aromatics	12
136.91	56147-63-8	1226.11	Indanes	11
137.17	4830-99-3	1228.57	Indanes	11
137.442		1231.13	Mono-Aromatics	12
137.593		1232.56	Mono-Aromatics	12
138.922		1244.99	Indanes	11
140.438	2177-48-2	1259.04	Indanes	11
140.838	1075-22-5	1262.72	Indanes	11
141.773		1271.27	Mono-Aromatics	12
142.423	700-12-9	1277.19	Mono-Aromatics	11
143.497	90-12-0	1286.89	Naphthalenes	11
145.213	91-57-6	1302.67	Naphthalenes	11
146.545	22531-20-0	1316.71	Mono-Aromatics	12
147.453	13556-58-6	1326.2	Mono-Aromatics	12
148.433	42775-77-9	1336.37	Mono-Aromatics	13
149.18		1344.08	Mono-Aromatics	12
149.605		1348.45	I-Paraffins	13
150.33	10222-95-4	1355.87	Mono-Aromatics	12
151.747	92-52-4	1370.26	Mono-Aromatics	12
153.622	62238-11-3	1389.1	I-Paraffins	13
153.86	939-27-5	1391.47	Naphthalenes	12
154.718	629-59-4	1400	Paraffin	14
154.718	581-42-0	1400	Naphthalenes	12
154.882	582-16-1	1401.86	Naphthalenes	12
155.933	14276-95-0	1413.77	Indanes	12
156.158	575-37-1	1416.31	Naphthalenes	12
156.158	575-41-7	1416.31	Naphthalenes	12
156.505	575-43-9	1420.21	Naphthalenes	12
158.062	571-58-4	1437.62	Naphthalenes	12
158.062	581-40-8	1437.62	Naphthalenes	12
158.31	571-61-9	1440.39	Naphthalenes	12
159.472	573-98-8	1453.24	Naphthalenes	12
161.747	643-93-6	1478.14	Mono-Aromatics	13
162.085	62185-21-1	1481.81	I-Paraffins	12

162.597	644-08-6	1487.35	Mono-Aromatics	13
163.205	2765-18-6	1493.91	Naphthalenes	13
163.522		1497.32	Unidentified	0
163.772	629-62-9	1500	Paraffin	15
164.045	829-26-5	1502.45	Naphthalenes	13
164.488		1506.42	Unidentified	0
164.937		1510.42	Unidentified	0
165.185		1512.63	Naphthalenes	13
165.588		1516.21	Unidentified	0
165.793		1518.03	Unidentified	0
165.995	2131-42-2	1519.82	Naphthalenes	13
166.45	605-39-0	1523.84	Mono-Aromatics	14
166.49	2131-41-1	1524.19	Naphthalenes	13
167.86		1536.23	Naphthalenes	13
168.222		1539.39	Naphthalenes	13
169.212	2027-17-0	1548	Naphthalenes	13
169.393	2245-38-7	1549.58	Naphthalenes	13
169.553	5707-44-8	1550.97	Mono-Aromatics	14
169.677		1552.03	Unidentified	0
170.64		1560.34	Unidentified	0
170.958	612-75-9	1563.08	Mono-Aromatics	14
171.245		1565.54	Unidentified	0
171.493		1567.66	Unidentified	0
171.997		1571.96	Unidentified	0
172.737	613-33-2	1578.26	Mono-Aromatics	14
172.938	59919-41-4	1579.97	Naphthalenes	14
173.44	21895-16-9	1584.22	Mono-Aromatics	15
174.483		1593.01	Mono-Aromatics	14
179.015	13764-18-6	1630.59	Naphthalenes	14
COMPONENT	**%WGT**	**%VOL**	**%MOL**	**AREA**
i-Butane	2.075	2.863	3.478	2099.631
n-Butane	0.035	0.047	0.059	35.79
i-Pentane	10.32	12.661	13.934	10515.044
Unidentified	0.163	0.152	0.106	167.882
n-Pentane	0.066	0.081	0.09	67.694
2,2-Dimethylbutane	3.949	4.659	4.465	4040.021
4-Methylpentene-1-trans	0.014	0.016	0.016	14.667
Cyclopentane	9.67	9.861	13.432	10133.801
2,3-Dimethylbutane	0.168	0.193	0.19	171.483
2-Methylpentane	0.544	0.631	0.615	556.234
Unidentified	0.012	0.011	0.008	12.178
3-Methylpentane	0.484	0.553	0.547	494.63
Hexene-1	8.861	10.007	10.257	9286.298

n-Hexane	0.973	1.12	1.1	995.672
t-Hexene-3	0.003	0.003	0.004	3.245
t-Hexene-2	0.015	0.017	0.017	15.798
2-Methylpentene-2	0.002	0.002	0.002	2.237
3-Methyl-c-pentene-2	0.008	0.008	0.009	8.038
c-Hexene-2	0.002	0.002	0.002	1.697
2-Pentene,3-methyl-	0.002	0.002	0.002	1.831
2,2-Dimethylpentane	0.075	0.082	0.073	77.291
Methylcyclopentane	0.381	0.387	0.442	399.731
2,4-Dimethylpentane	0.096	0.106	0.094	98.961
2,2,3-Trimethylbutane	0.009	0.01	0.009	9.726
1-Methylcyclopentene	0.002	0.002	0.002	2.153
2-Pentene,2,4-dimethyl-	0.054	0.057	0.053	56.14
Cyclohexane	0.094	0.092	0.109	98.241
2-Methylhexane	0.251	0.276	0.244	258.139
2,3-Dimethylpentane	0.091	0.1	0.088	93.198
1,1-Dimethylcyclopentane	0.013	0.013	0.013	13.62
3-Methylhexane	0.215	0.235	0.209	220.37
1t,3-Dimethylcyclopentane	0.013	0.012	0.012	13.128
1c,3-Dimethylcyclopentane	0.01	0.01	0.01	10.754
3-Ethylpentane	0.013	0.014	0.012	13.149
1t,2-Dimethylcyclopentane	0.013	0.013	0.013	13.702
2,2,4-Trimethylpentane	0.044	0.048	0.038	45.411
n-Heptane	0.024	0.027	0.023	24.447
Methylcyclohexane	0.044	0.043	0.043	45.712
1,1,3-Trimethylcyclopentane	0.004	0.004	0.003	3.941
Ethylcyclopentane	0.231	0.226	0.229	241.624
2,2,3-Trimethylpentane	0.147	0.158	0.126	151.688
2,4-Dimethylhexane	0.231	0.249	0.197	238.167
Cyclopentane,1,2,4-trimethyl-,(1à,2á,4à)-	0.011	0.011	0.01	11.454
1t,2c,3-Trimethylcyclopentane	0.013	0.013	0.011	13.684
2,3,4-Trimethylpentane	1.972	2.123	1.681	2028.904
1-Ethylcyclopentene	0.004	0.004	0.004	4.722
2,3,3-Trimethylpentane	2.85	3.055	2.43	2932.625
Toluene	5.659	4.988	5.983	6316.994
5,5-Dimethyl-1,3-hexadiene	0.07	0.072	0.062	74.951
2,3-Dimethylhexane	0.574	0.617	0.49	590.693
2-Methyl-3-ethylpentane	0.033	0.036	0.028	34.239
2-Methylheptane	0.099	0.106	0.084	101.376
4-Methylheptane	0.029	0.031	0.025	29.891
Hexane,2,3,3-trimethyl-	0.065	0.068	0.049	66.567

3,4-Dimethylhexane	0.068	0.073	0.058	69.804
1c,2c,4-Trimethylcyclopentane	0.065	0.064	0.056	67.678
3-Ethylhexane	0.218	0.233	0.186	223.983
1,3-dimethyl-c-cyclohexane	0.066	0.065	0.057	68.895
1,1-Dimethylcyclohexane	0.007	0.007	0.006	7.581
2,2,5-Trimethylhexane	1.883	1.983	1.43	1941.73
3c-Ethylmethylcyclopentane	0.006	0.006	0.005	6.042
3t-Ethylmethylcyclopentane	0.006	0.006	0.006	6.725
1c,4-Dimethylcyclohexane	0.022	0.022	0.019	23.304
Unidentified	0.009	0.008	0.006	9.256
C8_Naphtheno-Olefins(1)	0.101	0.096	0.09	108.298
n-Octane	0.238	0.259	0.203	244.901
Cyclohexane c&t,1,4-dimethyl-	0.107	0.105	0.093	112.459
Cyclopentene,1,2,3-trimethyl-	0.051	0.048	0.045	53.904
2-Hexene,3,5-dimethyl-	0.008	0.008	0.007	8.086
1,3-Cyclopentadiene,1,2-dimet	0.005	0.005	0.006	5.81
Cyclopentene,1-(1-methylethyl)-	0.332	0.303	0.294	354.648
Cyclopentane,1-ethyl-2-methyl-	0.003	0.003	0.002	2.879
C8_Iso-Olefins(3)	0.005	0.005	0.004	5.133
C9_I-Paraffins(3)	0.057	0.061	0.043	58.8
C8_Naphtheno-Olefins(3)	0.055	0.057	0.049	58.8
Ethylcyclohexane	0.249	0.24	0.216	260.548
2,6-Dimethylheptane	0.127	0.134	0.096	130.832
1-Ethyl-2-Methylcyclopentene	0.004	0.004	0.003	4.202
C8_Naphtheno-Olefins(4)	0.125	0.13	0.111	131.391
2,5-Dimethylheptane	0.18	0.19	0.137	185.683
Heptane,3,3-dimethyl-	0.011	0.011	0.008	10.996
1,1,4-Trimethylcyclohexane	0.008	0.008	0.006	8.349
C9_Mono-Naphthenes(8)	0.017	0.017	0.013	18.032
Unidentified	0.001	0.001	0.001	0.83
trans-1,3-Diethylcyclopentane	0.007	0.006	0.005	7.157
Unidentified	0.005	0.005	0.003	5.323
Ethylbenzene	1.766	1.556	1.621	1956.731
1c,2t,4t-Trimethylcyclohexane	0.179	0.179	0.138	187.215
C9_Mono-Naphthenes(12)	0.003	0.003	0.002	3.311
Cyclohexane,1,3,5-trimethyl-,(1à,3à,5á)-	0.016	0.016	0.013	16.966
m-Xylene	5.213	4.556	4.784	5775.697
p-Xylene	2.131	1.882	1.956	2361.166
3,5-Dimethylheptane	0.012	0.012	0.009	11.94
1-Heptene,5-methyl-	0.017	0.018	0.015	18.08
Unidentified	0.01	0.009	0.006	9.829

C9_Mono-Naphthenes(13)	0.009	0.009	0.007	9.508
4-Ethylheptane	0.014	0.015	0.011	14.717
Cyclopentane,1-methyl-3-(2-methyl-2-propenyl)-	0.009	0.008	0.006	9.346
4-Methyloctane	0.086	0.091	0.066	89.089
2-Methyloctane	0.11	0.116	0.084	113.551
3-Hexene,2,3-dimethyl-	0.013	0.013	0.011	13.436
Heptane,3-ethyl-	0.069	0.073	0.053	71.62
3-Methyloctane	0.216	0.227	0.164	222.488
3-Heptyne,5-ethyl-5-methyl-	0.002	0.002	0.001	1.947
2,6-Dimethylheptene-1	0.151	0.157	0.117	158.773
Unidentified	0.032	0.029	0.021	32.558
o-Xylene	1.93	1.667	1.771	2138.208
C9_Iso-Olefins(3)	0.108	0.121	0.084	113.509
2,2,4-trimethylheptane	0.212	0.219	0.145	218.649
Cyclopentane,1-methyl-2-propyl-	0.047	0.046	0.036	48.837
Unidentified	0	0	0	0.289
1-Ethyl-4-methylcyclohexane	0.118	0.117	0.091	123.945
cis-1-Ethyl-3-methyl-cyclohexane	0.053	0.053	0.041	55.961
Octane,3,3-dimethyl-	0.206	0.214	0.141	213.247
t-Nonene-3	0.009	0.009	0.007	9.601
trans-1,2-Diethyl cyclopentane	0	0	0	0.238
Cyclohexane,1-ethyl-2-methyl-,cis-	0.007	0.007	0.006	7.726
Cyclohexane,1-isopropyl-1-methyl-	0.005	0.005	0.004	5.465
C10_Iso-Olefins(1)	0.004	0.005	0.003	4.66
2-Methyl-2-octene	0.01	0.011	0.008	10.824
Heptane,3,3,5-trimethyl-	0.098	0.102	0.067	101.244
n-Nonane	0.383	0.406	0.291	395.017
1,1-Methylethylcyclohexane	0.085	0.083	0.065	88.937
i-Butylcyclohexane	0.004	0.004	0.003	4.637
Cyclohexane,1-ethyl-4-methyl-,trans-	0.014	0.014	0.011	14.464
i-Propylbenzene	0.028	0.025	0.023	30.792
C9_Mono-Naphthenes(23)	0.024	0.024	0.019	25.347
Propylcyclohexane	0.008	0.008	0.006	8.711
Heptane,2,3,5-trimethyl-	0.049	0.051	0.033	50.26
C10_I-Paraffins(5)	0.011	0.012	0.008	11.847
Heptane,2,4,6-trimethyl-	0.008	0.009	0.006	8.492
1,6-Octadiene,2,5-dimethyl-,(E)-	0.001	0.002	0.001	1.526
C9_Mono-Naphthenes(25)	0.008	0.008	0.007	8.84

Unidentified	0.026	0.024	0.017	26.916
2,3,6-trimethylheptane	0.015	0.016	0.01	15.527
2,7-dimethyloctane	0.007	0.007	0.004	6.735
2,6-Dimethyloctane	0.034	0.035	0.023	35.261
n-Propylbenzene	0.662	0.581	0.537	728.812
3-Methyl-5-ethylheptane	0.003	0.003	0.002	2.788
Cyclopentane,2-isopropyl-1,3-dimethyl-	0.002	0.003	0.002	2.565
1-Methyl-3-ethylbenzene	2.517	2.207	2.04	2770.84
1-Methyl-4-ethylbenzene	1.197	1.058	0.97	1317.962
Unidentified	0.004	0.004	0.002	3.917
1,3,5-Trimethylbenzene	1.392	1.225	1.128	1532.125
5-Methylnonane	0.011	0.011	0.007	10.952
2,4,6-Trimethyloctane	0.032	0.033	0.02	33.346
1-Methyl-2-ethylbenzene	1.034	0.893	0.838	1138.323
3-Ethyloctane	0.002	0.002	0.002	2.329
3-Methylnonane	0.046	0.048	0.032	47.811
1,2,4-Trimethylbenzene	4.696	4.076	3.806	5169.299
C9_Mono-Naphthenes(30)	0.358	0.34	0.276	374.959
i-Butylbenzene	0.084	0.074	0.061	92.328
sec-Butylbenzene	0.093	0.083	0.068	102.096
n-Decane	0.054	0.056	0.037	55.305
1,2,3-Trimethylbenzene	0.891	0.757	0.722	980.334
1-Methyl-3-i-propylbenzene	0.164	0.144	0.119	179.207
1-Methyl-4-i-propylbenzene	0.043	0.038	0.031	47.331
C11_I-Paraffins(7)	0.003	0.003	0.002	2.704
C11_I-Paraffins(8)	0.001	0.001	0.001	1.33
Indan	0.298	0.227	0.246	333.727
C11_I-Paraffins(10)	0.003	0.004	0.002	3.614
C11_I-Paraffins(12)	0.006	0.006	0.003	5.766
Indene	0.018	0.014	0.015	20.221
C11_I-Paraffins(14)	0.006	0.006	0.004	6.516
Heptane,5-ethyl-2,2,3-trimethyl-	0.003	0.003	0.002	3.423
Undecane,2-methyl-	0.005	0.005	0.003	5.315
1,3-Diethylbenzene	0.18	0.159	0.13	196.731
1-Methyl-3-n-propylbenzene	0.508	0.446	0.368	555.863
1-Methyl-4-n-propylbenzene	0.285	0.25	0.207	311.784
1,4-Diethylbenzene	0.136	0.12	0.099	149.342
1,3-Dimethyl-5-ethylbenzene	0.472	0.413	0.342	516.387
1,2-Diethylbenzene	0.028	0.024	0.02	30.129
C10_Mono-Aromatics(2)	0.016	0.014	0.011	17.232
1-Methyl-2-n-propylbenzene	0.184	0.161	0.133	201.087

Decane,5-methyl-	0.004	0.004	0.003	4.305
C11_Iso-Olefins(1)	0.002	0.002	0.001	2.172
Decane,4-methyl-	0.024	0.025	0.015	25.058
1,4,Dimethyl-2-ethylbenzene	0.45	0.395	0.327	492.928
Benzene,(2-methyl-1-propenyl)-	0.543	0.458	0.401	604.051
Decane,3-methyl-	0.03	0.031	0.019	31.291
1,2-Dimethyl-4-ethylbenzene	1.204	1.055	0.874	1317.88
Indan,1-methyl-	0.027	0.022	0.02	30.234
Unidentified	0.029	0.027	0.019	29.517
1-Methyl-4-t-butylbenzene	0.093	0.082	0.061	101.015
Unidentified	0.026	0.024	0.017	26.921
Cyclopropane,1,2-dimethyl-1-pentyl-	0.013	0.012	0.009	13.691
1-Octene,6-methyl-	0.027	0.03	0.021	28.691
C9_Iso-Olefins(5)	0.03	0.033	0.023	31.723
1-Ethyl-3-i-propylbenzene	0.146	0.123	0.096	158.907
1,2-Dimethyl-3-ethylbenzene	0.585	0.513	0.425	640.646
Unidentified	0.084	0.078	0.054	85.981
n-Undecane	0.458	0.471	0.286	474.032
1-Ethyl-4-i-propylbenzene	1.559	1.378	1.025	1699.698
1,2,4,5-Tetramethylbenzene	2.268	1.942	1.647	2482.902
C11_Mono-Aromatics(2)	0.017	0.015	0.011	18.321
Unidentified	0.05	0.046	0.032	50.888
1H-Indene,2,3-dihydro-2,2-dime	0.027	0.022	0.018	30.324
C11_I-Paraffins(25)	0.041	0.042	0.026	42.769
C12_I-Paraffins(4)	0.009	0.009	0.005	9.237
C12_I-Paraffins(5)	0.008	0.008	0.005	8.584
4-Methylindan	1.198	0.929	0.882	1331.705
C11_Mono-Naphthenes(1)	0.002	0.002	0.001	2.003
Benzene,1,3-diethyl-5-methyl-	0.311	0.274	0.205	339.613
C11_Mono-Aromatics(5)	0.071	0.062	0.047	77.253
Benzene,1-(1,1-dimethylethyl)-3-methyl-	0.525	0.465	0.345	572.518
1H-Indene,1-methyl-	0.124	0.106	0.093	140.483
2-Methylindan	1.112	0.886	0.819	1236.482
1,3-Dimethyl-2-ethylbenzene	1.159	1.016	0.841	1268.846
C11_Mono-Naphthenes(2)	0.014	0.014	0.009	14.531
Benzene,1,4-dimethyl-2-(1-methylethyl)-	0.094	0.083	0.062	102.957
n-Pentylbenzene	0.22	0.194	0.145	239.939
1,4-diethyl-2-methylbenzene	0.276	0.242	0.181	300.77

Benzene,1-ethyl-3-(1-methylethyl)-	0.2	0.177	0.131	217.735
C10_I-Paraffins(21)	0.041	0.042	0.028	42.641
Benzene,(1,1-dimethylpropyl)-	0.237	0.21	0.156	258.359
2,4-diethyl-1-methylbenzene	0.283	0.249	0.186	308.322
Decane,4-ethyl-	0.041	0.031	0.023	42.414
C11_Mono-Aromatics(8)	0.006	0.006	0.004	7.084
Undecane,2,7-dimethyl-	0.032	0.033	0.017	33.428
1-methyl-4-(1-methylpropyl)be	0.357	0.316	0.235	389.28
Naphthalene	0.216	0.158	0.164	247.62
1-t-Butyl-3,5-dimethylbenzene	0.027	0.024	0.016	29.705
1H-Indene,2,3-dihydro-1,3-dimethyl-	0.006	0.005	0.004	6.931
Unidentified	0.006	0.005	0.004	5.991
4,7-Dimethyl Indane	0.073	0.057	0.048	80.48
1,1-Dimethyl Indane	0.013	0.01	0.008	13.99
1t-Butyl-4-ethylbenzene	0.065	0.058	0.039	71.135
1,3-Di-n-propylbenzene	0.157	0.14	0.095	171.135
Benzene,1,3-dimethyl-5-(1-methylethyl)-	0.071	0.063	0.047	77.435
C11_Mono-Aromatics(9)	0.001	0.001	0.001	1.344
n-Dodecane	0.192	0.195	0.11	198.888
Benzene,(3,3-dimethylbutyl)	0.007	0.006	0.004	7.456
Benzene,2,4-dimethyl-1-(1-methylethyl)-	0.003	0.003	0.002	3.78
n-propyl indane	0.009	0.008	0.006	10.183
C11_Mono-Aromatics(12)	0.002	0.002	0.002	2.694
C11_Mono-Aromatics(14)	0.026	0.023	0.017	28.498
1,3,5-trimethyl-2-propylbenze	0.004	0.003	0.002	4.063
2-Ethyl-2,3-dihydro-1H-indene	0.008	0.007	0.006	9.257
1H-Indene,1-ethyl-2,3-dihydro-	0.004	0.003	0.002	3.991
C12_Mono-Aromatics(5)	0.004	0.003	0.002	4.079
C12_Mono-Aromatics(6)	0.003	0.003	0.002	3.537
C11_Indanes(1)	0.026	0.021	0.018	29.475
1-H-Indene,1-3-dimethyl	0.014	0.011	0.009	15.346
1H-Indene,2,3-dihydro-5,6-dimethyl-	0.002	0.001	0.001	2.023
C12_Mono-Aromatics(10)	0.002	0.002	0.001	2.398
Pentamethylbenzene	0.072	0.063	0.047	78.672
2-Methylnaphthalene	0.394	0.293	0.27	447.599
1-Methylnaphthalene	0.212	0.16	0.146	241.392
Naphthalene, 6-ethyl-1,2,3,4-tetrahydro-	0.004	0.003	0.002	4.542

Naphthalene, 1-ethyl-1,2,3,4-tetrahydro-	0.003	0.002	0.002	3.165
Naphthalene, 1,2,3,4-tetrahydro-6-propyl-	0.003	0.003	0.002	3.735
C12_Mono-Aromatics(17)	0.003	0.002	0.002	2.78
C13_I-Paraffins(4)	0.002	0.002	0.001	1.771
Benzene, 1,2,4-trimethyl-5-(1-methylethyl)-	0.002	0.002	0.001	2.698
1,1'-Biphenyl	0.009	0.006	0.005	9.749
Decane, 2,3,5-trimethyl-	0.02	0.02	0.011	21.033
2-Ethylnaphthalene	0.016	0.012	0.01	18.247
n-Tetradecane	0.033	0.032	0.016	33.742
Naphthalene,2,6 dimethyl	0	0	0	0.034
Naphthalene,2,7 dimethyl	0.029	0.022	0.018	32.407
1H-Indene, 2,3-dihydro-1,1,6-trimethyl-	0.002	0.001	0.001	1.732
Naphthalene,1,7-dimethyl	0.037	0.028	0.023	41.587
Naphthalene, 1,3-dimethyl-	0.037	0.028	0.023	41.587
Naphthalene, 1,6-dimethyl-	0.036	0.027	0.022	40.15
Naphthalene-1,4-dimethyl	0.013	0.01	0.008	14.29
Naphthalene, 2,3-dimethyl-	0.013	0.01	0.008	14.29
Naphthalene, 1,5-dimethyl-	0.003	0.002	0.002	3.127
Naphthalene, 1,2-dimethyl-	0.019	0.014	0.012	21.415
1,1'-Biphenyl, 3-methyl-	0.02	0.015	0.012	22.643
Octane, 3,4,5,6-tetramethyl-	0.002	0.002	0.001	2.562
1,1'-Biphenyl, 4-methyl-	0.015	0.012	0.009	17.008
Naphthalene, 1-propyl-	0.004	0.003	0.002	4.057
Unidentified	0.003	0.002	0.002	2.59
n-Pentadecane	0.002	0.002	0.001	2.376
Naphthalene, 2,3,6-trimethyl-	0.008	0.006	0.004	8.473
Unidentified	0.005	0.005	0.003	5.303
Unidentified	0.004	0.004	0.003	4.397
C13_Naphthalenes(1)	0.004	0.003	0.002	3.945
Unidentified	0.005	0.004	0.003	4.695
Unidentified	0.002	0.002	0.001	1.796
Naphthalene, 1,4,6-trimethyl-	0.012	0.01	0.007	13.731
2,2'-Dimethylbiphenyl	0.008	0.006	0.004	9.065
Naphthalene, 1,4,5-trimethyl-	0.011	0.008	0.006	12.069
C13_Naphthalenes(4)	0.006	0.004	0.003	6.461
C13_Naphthalenes(5)	0.005	0.004	0.003	5.985
Naphthalene, 2-(1-methylethyl)-	0.004	0.003	0.002	4.683
Naphthalene, 1,6,7-trimethyl-	0.005	0.004	0.003	6.078

4-Ethylbiphenyl	0.006	0.005	0.003	6.717
Unidentified	0.003	0.003	0.002	3.537
Unidentified	0.004	0.004	0.003	4.392
3,3'-Dimethylbiphenyl	0.013	0.01	0.007	14.511
Unidentified	0.002	0.002	0.001	1.752
Unidentified	0.002	0.002	0.002	2.501
Unidentified	0.012	0.011	0.008	12.579
4,4'-Dimethylbiphenyl	0.001	0.001	0.001	1.467
Naphthalene, 2,6-diethyl	0.003	0.002	0.002	3.331
Benzene, 1-methyl-3-[(4-methylphenyl)methyl]-	0.003	0.003	0.002	3.918
C14_Mono-Aromatics(1)	0.008	0.006	0.004	8.59
1,4,6,7-tetramethylnaphthalene	0.002	0.002	0.001	2.683
AVERAGE_MW	**AVERAGE_SG**	**BP(K)**	**DBE**	**PMI**
2.021	0.016	261.45	0	0.000312
0.034	0	272.65	0	0.000007
10.054	0.078	303.15	0	0.00409
0.159	0.001	302.25	0	0
0.065	0.001	308.35	0	0.00003
3.847	0.03	321.55	0	0.002364
0.014	0	331.5	1	0.000021
9.42	0.074	322.45	1	0.011811
0.163	0.001	331.85	0	0.000126
0.53	0.004	332.75	0	0.000418
0.012	0	329.15	0	0
0.471	0.004	335.85	0	0.000398
8.632	0.067	335.15	1	0.014363
0.948	0.007	341.85	0	0.000916
0.003	0	338.75	1	0.000005
0.015	0	341.05	1	0.000028
0.002	0	340.45	1	0.000004
0.007	0	340.85	1	0.000014
0.002	0	340.84	1	0.000003
0.002	0	337.75	1	0.000003
0.073	0.001	351.05	0	0.000087
0.372	0.003	344.95	1	0.000769
0.094	0.001	353.65	0	0.000118
0.009	0	354.85	0	0.000012
0.002	0	351.55	2	0.000007
0.052	0	356.55	1	0.00014

0.091	0.001	353.85	1	0.000231
0.245	0.002	363.25	0	0.000382
0.088	0.001	362.95	0	0.000137
0.013	0	360.65	1	0.000037
0.209	0.002	363.85	0	0.00033
0.012	0	364.85	1	0.000039
0.01	0	363.95	1	0.000032
0.012	0	365.45	0	0.00002
0.013	0	365.05	1	0.000041
0.043	0	371.15	0	0.00008
0.023	0	371.55	0	0.000044
0.042	0	374.05	1	0.000169
0.004	0	378.05	1	0.000016
0.225	0.002	376.65	1	0.000948
0.144	0.001	383.05	0	0.000351
0.225	0.002	382.55	0	0.000545
0.011	0	389.45	1	0.00006
0.013	0	389.45	1	0.000072
1.921	0.015	386.65	0	0.005096
0.004	0	379.95	2	0.000029
2.776	0.022	387.95	0	0.00759
5.513	0.043	383.75	4	0.068432
0.068	0.001	388.85	2	0.000573
0.559	0.004	388.15	0	0.001536
0.032	0	388.15	0	0.000089
0.096	0.001	390.85	0	0.000281
0.028	0	390.15	0	0.000081
0.063	0	411.05	0	0.000295
0.066	0.001	389.75	0	0.000188
0.063	0	388.38	1	0.000347
0.212	0.002	390.65	0	0.000617
0.064	0	393.25	1	0.000396
0.007	0	391.15	1	0.000041
1.834	0.014	397.25	0	0.006219
0.006	0	393.05	1	0.000035
0.006	0	393.05	1	0.000038
0.022	0	399.047	1	0.000153
0.009	0	406.15	0	0
0.099	0.001	403.95	2	0.001176
0.232	0.002	398.15	0	0.000803
0.105	0.001	394.25	1	0.000661

0.049	0	393.55	2	0.000459
0.008	0	386.04	1	0.000039
0.005	0	379.55	3	0.000047
0.324	0.003	399.15	2	0.003441
0.003	0	397.25	1	0.000018
0.005	0	419.75	1	0.000055
0.056	0	405.85	0	0.00023
0.054	0	391.05	2	0.000473
0.242	0.002	402.55	1	0.001858
0.124	0.001	408.35	0	0.000543
0.004	0	408.25	0	0.000017
0.122	0.001	391.05	2	0.001076
0.175	0.001	408.95	0	0.000782
0.01	0	410.25	0	0.000048
0.008	0	408.15	1	0.000068
0.017	0	408.15	1	0.000147
0.001	0	415.75	0	0
0.007	0	417.55	1	0.000073
0.005	0	417.55	0	0
1.721	0.013	409.35	4	0.038724
0.174	0.001	416.15	1	0.001841
0.003	0	408.15	1	0.000027
0.016	0	412.649	1	0.000154
5.079	0.04	411.15	4	0.119272
2.076	0.016	412.76	4	0.050657
0.011	0	409.15	0	0.000051
0.017	0	385.55	1	0.000087
0.009	0	425.05	0	0
0.009	0	408.15	1	0.000077
0.014	0	414.35	0	0.00007
0.009	0	439.65	2	0.00024
0.084	0.001	414.75	0	0.000431
0.107	0.001	416.45	0	0.000572
0.012	0	387.45	1	0.000068
0.068	0.001	416.15	0	0.000358
0.21	0.002	416.65	0	0.001125
0.002	0	428.45	2	0.000038
0.148	0.001	410.45	1	0.001364
0.031	0	412.649	0	0
1.88	0.015	416.15	4	0.049727
0.106	0.001	418.15	1	0.001171

0.206	0.002	422.35	0	0.001265
0.045	0	422.05	1	0.000553
0	0	422.05	0	0
0.115	0.001	423.95	1	0.001469
0.052	0	423.95	1	0.000664
0.201	0.002	434.15	0	0.001644
0.009	0	418.85	1	0.000101
0	0	415.93	1	0.000002
0.007	0	429.15	1	0.000104
0.005	0	436.65	1	0.000088
0.004	0	420.15	1	0.00005
0.01	0	420.15	1	0.000117
0.095	0.001	428.95	0	0.000687
0.373	0.003	424.85	0	0.002433
0.083	0.001	425.35	1	0.001091
0.004	0	444.45	1	0.000091
0.013	0	423.95	1	0.000172
0.027	0	425.55	4	0.000903
0.024	0	423.95	1	0.000301
0.008	0	428.15	1	0.000114
0.047	0	431.05	0	0.000359
0.011	0	419.8167	0	0.000065
0.008	0	422.15	0	0.000049
0.001	0	428.48	2	0.00003
0.008	0	418.35	1	0.000092
0.026	0	425.35	0	0
0.015	0	430.05	0	0.000108
0.006	0	431.65	0	0.000049
0.033	0	432.85	0	0.000263
0.645	0.005	433.65	4	0.026044
0.003	0	432.55	0	0.000021
0.002	0	433.7	1	0.000039
2.452	0.019	434.45	4	0.10098
1.166	0.009	435.15	4	0.048865
0.004	0	410.75	0	0
1.356	0.011	439.85	4	0.063793
0.01	0	438.25	0	0.000093
0.031	0	445.35	0	0.000339
1.007	0.008	437.15	4	0.044335
0.002	0	439.65	0	0.000021
0.045	0	440.95	0	0.000436

4.575	0.036	441.15	4	0.222289
0.349	0.003	418.35	1	0.003887
0.082	0.001	448.55	4	0.004803
0.091	0.001	446.45	4	0.005038
0.052	0	448.05	0	0.000602
0.868	0.007	448.15	4	0.050218
0.159	0.001	448.25	4	0.009252
0.042	0	449.15	4	0.0025
0.003	0	457.15	0	0.000037
0.001	0	457.15	0	0.000018
0.291	0.002	449.65	5	0.020962
0.003	0	452.55	0	0.000044
0.005	0	457.15	0	0.000079
0.017	0	454.75	6	0.001656
0.006	0	457.15	0	0.000089
0.003	0	469.85	0	0.000065
0.005	0	482.05	0	0.00014
0.175	0.001	454.85	4	0.012005
0.495	0.004	456.85	4	0.035698
0.277	0.002	457.35	4	0.020281
0.133	0.001	446.45	4	0.00737
0.459	0.004	457.75	4	0.033936
0.027	0	456.65	4	0.001925
0.015	0	456.65	4	0.001101
0.179	0.001	459.65	4	0.013876
0.004	0	459.25	0	0.000062
0.002	0	464.75	1	0.000072
0.024	0	460.55	0	0.000375
0.439	0.003	460.05	4	0.034366
0.529	0.004	461.05	5	0.051056
0.029	0	462.25	0	0.000489
1.173	0.009	462.65	4	0.098258
0.026	0	466.55	5	0.00293
0.028	0	466.55	0	0
0.09	0.001	465.95	4	0.00824
0.026	0	430.51	0	0
0.013	0	430.51	1	0.00019
0.027	0	410.75	1	0.000248
0.029	0	410.75	1	0.000274
0.142	0.001	476.35	4	0.01705
0.57	0.004	465.15	4	0.050966

0.082	0.001	482.35	0	0
0.446	0.003	469.05	0	0.008841
1.519	0.012	470.15	4	0.154767
2.209	0.017	469.15	4	0.219287
0.016	0	463.45	4	0.001401
0.048	0	472.05	0	0
0.027	0	474.25	5	0.00364
0.04	0	457.15	0	0.000586
0.009	0	457.15	0	0.000127
0.008	0	457.15	0	0.000118
1.167	0.009	479.25	5	0.181654
0.002	0	457.15	0	0.000027
0.303	0.002	475.95	4	0.036052
0.069	0.001	475.95	4	0.008201
0.512	0.004	461.95	4	0.042098
0.121	0.001	465.76	6	0.015413
1.083	0.008	467.65	5	0.124055
1.129	0.009	463.25	4	0.096084
0.014	0	457.15	0	0.000199
0.092	0.001	469.35	4	0.009141
0.214	0.002	478.55	4	0.027302
0.269	0.002	479.85	4	0.035438
0.195	0.002	465.65	4	0.017624
0.04	0	489.45	0	0.001376
0.231	0.002	463.15	4	0.019597
0.275	0.002	479.05	4	0.035557
0.04	0	473.52	0	0.00089
0.006	0	483.15	4	0.000912
0.031	0	495.96	0	0.001287
0.348	0.003	469.05	4	0.034437
0.21	0.002	494.65	7	0.066528
0.027	0	481.05	4	0.003626
0.006	0	481.85	5	0.00102
0.006	0	470.15	0	0
0.071	0.001	499.75	5	0.019386
0.012	0	464.15	5	0.001288
0.064	0	484.65	4	0.009572
0.153	0.001	476.15	4	0.018322
0.069	0.001	467.05	4	0.006501
0.001	0	467.05	4	0.000113
0.187	0.001	488.15	0	0.006181

0.007	0	497.41	4	0.001422
0.003	0	472.55	4	0.000367
0.009	0	507.15	5	0.003041
0.002	0	465.95	4	0.00022
0.025	0	465.95	4	0.002325
0.004	0	505.25	4	0.00097
0.008	0	488.35	5	0.001625
0.004	0	495.15	5	0.000845
0.004	0	477.15	4	0.000448
0.003	0	477.15	4	0.000389
0.026	0	451.05	5	0.001918
0.013	0	502.05	6	0.004549
0.002	0	500.75	5	0.000501
0.002	0	493.45	5	0.000487
0.07	0.001	502.15	4	0.017142
0.383	0.003	513.15	7	0.205162
0.207	0.002	513.05	7	0.110323
0.004	0	519.75	5	0.00194
0.003	0	512.85	5	0.001103
0.003	0	537.95	5	0.002813
0.002	0	477.15	4	0.000306
0.002	0	495.52	0	0.000067
0.002	0	492.15	4	0.000446
0.008	0	528.15	8	0.007862
0.02	0	495.52	0	0.0008
0.016	0	530.9278	7	0.014321
0.032	0	525.15	0	0.003024
0	0	535.15	7	0.00003
0.028	0	536.15	7	0.029877
0.002	0	273.15	5	0.000002
0.036	0	535.65	7	0.03775
0.036	0	536.15	7	0.038341
0.035	0	537.15	7	0.038185
0.012	0	541.6	7	0.015626
0.012	0	542.05	7	0.015849
0.003	0	538.75	7	0.003127
0.018	0	541.15	7	0.023087
0.019	0	545.85	8	0.031691
0.002	0	472.2	0	0.000052
0.015	0	540.95	8	0.020376
0.004	0	548.45	7	0.005608

0.002	0	543.75	0	0
0.002	0	543.75	0	0.000378
0.007	0	536.65	7	0.008061
0.005	0	536.65	0	0
0.004	0	540	0	0
0.003	0	540	7	0.004167
0.004	0	557.85	0	0
0.002	0	554.25	0	0
0.012	0	554.25	7	0.022916
0.008	0	531	8	0.007974
0.01	0	563.45	7	0.027088
0.006	0	559.95	7	0.013022
0.005	0	540	7	0.00626
0.004	0	540	7	0.004947
0.005	0	559.95	7	0.012249
0.006	0	564.2	8	0.017189
0.003	0	564.2	0	0
0.004	0	562.4667	0	0
0.012	0	562.4667	8	0.035023
0.002	0	557.3333	0	0
0.002	0	554	0	0
0.012	0	554	0	0
0.001	0	568	8	0.004272
0.003	0	567.75	7	0.008739
0.003	0	563.15	8	0.009785
0.007	0	554	8	0.015651
0.002	0	576.05	7	0.009342

2.) C0 TR2338A

TIME	CASNO	RI	GROUP	CARBON#
6.527		186.68	Unidentified	0
6.71		191.92	Unidentified	0
8.248	75-28-5	371.24	I-Paraffins	4
8.373		376.02	Unidentified	0
8.927		393.23	Unidentified	0
9.197	106-97-8	400	Paraffin	4
9.67	463-82-1	415.66	I-Paraffins	5
12.77	78-78-4	478.6	I-Paraffins	5
12.847	591-93-5	479.69	Di-Olefins	5
14.473	109-66-0	500	Paraffin	5
14.767	78-79-5	505.38	Di-Olefins	5
17.02	75-83-2	541.06	I-Paraffins	6
18.273	142-29-0	557.6	Naphtheno-Olefins	5
18.735	691-37-2	563.24	Iso-Olefins	6
19.165	287-92-3	568.3	Mono-Naphthenes	5
19.665	107-83-5	573.96	I-Paraffins	6
20.257	763-30-4	580.39	Di-Olefins	6
21.395	592-41-6	591.98	n-Olefins	6
22.238	110-54-3	600	Paraffin	6
22.508	13269-52-8	603.28	n-Olefins	6
22.728	4050-45-7	605.92	n-Olefins	6
23.173	922-62-3	611.13	Iso-Olefins	6
23.533	7688-21-3	615.25	n-Olefins	6
24.587	96-37-7	626.8	Mono-Naphthenes	6
24.975	108-08-7	630.89	I-Paraffins	7
25.31	594-56-9	634.34	Iso-Olefins	7
27.885	110-82-7	658.98	Mono-Naphthenes	6
28.883	591-76-4	667.73	I-Paraffins	7
29.057	565-59-3	669.21	I-Paraffins	7
29.887	589-34-4	676.13	I-Paraffins	7
30.663	1759-58-6	682.38	Mono-Naphthenes	7
31.01	2532-58-3	685.11	Mono-Naphthenes	7
31.543	540-84-1	689.23	I-Paraffins	8
32.995	142-82-5	700	Paraffin	7
35.948	108-87-2	718.81	Mono-Naphthenes	7
36.233	590-73-8	720.52	I-Paraffins	8
36.37	4516-69-2	721.34	Mono-Naphthenes	8
37.903	1640-89-7	730.24	Mono-Naphthenes	7
38.115	564-02-3	731.43	I-Paraffins	8
38.232	589-43-5	732.08	I-Paraffins	8
39.262	16883-48-0	737.76	Mono-Naphthenes	8
39.45	563-16-6	738.78	I-Paraffins	8
40.61	15890-40-1	744.92	Mono-Naphthenes	8

41.158	565-75-3	747.75	I-Paraffins	8
42.012	560-21-4	752.07	I-Paraffins	8
42.277	108-88-3	753.39	Mono-Aromatics	7
43.285	609-26-7	758.32	I-Paraffins	8
43.527	3404-78-2	759.48	Iso-Olefins	8
44.538	592-27-8	764.26	I-Paraffins	8
44.87	589-53-7	765.8	I-Paraffins	8
45.128	16747-28-7	766.99	I-Paraffins	9
45.255	583-48-2	767.57	I-Paraffins	8
45.85		770.27	Unidentified	0
46.225	2815-58-9	771.95	Mono-Naphthenes	8
46.653	619-99-8	773.86	I-Paraffins	8
47.085	638-04-0	775.75	Mono-Naphthenes	8
48.415	590-66-9	781.46	Mono-Naphthenes	8
48.867	3522-94-9	783.36	I-Paraffins	9
49.282	2613-66-3	785.09	Mono-Naphthenes	8
49.818	3726-47-4	787.3	Mono-Naphthenes	8
50.14	624-29-3	788.61	Mono-Naphthenes	8
50.487		790.01	I-Paraffins	9
51.425		793.75	Naphtheno-Olefins	8
53.04	111-65-9	800	Paraffin	8
53.418	589-90-2	801.51	Mono-Naphthenes	8
54.942	473-91-6	807.45	Naphtheno-Olefins	8
55.372	3404-79-3	809.09	Iso-Olefins	8
57.182		815.85	Unidentified	0
57.863	1462-07-3	818.33	Naphtheno-Olefins	8
58.558	3726-46-3	820.83	Mono-Naphthenes	8
58.995		822.38	Iso-Olefins	8
60.413		827.34	I-Paraffins	9
60.413		827.34	Naphtheno-Olefins	8
61.318		830.43	Mono-Naphthenes	9
62.247	1678-91-7	833.55	Mono-Naphthenes	8
62.668	1072-05-5	834.95	I-Paraffins	9
63.328	1068-19-5	837.12	Naphtheno-Olefins	9
64.08		839.56	Naphtheno-Olefins	8
65.068	2216-30-0	842.72	I-Paraffins	9
65.485	4032-86-4	844.03	I-Paraffins	9
65.975	7094-27-1	845.57	Mono-Naphthenes	9
66.445		847.03	Mono-Naphthenes	9
67.053		848.9	Mono-Naphthenes	9
68.633		853.69	Unidentified	0
69.623	100-41-4	856.62	Mono-Aromatics	8
69.862	7667-60-9	857.32	Mono-Naphthenes	9
71.388	1795-27-3	861.74	Mono-Naphthenes	9
73.088	108-38-3	866.53	Mono-Aromatics	8
73.395	106-42-3	867.39	Mono-Aromatics	8

73.708	926-82-9	868.25	I-Paraffins	9
74.01	13151-04-7	869.08	Iso-Olefins	8
74.537		870.53	Mono-Naphthenes	9
74.853	2216-32-2	871.39	I-Paraffins	9
75.902	2216-34-4	874.21	I-Paraffins	9
76.243	3221-61-2	875.12	I-Paraffins	9
76.917	7145-23-5	876.9	Iso-Olefins	8
77.715	15869-80-4	878.99	I-Paraffins	9
78.267	922-28-1	880.43	I-Paraffins	9
78.697	61228-10-2	881.53	Iso-Olefins	10
79.045	16747-38-9	882.43	I-Paraffins	9
79.535	1795-26-2	883.67	Mono-Naphthenes	9
80.067	95-47-6	885.02	Mono-Aromatics	8
80.387	15869-92-8	885.82	I-Paraffins	10
80.657	14720-74-2	886.5	I-Paraffins	10
81.425	3728-57-2	888.41	Mono-Naphthenes	9
81.667	3728-56-1	889.01	Mono-Naphthenes	9
82.268	19489-10-2	890.49	Mono-Naphthenes	9
82.525	4110-44-5	891.11	I-Paraffins	10
83.103	20063-92-7	892.52	n-Olefins	9
83.508	4923-77-7	893.5	Mono-Naphthenes	9
84.853		896.71	Iso-Olefins	10
85.537	16993-86-5	898.32	Iso-Olefins	9
85.78	7154-80-5	898.89	I-Paraffins	10
86.258	111-84-2	900	Paraffin	9
86.682	4926-90-3	902.3	Mono-Naphthenes	9
87.23	1678-98-4	905.26	Mono-Naphthenes	10
87.435	6236-88-0	906.37	Mono-Naphthenes	9
88.863	98-82-8	913.97	Mono-Aromatics	9
89.232		915.91	Mono-Naphthenes	9
89.775	1678-92-8	918.75	Mono-Naphthenes	9
90.302	20278-85-7	921.49	I-Paraffins	10
90.685		923.48	I-Paraffins	10
90.852	2613-61-8	924.34	I-Paraffins	10
91.037	2539-75-5	925.29	Naphtheno-Olefins	9
91.337	68702-25-0	926.83	Iso-Olefins	10
91.783		929.11	Mono-Naphthenes	9
92.327		931.87	Mono-Naphthenes	9
92.473		932.61	I-Paraffins	10
93.34	4032-93-3	936.97	I-Paraffins	10
93.622	1072-16-8	938.38	I-Paraffins	10
94.095		940.73	Mono-Naphthenes	10
94.433	2051-30-1	942.41	I-Paraffins	10
94.782	16747-31-2	944.13	I-Paraffins	9
95.233		946.34	Unidentified	0
95.568	103-65-1	947.98	Mono-Aromatics	9

95.91	13475-78-0	949.64	I-Paraffins	10
96.448	32281-85-9	952.25	Mono-Naphthenes	10
97.292	620-14-4	956.31	Mono-Aromatics	9
97.643	622-96-8	957.99	Mono-Aromatics	9
98.435		961.74	Unidentified	0
98.818	108-67-8	963.55	Mono-Aromatics	9
99.273	13990-93-7	965.69	Mono-Naphthenes	10
99.797	15869-85-9	968.13	I-Paraffins	10
100.217	62016-37-9	970.08	I-Paraffins	11
100.64	611-14-3	972.04	Mono-Aromatics	9
101.008	29053-04-1	973.73	Mono-Naphthenes	10
101.203	5881-17-4	974.63	I-Paraffins	10
101.467	19482-57-6	975.84	Iso-Olefins	10
101.813	4/6/5911	977.42	I-Paraffins	10
102.512	61868-42-6	980.59	I-Paraffins	11
102.698		981.43	Mono-Naphthenes	10
103.03		982.93	I-Paraffins	10
103.233	300-57-2	983.84	Mono-Aromatics	9
103.582	95-63-6	985.4	Mono-Aromatics	9
103.983		987.2	I-Paraffins	10
104.127		987.83	I-Paraffins	11
104.318		988.69	I-Paraffins	10
104.358	53771-88-3	988.86	Mono-Naphthenes	9
105.643	62016-30-2	994.53	I-Paraffins	11
105.888	62016-26-6	995.6	I-Paraffins	11
106.208	538-93-2	997	Mono-Aromatics	10
106.685	135-98-8	999.07	Mono-Aromatics	10
106.9	124-18-5	1000	Paraffin	10
107.18		1002	I-Paraffins	11
107.473	62016-19-7	1004.08	I-Paraffins	11
108.237	526-73-8	1009.48	Mono-Aromatics	9
108.545	535-77-3	1011.65	Mono-Aromatics	10
109.047	99-87-6	1015.17	Mono-Aromatics	10
109.338		1017.2	I-Paraffins	11
109.537		1018.59	Unidentified	0
109.732		1019.94	I-Paraffins	11
110.073	496-11-7	1022.31	Indanes	9
110.377		1024.41	I-Paraffins	11
110.858		1027.72	I-Paraffins	11
111.138	527-84-4	1029.64	Mono-Aromatics	10
111.363	62016-14-2	1031.18	I-Paraffins	11
111.643		1033.1	I-Paraffins	11
112.388	62199-06-8	1038.16	I-Paraffins	12
112.668	7045-71-8	1040.05	I-Paraffins	12
112.933	141-93-5	1041.84	Mono-Aromatics	10
113.31	1074-43-7	1044.37	Mono-Aromatics	10

113.875	1074-55-1	1048.15	Mono-Aromatics	10
114.033	105-05-5	1049.21	Mono-Aromatics	10
114.365	934-74-7	1051.42	Mono-Aromatics	10
114.695	135-01-3	1053.61	Mono-Aromatics	10
114.912		1055.04	Mono-Aromatics	10
115.345		1057.9	I-Paraffins	11
115.615	1074-17-5	1059.68	Mono-Aromatics	10
115.783		1060.78	I-Paraffins	10
115.95	13151-35-4	1061.87	I-Paraffins	11
116.245		1063.8	Mono-Aromatics	9
116.497	2847-72-5	1065.44	I-Paraffins	11
117.158	1758-88-9	1069.74	Mono-Aromatics	10
117.415	768-49-0	1071.4	Mono-Aromatics	10
117.928	13151-34-3	1074.71	I-Paraffins	11
118.317	934-80-5	1077.21	Mono-Aromatics	10
118.548	767-58-8	1078.69	Indanes	10
118.773		1080.13	Unidentified	0
119.147	98-51-1	1082.51	Mono-Aromatics	11
119.462		1084.51	I-Paraffins	11
119.67		1085.83	Unidentified	0
119.845	62238-04-4	1086.94	Mono-Naphthenes	10
120.022	74630-42-5	1088.05	Iso-Olefins	12
120.222	13151-10-5	1089.31	Iso-Olefins	9
120.483		1090.96	Iso-Olefins	9
120.837	20024-91-3	1093.18	Mono-Aromatics	11
121.132	933-98-2	1095.03	Mono-Aromatics	10
121.303		1096.1	Unidentified	0
121.432	16021-20-8	1096.9	Mono-Aromatics	11
121.687		1098.49	Unidentified	0
121.93	1120-21-4	1100	Paraffin	11
122.253	6004-38-2	1102.77	Indanes	10
122.808	4218-48-8	1107.51	Mono-Aromatics	11
123.325	95-93-2	1111.91	Mono-Aromatics	10
123.468	2547-27-5	1113.12	Di/Bicyclo-Naphthenes	11
123.608		1114.31	Mono-Aromatics	11
123.743	1074-92-6	1115.45	Mono-Aromatics	11
123.908		1116.84	Unidentified	0
124.12	20836-11-7	1118.63	Indanes	11
124.257		1119.78	Mono-Aromatics	11
124.418		1121.14	I-Paraffins	11
125.143		1127.21	I-Paraffins	12
125.53	824-22-6	1130.44	Indanes	10
125.888		1133.41	Mono-Naphthenes	11
126.173	2050-24-0	1135.78	Mono-Aromatics	11
126.357		1137.29	Mono-Aromatics	11

126.522	1075-38-3	1138.66	Mono-Aromatics	11
126.705	767-59-9	1140.17	Indenes	10
126.9	824-63-5	1141.78	Indanes	10
127.408	4/4/2870	1145.95	Mono-Aromatics	10
127.745		1148.71	Mono-Naphthenes	11
127.957	4132-72-3	1150.44	Mono-Aromatics	11
128.145	538-68-1	1151.97	Mono-Aromatics	11
128.543	13632-94-5	1155.21	Mono-Aromatics	11
128.673	4920-99-4	1156.27	Mono-Aromatics	11
128.912		1158.2	I-Paraffins	10
129.097	2049-95-8	1159.69	Mono-Aromatics	11
129.345	1758-85-6	1161.7	Mono-Aromatics	11
129.54	1636-44-8	1163.27	I-Paraffins	12
129.862		1165.86	Mono-Aromatics	11
130.048	17301-24-5	1167.36	I-Paraffins	13
130.193	1595-16-0	1168.52	Mono-Aromatics	11
130.66	91-20-3	1172.25	Naphthalenes	10
130.842	98-19-1	1173.7	Mono-Aromatics	12
131.017		1175.09	I-Paraffins	12
131.163	4175-53-5	1176.26	Indanes	11
131.385		1178.02	Unidentified	0
131.715	6682-71-9	1180.63	Indanes	11
131.922	4912-92-9	1182.27	Indanes	11
132.365	7364-19-4	1185.76	Mono-Aromatics	12
132.64		1187.93	Indanes	12
133	99-62-7	1190.75	Mono-Aromatics	12
133.217	4706-90-5	1192.44	Mono-Aromatics	11
133.647		1195.8	Mono-Aromatics	11
134.187	112-40-3	1200	Paraffin	12
134.602	17314-92-0	1204	Mono-Aromatics	12
134.887		1206.74	Mono-Aromatics	12
135.175	4706-89-2	1209.51	Mono-Aromatics	11
135.367	60584-82-9	1211.35	Indanes	12
135.948		1216.9	Mono-Aromatics	11
136.237	4/2/4810	1219.64	Mono-Aromatics	12
136.352		1220.74	Unidentified	0
136.508		1222.22	Unidentified	0
136.922	56147-63-8	1226.14	Indanes	11
137.177	4830-99-3	1228.55	Indanes	11
137.45		1231.12	Mono-Aromatics	12
138.723	1985-97-3	1243.06	Mono-Aromatics	12
138.92		1244.89	Indanes	11
140.015	6044-71-9	1255.05	I-Paraffins	13
140.05	2/3/6031	1255.37	Mono-Aromatics	12
140.443	2177-48-2	1259	Indanes	11
140.843	1075-22-5	1262.67	Indanes	11

141.282		1266.69	Unidentified	0
141.775		1271.2	Mono-Aromatics	12
142.43	700-12-9	1277.15	Mono-Aromatics	11
143.058		1282.84	Indanes	12
143.497	90-12-0	1286.79	Naphthalenes	11
143.857		1290.03	Mono-Aromatics	12
145.218	91-57-6	1302.61	Naphthalenes	11
146.547	22531-20-0	1316.62	Mono-Aromatics	12
147.465	13556-58-6	1326.23	Mono-Aromatics	12
148.428	42775-77-9	1336.24	Mono-Aromatics	13
149.195		1344.15	Mono-Aromatics	12
149.613		1348.46	I-Paraffins	13
150.333	10222-95-4	1355.83	Mono-Aromatics	12
151.745	92-52-4	1370.19	Mono-Aromatics	12
153.628	62238-11-3	1389.12	I-Paraffins	13
153.863	939-27-5	1391.47	Naphthalenes	12
154.722	629-59-4	1400	Paraffin	14
154.722	581-42-0	1400	Naphthalenes	12
154.885	582-16-1	1401.86	Naphthalenes	12
155.94	14276-95-0	1413.8	Indanes	12
156.16	575-37-1	1416.28	Naphthalenes	12
156.16	575-41-7	1416.28	Naphthalenes	12
156.508	575-43-9	1420.2	Naphthalenes	12
157.042		1426.18	Unidentified	0
158.065	571-58-4	1437.6	Naphthalenes	12
158.065	581-40-8	1437.6	Naphthalenes	12
158.308	571-61-9	1440.3	Naphthalenes	12
159.477	573-98-8	1453.22	Naphthalenes	12
161.748	643-93-6	1478.07	Mono-Aromatics	13
162.103	62185-21-1	1481.92	I-Paraffins	12
162.605	644-08-6	1487.34	Mono-Aromatics	13
163.217	2765-18-6	1493.93	Naphthalenes	13
163.528		1497.28	Unidentified	0
163.782	629-62-9	1500	Paraffin	15
164.057	829-26-5	1502.49	Naphthalenes	13
164.203		1503.81	Unidentified	0
164.49		1506.39	Unidentified	0
164.938		1510.43	Unidentified	0
165.188		1512.67	Naphthalenes	13
165.6		1516.36	Unidentified	0
165.795		1518.1	Unidentified	0
165.993	2131-42-2	1519.87	Naphthalenes	13
166.493	2131-41-1	1524.32	Naphthalenes	13
167.862		1536.44	Naphthalenes	13
168.223		1539.63	Naphthalenes	13
169.22	2027-17-0	1548.37	Naphthalenes	13

169.402	2245-38-7	1549.96	Naphthalenes	13
169.558	5707-44-8	1551.33	Mono-Aromatics	14
169.687		1552.45	Unidentified	0
170.645		1560.78	Unidentified	0
170.962	612-75-9	1563.52	Mono-Aromatics	14
171.512		1568.27	Unidentified	0
172.003		1572.5	Unidentified	0
172.743	613-33-2	1578.85	Mono-Aromatics	14
172.943	59919-41-4	1580.56	Naphthalenes	14
173.432	21895-16-9	1584.73	Mono-Aromatics	15
174.483		1593.67	Mono-Aromatics	14
178.558	13764-18-6	1627.77	Naphthalenes	14

COMPONENT	**%WGT**	**%VOL**	**%MOL**	**AREA**	**AVERAGE_MW**
Unidentified	0.000	0.000	0.000	0.102	0.000
Unidentified	0.000	0.000	0.000	0.111	0.000
i-Butane	2.400	3.294	4.155	2507.063	2.415
Unidentified	0.021	0.019	0.014	21.834	0.021
Unidentified	0.000	0.000	0.000	0.361	0.000
n-Butane	0.011	0.015	0.019	11.568	0.011
2,2-Dimethylpropane	0.001	0.001	0.001	0.990	0.001
i-Pentane	9.563	11.673	13.339	10060.557	9.624
1,4-Pentadiene	0.116	0.133	0.172	129.504	0.117
n-Pentane	0.063	0.076	0.088	66.554	0.064
2-Methyl-1,3-Butadiene	0.012	0.014	0.018	13.572	0.012
2,2-Dimethylbutane	4.065	4.771	4.747	4293.292	4.091
Cyclopentene	0.001	0.001	0.002	1.380	0.001
4-Methylpentene-1-trans	0.011	0.012	0.013	11.753	0.011
Cyclopentane	10.119	10.267	14.520	10949.662	10.184
2-Methylpentane	0.007	0.008	0.009	7.735	0.007
2-Methyl-1,4-pentadiene	0.008	0.009	0.010	8.818	0.008
Hexene-1	6.339	7.123	7.580	6859.619	6.380
n-Hexane	0.024	0.028	0.028	25.555	0.024

t-Hexene-3	0.002	0.002	0.003	2.310	0.002
t-Hexene-2	0.010	0.012	0.012	11.017	0.010
3-Methyl-c-pentene-2	0.005	0.005	0.005	4.885	0.005
c-Hexene-2	0.001	0.001	0.001	1.318	0.001
Methylcyclopentane	0.000	0.000	0.000	0.288	0.000
2,4-Dimethylpentane	0.003	0.003	0.003	3.080	0.003
2,3,3-Trimethylbutene-1	0.001	0.001	0.001	0.946	0.001
Cyclohexane	0.002	0.002	0.002	1.919	0.002
2-Methylhexane	0.002	0.003	0.002	2.520	0.002
2,3-Dimethylpentane	0.015	0.016	0.015	15.750	0.015
3-Methylhexane	0.003	0.003	0.003	3.357	0.003
1t,3-Dimethylcyclopentane	0.001	0.001	0.001	0.998	0.001
1c,3-Dimethylcyclopentane	0.001	0.001	0.001	0.792	0.001
2,2,4-Trimethylpentane	4.460	4.875	3.929	4739.027	4.489
n-Heptane	0.015	0.017	0.015	16.281	0.015
Methylcyclohexane	0.058	0.057	0.060	63.174	0.059
2,2-Dimethylhexane	0.022	0.023	0.019	23.080	0.022
1,1,3-Trimethylcyclopentane	0.008	0.008	0.007	8.223	0.008
Ethylcyclopentane	0.329	0.321	0.338	356.518	0.332
2,2,3-Trimethylpentane	0.214	0.228	0.189	227.432	0.215
2,4-Dimethylhexane	0.313	0.334	0.275	332.060	0.315
Cyclopentane, 1,2,4-trimethyl-, (1à,2á,4à)-	0.018	0.018	0.016	19.299	0.018
3,3-Dimethylhexane	0.003	0.003	0.002	2.764	0.003
1t,2c,3-Trimethylcyclopentane	0.021	0.021	0.018	22.295	0.021
2,3,4-Trimethylpentane	2.450	2.624	2.158	2602.878	2.465
2,3,3-Trimethylpentane	3.442	3.672	3.033	3657.853	3.465
Toluene	0.013	0.011	0.014	15.024	0.013
2-Methyl-3-ethylpentane	0.692	0.735	0.610	735.307	0.696
2-Hexene, 2,5-dimethyl-	0.038	0.040	0.034	41.409	0.039
2-Methylheptane	0.127	0.135	0.112	134.739	0.128

4-Methylheptane	0.039	0.041	0.034	41.223	0.039
Hexane, 2,3,3-trimethyl-	0.074	0.078	0.058	78.640	0.074
3,4-Dimethylhexane	0.089	0.095	0.078	94.242	0.089
Unidentified	0.004	0.003	0.002	3.764	0.004
1c,2c,4-Trimethylcyclopentane	0.086	0.085	0.077	92.928	0.086
3-Ethylhexane	0.280	0.299	0.247	297.369	0.282
1,3-dimethyl-c-cyclohexane	0.084	0.082	0.075	90.355	0.084
1,1-Dimethylcyclohexane	0.017	0.017	0.016	18.909	0.018
2,2,5-Trimethylhexane	2.264	2.371	1.776	2410.222	2.278
3c-Ethylmethylcyclopentane	0.019	0.019	0.017	20.976	0.020
3t-Ethylmethylcyclopentane	0.018	0.018	0.016	19.752	0.018
1c,4-Dimethylcyclohexane	0.036	0.035	0.032	38.664	0.036
C9_I-Paraffins(1)	0.029	0.029	0.022	30.504	0.029
C8_Naphtheno-Olefins(1)	0.135	0.127	0.123	148.823	0.136
n-Octane	0.306	0.331	0.270	325.040	0.308
Cyclohexane c&t, 1,4-dimethyl-	0.137	0.134	0.123	147.876	0.138
Cyclopentene, 1,2,3-trimethyl-	0.069	0.065	0.063	75.572	0.069
2-Hexene, 3,5-dimethyl-	0.018	0.018	0.016	19.844	0.018
Unidentified	0.008	0.007	0.005	8.194	0.008
Cyclopentene, 1-(1-methylethyl)-	0.406	0.368	0.372	447.697	0.409
Cyclopentane, 1-ethyl-2-methyl-	0.006	0.006	0.006	6.946	0.006
C8_Iso-Olefins(3)	0.006	0.006	0.005	6.364	0.006
C9_I-Paraffins(3)	0.078	0.083	0.061	83.422	0.079
C8_Naphtheno-Olefins(3)	0.076	0.078	0.069	83.422	0.076
C9_Mono-Naphthenes(3)	0.001	0.001	0.001	1.460	0.001

Ethylcyclohexane	0.324	0.311	0.291	351.033	0.326
2,6-Dimethylheptane	0.160	0.167	0.125	169.962	0.161
1-Ethyl-2-Methylcyclopentene	0.008	0.009	0.006	8.756	0.008
C8_Naphtheno-Olefins(4)	0.167	0.173	0.153	181.056	0.168
2,5-Dimethylheptane	0.254	0.266	0.199	270.236	0.255
Heptane, 3,3-dimethyl-	0.021	0.022	0.017	22.882	0.022
1,1,4-Trimethylcyclohexane	0.014	0.014	0.011	15.093	0.014
C9_Mono-Naphthenes(8)	0.031	0.030	0.025	33.334	0.031
trans-1,3-Diethylcyclopentane	0.019	0.016	0.015	20.050	0.019
Unidentified	0.011	0.010	0.007	11.253	0.011
Ethylbenzene	2.167	1.900	2.054	2478.740	2.181
1c,2t,4t-Trimethylcyclohexane	0.205	0.205	0.164	221.988	0.206
Cyclohexane, 1,3,5-trimethyl-, (1à,3à,5á)-	0.041	0.040	0.032	43.887	0.041
m-Xylene	6.372	5.540	6.040	7288.978	6.413
p-Xylene	2.525	2.218	2.393	2888.264	2.541
3,5-Dimethylheptane	0.050	0.053	0.039	53.431	0.051
1-Heptene, 5-methyl-	0.064	0.067	0.057	69.012	0.064
C9_Mono-Naphthenes(13)	0.015	0.015	0.012	16.765	0.016
4-Ethylheptane	0.032	0.033	0.025	34.000	0.032
4-Methyloctane	0.118	0.123	0.092	125.358	0.118
2-Methyloctane	0.141	0.148	0.111	150.419	0.142
3-Hexene, 2,3-dimethyl-	0.019	0.020	0.017	20.550	0.019
Heptane, 3-ethyl-	0.100	0.104	0.078	106.064	0.100
3,4-Dimethylheptane	0.269	0.282	0.211	286.628	0.271

3-Heptyne, 5-ethyl-5-methyl-	0.003	0.003	0.002	3.722	0.003
Pentane, 2,3,3,4-tetramethyl-	0.190	0.200	0.150	202.887	0.191
1c,2t,4c-Trimethylcyclohexane	0.046	0.046	0.037	49.643	0.046
o-Xylene	2.312	1.986	2.192	2644.705	2.327
Octane, 3,4-dimethyl-	0.126	0.130	0.089	134.397	0.127
2,2,4-trimethylheptane	0.254	0.262	0.179	270.585	0.255
Cyclopentane, 1-methyl-2-propyl-	0.070	0.069	0.056	76.100	0.071
1-Ethyl-4-methylcyclohexane	0.190	0.187	0.152	205.883	0.191
cis-1-Ethyl-3-methyl-cyclohexane	0.081	0.079	0.064	87.162	0.081
Octane, 3,3-dimethyl-	0.252	0.260	0.179	269.274	0.254
t-Nonene-3	0.013	0.013	0.010	14.160	0.013
Cyclohexane, 1-ethyl-2-methyl-, cis-	0.026	0.025	0.021	28.049	0.026
C10_Iso-Olefins(1)	0.006	0.007	0.005	7.025	0.007
2-Methyl-2-octene	0.024	0.025	0.019	25.972	0.024
Heptane, 3,3,5-trimethyl-	0.158	0.163	0.112	168.822	0.159
n-Nonane	0.551	0.581	0.433	586.908	0.555
1,1-Methylethylcyclohexane	0.117	0.114	0.093	126.742	0.118
i-Butylcyclohexane	0.007	0.006	0.005	7.312	0.007
Cyclohexane, 1-ethyl-4-methyl-, trans-	0.019	0.019	0.015	20.965	0.019
i-Propylbenzene	0.033	0.029	0.028	37.492	0.033
C9_Mono-Naphthenes(23)	0.071	0.070	0.057	76.876	0.072
Propylcyclohexane	0.024	0.023	0.019	26.019	0.024
Heptane, 2,3,5-trimethyl-	0.114	0.118	0.081	121.770	0.115
C10_I-Paraffins(5)	0.027	0.028	0.019	29.073	0.027
Heptane, 2,4,6-trimethyl-	0.021	0.022	0.015	22.547	0.021

Cyclohexene,1-propyl-	0.006	0.006	0.005	6.745	0.006
1,6-Octadiene, 2,5-dimethyl-, (E)-	0.001	0.001	0.001	1.282	0.001
C9_Mono-Naphthenes(25)	0.023	0.022	0.019	25.423	0.024
C9_Mono-Naphthenes(27)	0.057	0.053	0.045	61.601	0.057
C10_I-Paraffins(9)	0.045	0.046	0.032	47.598	0.045
2,3,6-trimethylheptane	0.098	0.101	0.069	104.122	0.098
2,7-dimethyloctane	0.010	0.011	0.007	11.019	0.010
C10_Mono-Naphthenes(1)	0.002	0.002	0.002	2.298	0.002
2,6-Dimethyloctane	0.051	0.053	0.036	54.238	0.051
Hexane, 3,3,4-trimethyl-	0.003	0.003	0.002	3.110	0.003
Unidentified	0.003	0.003	0.002	2.954	0.003
n-Propylbenzene	0.521	0.455	0.436	592.455	0.525
3-Methyl-5-ethylheptane	0.014	0.014	0.010	14.770	0.014
Cyclopentane, 2-isopropyl-1,3-dimethyl-	0.006	0.006	0.004	6.458	0.006
1-Methyl-3-ethylbenzene	1.899	1.656	1.590	2158.250	1.911
1-Methyl-4-ethylbenzene	0.897	0.789	0.751	1019.548	0.903
Unidentified	0.006	0.005	0.004	5.882	0.006
1,3,5-Trimethylbenzene	1.071	0.938	0.897	1217.521	1.078
Trans-1,4-diethylcyclohexane	0.001	0.001	0.001	0.815	0.001
5-Methylnonane	0.010	0.011	0.007	11.037	0.010
2,4,6-Trimethyloctane	1.075	1.100	0.692	1146.894	1.082
1-Methyl-2-ethylbenzene	0.779	0.669	0.653	885.957	0.784
Cyclopentane, 1-methyl-3-(2-methylpropyl)-	0.008	0.009	0.006	9.129	0.008
3-Ethyloctane	0.008	0.008	0.005	8.223	0.008
3-Octyne, 2,2-dimethyl-	0.001	0.001	0.001	0.836	0.001
3-Methylnonane	0.042	0.044	0.030	45.148	0.043
Heptane, 2,2,3,5-tetramethyl-	0.280	0.289	0.181	299.153	0.282
C10_Mono-Naphthenes(7)	0.008	0.008	0.006	9.040	0.008

C10_I-Paraffins(16)	0.011	0.011	0.008	11.559	0.011
Benzene, 2-propenyl-	0.086	0.072	0.073	99.059	0.086
1,2,4-Trimethylbenzene	3.553	3.068	2.975	4038.083	3.576
C10_I-Paraffins(17)	0.129	0.133	0.091	137.936	0.130
C11_I-Paraffins(2)	0.083	0.085	0.054	89.005	0.084
C10_I-Paraffins(18)	0.012	0.012	0.009	12.902	0.012
Cyclopentane, 1-methyl-3-(1-methylethyl)-	0.351	0.332	0.280	380.036	0.353
Octane, 2,3,3-trimethyl-	0.145	0.151	0.094	155.095	0.146
2,2,3-trimethyloctane	0.022	0.024	0.014	23.233	0.022
i-Butylbenzene	0.180	0.158	0.135	203.827	0.181
sec-Butylbenzene	0.083	0.073	0.062	93.370	0.083
n-Decane	0.049	0.051	0.035	52.661	0.050
C11_I-Paraffins(4)	0.044	0.047	0.028	46.878	0.044
Octane, 6-ethyl-2-methyl-	0.005	0.005	0.003	5.292	0.005
1,2,3-Trimethylbenzene	0.683	0.578	0.572	776.331	0.687
1-Methyl-3-i-propylbenzene	0.122	0.107	0.091	137.849	0.123
1-Methyl-4-i-propylbenzene	0.041	0.036	0.031	46.495	0.041
C11_I-Paraffins(7)	0.060	0.061	0.039	63.919	0.060
Unidentified	0.003	0.003	0.002	3.546	0.003
C11_I-Paraffins(8)	0.024	0.025	0.016	26.033	0.025
Indan	0.243	0.184	0.207	280.637	0.244
C11_I-Paraffins(10)	0.026	0.027	0.017	27.773	0.026
C11_I-Paraffins(12)	0.010	0.010	0.006	10.467	0.010
1-Methyl-2-i-propylbenzene	0.015	0.013	0.011	16.492	0.015

2,5,6-Trimethyloctane	0.260	0.264	0.167	277.721	0.262
C11_I-Paraffins(13)	0.010	0.011	0.007	11.091	0.010
Heptane, 5-ethyl-2,2,3-trimethyl-	0.056	0.056	0.033	59.341	0.056
Undecane, 2-methyl-	0.004	0.004	0.002	3.779	0.004
1,3-Diethylbenzene	0.278	0.244	0.208	313.981	0.280
1-Methyl-3-n-propylbenzene	0.429	0.375	0.322	485.520	0.432
1-Methyl-4-n-propylbenzene	0.289	0.253	0.217	326.887	0.291
1,4-Diethylbenzene	0.129	0.113	0.096	145.303	0.129
1,3-Dimethyl-5-ethylbenzene	0.432	0.376	0.324	487.909	0.434
1,2-Diethylbenzene	0.029	0.025	0.022	32.982	0.029
C10_Mono-Aromatics(2)	0.020	0.018	0.015	23.118	0.021
C11_I-Paraffins(17)	0.009	0.009	0.006	9.634	0.009
1-Methyl-2-n-propylbenzene	0.185	0.162	0.139	209.570	0.187
C10_I-Paraffins(20)	0.005	0.005	0.004	5.335	0.005
Decane, 5-methyl-	0.032	0.032	0.021	34.007	0.032
C9_Mono-Aromatics(1)	0.002	0.002	0.002	2.633	0.002
Decane, 4-methyl-	0.023	0.023	0.015	24.587	0.023
1,4,Dimethyl-2-ethylbenzene	0.480	0.419	0.360	543.042	0.483
Benzene, (2-methyl-1-propenyl)-	0.597	0.501	0.455	685.132	0.601
Decane, 3-methyl-	0.037	0.038	0.024	39.676	0.037
1,2-Dimethyl-4-ethylbenzene	1.301	1.135	0.976	1471.087	1.310
Indan, 1-methyl-	0.016	0.013	0.012	18.412	0.016
Unidentified	0.016	0.014	0.010	16.441	0.016
1-Methyl-4-t-butylbenzene	0.101	0.089	0.068	113.506	0.101
C11_I-Paraffins(22)	0.007	0.007	0.004	7.105	0.007
Unidentified	0.031	0.029	0.021	33.284	0.032

Cyclopropane, 1,2-dimethyl-1-pentyl-	0.013	0.012	0.009	14.091	0.013
1-Undecene, 7-methyl-	0.003	0.003	0.002	3.239	0.003
1-Octene, 6-methyl-	0.033	0.036	0.026	35.722	0.033
C9_Iso-Olefins(5)	0.035	0.037	0.028	37.391	0.035
1-Ethyl-3-i-propylbenzene	0.158	0.132	0.107	177.320	0.159
1,2-Dimethyl-3-ethylbenzene	0.630	0.550	0.472	712.274	0.634
Unidentified	0.010	0.009	0.007	10.629	0.010
1-Ethyl-2-i-propylbenzene	0.003	0.003	0.002	3.675	0.003
Unidentified	0.081	0.075	0.055	86.172	0.082
n-Undecane	0.588	0.601	0.378	627.755	0.592
4,7-Methano-1H-indene, octahydro-	0.007	0.005	0.005	7.787	0.007
1-Ethyl-4-i-propylbenzene	1.727	1.519	1.173	1944.330	1.738
1,2,4,5-Tetramethylbenzene	2.517	2.145	1.889	2845.759	2.533
trans-4a-Methyl-decahydronaphthalene	0.001	0.001	0.001	1.161	0.001
C11_Mono-Aromatics(2)	0.018	0.016	0.012	20.458	0.018
1-t-Butyl-2-methylbenzene	0.001	0.001	0.001	1.600	0.001
Unidentified	0.055	0.051	0.037	58.757	0.056
1H-Indene,2,3-dihydro-2,2-dime	0.017	0.013	0.011	18.967	0.017
C11_Mono-Aromatics(3)	0.004	0.003	0.003	4.159	0.004
C11_I-Paraffins(25)	0.051	0.052	0.033	53.969	0.051
C12_I-Paraffins(4)	0.013	0.013	0.008	13.727	0.013
4-Methylindan	1.339	1.033	1.019	1536.929	1.347
C11_Mono-Naphthenes(1)	0.002	0.002	0.002	2.558	0.002
Benzene, 1,3-diethyl-5-methyl-	0.328	0.287	0.223	369.676	0.330
C11_Mono-Aromatics(5)	0.085	0.075	0.058	96.054	0.086
Benzene, 1-(1,1-dimethylethyl)-3-methyl-	0.556	0.490	0.378	626.287	0.560

1H-Indene, 1-methyl-	0.121	0.103	0.094	141.194	0.122
2-Methylindan	1.216	0.964	0.926	1396.661	1.224
1,3-Dimethyl-2-ethylbenzene	1.273	1.111	0.955	1439.252	1.281
C11_Mono-Naphthenes(2)	0.011	0.011	0.007	12.075	0.011
Benzene, 1,4-dimethyl-2-(1-methylethyl)-	0.090	0.079	0.061	101.637	0.090
n-Pentylbenzene	0.223	0.196	0.152	251.555	0.225
1,4-diethyl-2-methylbenzene	0.294	0.257	0.200	331.374	0.296
Benzene, 1-ethyl-3-(1-methylethyl)-	0.211	0.185	0.143	237.337	0.212
C10_I-Paraffins(21)	0.047	0.048	0.034	50.583	0.048
Benzene, (1,1-dimethylpropyl)-	0.257	0.226	0.174	288.961	0.258
2,4-diethyl-1-methylbenzene	0.302	0.264	0.205	339.630	0.304
Decane, 4-ethyl-	0.051	0.039	0.030	54.358	0.051
C11_Mono-Aromatics(8)	0.012	0.010	0.008	13.252	0.012
Undecane, 2,7-dimethyl-	0.045	0.045	0.025	48.361	0.045
1-methyl-4-(1-methylpropyl)be	0.397	0.349	0.270	446.912	0.400
Naphthalene	0.229	0.167	0.180	270.673	0.230
1-t-Butyl-3,5-dimethylbenzene	0.037	0.032	0.023	41.180	0.037
C12_I-Paraffins(9)	0.001	0.001	0.000	0.876	0.001
1H-Indene, 2,3-dihydro-1,3-dimethyl-	0.008	0.007	0.006	9.654	0.009
Unidentified	0.008	0.007	0.005	8.483	0.008
4,7-Dimethyl Indane	0.082	0.064	0.057	93.988	0.083
1,1-Dimethyl Indane	0.013	0.010	0.009	14.501	0.013
1t-Butyl-4-ethylbenzene	0.095	0.084	0.059	106.393	0.095
C12_Indanes(1)	0.001	0.001	0.001	1.116	0.001
1,3-Di-n-propylbenzene	0.194	0.171	0.120	217.358	0.195

Benzene, 1,3-dimethyl-5-(1-methylethyl)-	0.118	0.103	0.080	132.470	0.118
C11_Mono-Aromatics(9)	0.003	0.003	0.002	3.209	0.003
n-Dodecane	0.274	0.277	0.162	293.369	0.276
Benzene, (3,3-dimethylbutyl)-	0.014	0.012	0.009	15.503	0.014
C12_Mono-Aromatics(4)	0.002	0.002	0.001	2.030	0.002
Benzene, 2,4-dimethyl-1-(1-methylethyl)-	0.003	0.003	0.002	3.866	0.003
n-propyl indane	0.011	0.010	0.007	12.914	0.011
C11_Mono-Aromatics(14)	0.041	0.036	0.028	46.114	0.041
1,3,5-trimethyl-2-propylbenze	0.007	0.006	0.004	7.475	0.007
Unidentified	0.002	0.002	0.001	2.111	0.002
Unidentified	0.004	0.003	0.002	3.792	0.004
2-Ethyl-2,3-dihydro-1H-indene	0.011	0.009	0.007	12.112	0.011
1H-Indene, 1-ethyl-2,3-dihydro-	0.009	0.008	0.006	10.767	0.009
C12_Mono-Aromatics(5)	0.003	0.003	0.002	3.632	0.003
Benzene, (1-ethyl-1-methylpropyl)-	0.005	0.005	0.003	5.928	0.005
C11_Indanes(1)	0.027	0.021	0.019	31.026	0.027
Dodecane, 6-methyl-	0.002	0.001	0.001	2.527	0.002
Benzene, (1-methylpentyl)-	0.001	0.001	0.001	1.291	0.001
1-H-Indene,1-3-dimethyl	0.018	0.014	0.013	20.774	0.018
1H-Indene, 2,3-dihydro-5,6-dimethyl-	0.006	0.005	0.004	6.942	0.006
Unidentified	0.001	0.001	0.001	1.235	0.001
C12_Mono-Aromatics(10)	0.002	0.002	0.002	2.713	0.002
Pentamethylbenzene	0.067	0.059	0.046	75.750	0.068
C12_Indanes(6)	0.000	0.000	0.000	0.390	0.000
2-Methylnaphthalene	0.363	0.269	0.257	425.852	0.365
C12_Mono-Aromatics(16)	0.003	0.002	0.002	3.262	0.003
1-Methylnaphthalene	0.196	0.148	0.139	230.443	0.197
Naphthalene, 6-ethyl-1,2,3,4-tetrahydro-	0.002	0.002	0.002	2.867	0.003
Naphthalene, 1-ethyl-1,2,3,4-tetrahydro-	0.001	0.001	0.001	1.235	0.001

Naphthalene, 1,2,3,4-tetrahydro-6-propyl-	0.002	0.002	0.001	2.827	0.003
C12_Mono-Aromatics(17)	0.002	0.001	0.001	1.766	0.002
C13_I-Paraffins(4)	0.001	0.001	0.001	1.115	0.001
Benzene, 1,2,4-trimethyl-5-(1-methylethyl)-	0.001	0.001	0.001	1.286	0.001
1,1'-Biphenyl	0.009	0.007	0.006	10.947	0.009
Decane, 2,3,5-trimethyl-	0.021	0.021	0.012	22.924	0.022
2-Ethylnaphthalene	0.016	0.012	0.010	18.985	0.016
n-Tetradecane	0.032	0.032	0.016	34.528	0.032
Naphthalene,2,6 dimethyl	0.000	0.000	0.000	0.035	0.000
Naphthalene,2,7 dimethyl	0.027	0.021	0.018	31.884	0.028
1H-Indene, 2,3-dihydro-1,1,6-trimethyl-	0.001	0.001	0.001	1.384	0.001
Naphthalene,1,7-dimethyl	0.035	0.026	0.022	40.601	0.035
Naphthalene, 1,3-dimethyl-	0.035	0.026	0.022	40.601	0.035
Naphthalene, 1,6-dimethyl-	0.036	0.027	0.023	41.795	0.036
Unidentified	0.000	0.000	0.000	0.237	0.000
Naphthalene-1,4-dimethyl	0.013	0.010	0.009	15.398	0.013
Naphthalene, 2,3-dimethyl-	0.013	0.010	0.009	15.398	0.013
Naphthalene, 1,5-dimethyl-	0.007	0.005	0.005	8.222	0.007
Naphthalene, 1,2-dimethyl-	0.018	0.013	0.012	20.860	0.018
1,1'-Biphenyl, 3-methyl-	0.020	0.016	0.012	23.697	0.020
Octane, 3,4,5,6-tetramethyl-	0.001	0.001	0.001	1.596	0.002
1,1'-Biphenyl, 4-methyl-	0.016	0.013	0.010	19.100	0.016
Naphthalene, 1-propyl-	0.002	0.002	0.001	2.649	0.002
Unidentified	0.002	0.002	0.001	2.268	0.002
n-Pentadecane	0.002	0.002	0.001	2.157	0.002
Naphthalene, 2,3,6-trimethyl-	0.010	0.008	0.006	11.889	0.010
Unidentified	0.002	0.001	0.001	1.682	0.002
Unidentified	0.001	0.001	0.001	1.566	0.001
Unidentified	0.003	0.002	0.002	2.805	0.003
C13_Naphthalenes(1)	0.006	0.005	0.004	7.022	0.006

Unidentified	0.003	0.003	0.002	2.937	0.003
Unidentified	0.002	0.002	0.002	2.506	0.002
Naphthalene, 1,4,6-trimethyl-	0.012	0.009	0.007	14.130	0.012
Naphthalene, 1,4,5-trimethyl-	0.017	0.013	0.010	20.203	0.018
C13_Naphthalenes(4)	0.009	0.007	0.005	10.547	0.009
C13_Naphthalenes(5)	0.008	0.006	0.005	9.011	0.008
Naphthalene, 2-(1-methylethyl)-	0.003	0.003	0.002	3.735	0.003
Naphthalene, 1,6,7-trimethyl-	0.004	0.003	0.002	4.691	0.004
4-Ethylbiphenyl	0.004	0.003	0.002	5.056	0.004
Unidentified	0.003	0.003	0.002	3.346	0.003
Unidentified	0.004	0.003	0.002	3.928	0.004
3,3'-Dimethylbiphenyl	0.013	0.010	0.007	14.729	0.013
Unidentified	0.002	0.002	0.002	2.598	0.002
Unidentified	0.011	0.010	0.007	11.337	0.011
4,4'-Dimethylbiphenyl	0.001	0.001	0.001	1.297	0.001
Naphthalene, 2,6-diethyl	0.003	0.002	0.002	3.494	0.003
Benzene, 1-methyl-3-[(4-methylphenyl)methyl]-	0.002	0.001	0.001	1.796	0.002
C14_Mono-Aromatics(1)	0.006	0.005	0.003	7.307	0.006
1,4,6,7-tetramethylnaphthalene	0.001	0.001	0.001	1.099	0.001

AVERAGE_SG	**BP(K)**	**DBE**	**PMI**
0	111.65	0	0
0	111.65	0	0
0.018	261.45	0	0.000361
0	338.15	0	0
0	271.453	0	0
0	272.65	0	0.000002
0	280.35	0	0
0.072	303.15	0	0.00379
0.001	302.25	2	0.000135
0	308.35	0	0.000028
0	307.25	2	0.000016
0.031	321.55	0	0.002433
0	317.35	2	0.000002
0	331.5	1	0.000016
0.077	322.45	1	0.01236
0	332.75	0	0.000006

0	329.15	2	0.000017
0.048	335.15	1	0.010275
0	341.85	0	0.000023
0	338.75	1	0.000004
0	341.05	1	0.000019
0	340.85	1	0.000008
0	340.84	1	0.000002
0	344.95	1	0.000001
0	353.65	0	0.000004
0	352.45	1	0.000002
0	353.85	1	0.000004
0	363.25	0	0.000004
0	362.95	0	0.000022
0	363.85	0	0.000005
0	364.85	1	0.000003
0	363.95	1	0.000002
0.034	371.15	0	0.008097
0	371.55	0	0.000028
0	374.05	1	0.000226
0	378.85	0	0.000047
0	378.05	1	0.000032
0.002	376.65	1	0.001355
0.002	383.05	0	0.000509
0.002	382.55	0	0.000735
0	389.45	1	0.000098
0	384.25	0	0.000006
0	389.45	1	0.000114
0.019	386.65	0	0.006332
0.026	387.95	0	0.009169
0	383.75	4	0.000158
0.005	388.15	0	0.001852
0	387.45	1	0.000201
0.001	390.85	0	0.000361
0	390.15	0	0.000109
0.001	411.05	0	0.000338
0.001	389.75	0	0.000246
0	388.38	0	0
0.001	388.38	1	0.000462
0.002	390.65	0	0.000793
0.001	393.25	1	0.000503
0	391.15	1	0.0001
0.017	397.25	0	0.007476
0	393.05	1	0.000116
0	393.05	1	0.000109
0	399.047	1	0.000246
0	406.15	0	0.000117

0.001	403.95	2	0.001565
0.002	398.15	0	0.001032
0.001	394.25	1	0.000842
0.001	393.55	2	0.000624
0	386.04	1	0.000093
0	379.55	0	0
0.003	399.15	2	0.004207
0	397.25	1	0.000042
0	419.75	1	0.000066
0.001	405.85	0	0.000316
0.001	391.05	2	0.00065
0	402.85	1	0.00001
0.002	402.55	1	0.002425
0.001	408.35	0	0.000684
0	408.25	0	0.000035
0.001	391.05	2	0.001436
0.002	408.95	0	0.001103
0	410.25	0	0.000096
0	408.15	1	0.000119
0	408.15	1	0.000263
0	417.55	1	0.000197
0	417.55	0	0
0.016	409.35	4	0.047509
0.002	416.15	1	0.002114
0	412.649	1	0.000385
0.048	411.15	4	0.145782
0.019	412.76	4	0.060014
0	409.15	0	0.000219
0	385.55	1	0.000322
0	408.15	1	0.000132
0	414.35	0	0.000158
0.001	414.75	0	0.000587
0.001	416.45	0	0.000733
0	387.45	1	0.0001
0.001	416.15	0	0.000513
0.002	413.75	0	0.00131
0	428.45	2	0.00007
0.001	414.45	0	0.000941
0	412.649	1	0.000435
0.017	416.15	4	0.059569
0.001	436.35	0	0.001059
0.002	422.35	0	0.001516
0.001	422.05	1	0.000835
0.001	423.95	1	0.002364
0.001	423.95	1	0.001001
0.002	434.15	0	0.00201

0	418.85	1	0.000144
0	429.15	1	0.000365
0	420.15	1	0.000074
0	420.15	1	0.000272
0.001	428.95	0	0.00111
0.004	424.85	0	0.003501
0.001	425.35	1	0.001506
0	444.45	1	0.000139
0	423.95	1	0.000241
0	425.55	4	0.001065
0.001	423.95	1	0.000883
0	428.15	1	0.000331
0.001	431.05	0	0.000843
0	419.8167	0	0.000153
0	422.15	0	0.000126
0	432.35	2	0.00014
0	428.48	2	0.000024
0	418.35	1	0.000255
0	425.35	1	0.000732
0	433.55	0	0.00035
0.001	430.05	0	0.000703
0	431.65	0	0.000077
0	444.45	1	0.000044
0	432.85	0	0.000392
0	412.75	0	0.000014
0	441.35	0	0
0.004	433.65	4	0.020505
0	432.55	0	0.000106
0	433.7	1	0.000094
0.014	434.45	4	0.076177
0.007	435.15	4	0.03661
0	436.35	0	0
0.008	439.85	4	0.049097
0	447.15	1	0.000017
0	438.25	0	0.000091
0.008	445.35	0	0.011301
0.006	437.15	4	0.033419
0	422.5945	1	0.000101
0	439.65	0	0.00007
0	428.45	2	0.000016
0	440.95	0	0.000399
0.002	446.97	0	0.00307
0	444.15	1	0.00017
0	440.95	0	0.000102
0.001	440.65	5	0.004807
0.027	441.15	4	0.168175

0.001	440.95	0	0.001218
0.001	445.45	0	0.000879
0	440.95	0	0.000114
0.003	415.49	1	0.003563
0.001	447.41	0	0.001609
0	452.75	0	0.000276
0.001	448.55	4	0.010269
0.001	446.45	4	0.004462
0	448.05	0	0.000555
0	452.75	0	0.000556
0	450.2	0	0.000059
0.005	448.15	4	0.038516
0.001	448.25	4	0.006893
0	449.15	4	0.002378
0	457.15	0	0.000848
0	457.15	0	0
0	457.15	0	0.000345
0.002	449.65	5	0.017072
0	452.55	0	0.000328
0	457.15	0	0.000139
0	451.35	4	0.000892
0.002	449.76	0	0.003054
0	457.15	0	0.000147
0	469.85	0	0.001095
0	482.05	0	0.000096
0.002	454.85	4	0.018556
0.003	456.85	4	0.030198
0.002	457.35	4	0.020593
0.001	446.45	4	0.006944
0.003	457.75	4	0.031054
0	456.65	4	0.002041
0	456.65	4	0.001431
0	457.15	0	0.000128
0.001	459.65	4	0.014006
0	432.85	0	0.000039
0	459.25	0	0.000476
0	449.25	4	0.000134
0	460.55	0	0.000356
0.004	460.05	4	0.036667
0.005	461.05	5	0.056085
0	462.25	0	0.0006
0.01	462.65	4	0.106226
0	466.55	5	0.001728
0	466.55	0	0
0.001	465.95	4	0.008968
0	457.15	0	0.000094

0	430.51	0	0
0	430.51	1	0.00019
0	478.15	1	0.000147
0	410.75	1	0.000299
0	410.75	1	0.000313
0.001	476.35	4	0.018426
0.005	465.15	4	0.05488
0	476.35	0	0
0	476.35	4	0.000382
0.001	482.35	0	0
0.004	469.05	0	0.011339
0	448.0167	3	0.000303
0.013	470.15	4	0.171466
0.019	469.15	4	0.243418
0	470.85	2	0.000065
0	463.45	4	0.001515
0	463.45	4	0.000118
0	472.05	0	0
0	474.25	5	0.002205
0	467.15	4	0.000339
0	457.15	0	0.000716
0	457.15	0	0.000182
0.01	479.25	5	0.203045
0	457.15	0	0.000034
0.002	475.95	4	0.038008
0.001	475.95	4	0.009876
0.004	461.95	4	0.044602
0.001	465.76	6	0.015004
0.009	467.65	5	0.135712
0.01	463.25	4	0.105555
0	457.15	0	0.00016
0.001	469.35	4	0.00874
0.002	478.55	4	0.027723
0.002	479.85	4	0.037815
0.002	465.65	4	0.018605
0	489.45	0	0.001581
0.002	463.15	4	0.021228
0.002	479.05	4	0.037934
0	473.52	0	0.001105
0	483.15	4	0.001653
0	495.96	0	0.001804
0.003	469.05	4	0.03829
0.002	494.65	7	0.070431
0	481.05	4	0.004869
0	470.15	0	0.000016
0	481.85	5	0.001375

0	470.15	0	0
0.001	499.75	5	0.021926
0	464.15	5	0.001293
0.001	484.65	4	0.013865
0	451.05	5	0.000071
0.001	476.15	4	0.022538
0.001	467.05	4	0.010771
0	467.05	4	0.000261
0.002	488.15	0	0.00883
0	497.41	4	0.002863
0	480.85	4	0.000238
0	472.55	4	0.000363
0	507.15	5	0.003735
0	465.95	4	0.003643
0	505.25	4	0.001728
0	505.25	0	0
0	453.45	0	0
0	488.35	5	0.002059
0	495.15	5	0.002208
0	477.15	4	0.000387
0	478.15	4	0.000648
0	451.05	5	0.001955
0	497.95	0	0.0001
0	481.15	4	0.000153
0	502.05	6	0.005964
0	500.75	5	0.001666
0	495.52	0	0
0	493.45	5	0.000533
0.001	502.15	4	0.015985
0	451.05	5	0.000025
0.003	513.15	7	0.189046
0	477.15	4	0.000347
0.001	513.05	7	0.102002
0	519.75	5	0.001186
0	512.85	5	0.000417
0	537.95	5	0.002062
0	477.15	4	0.000188
0	495.52	0	0.000041
0	492.15	4	0.000206
0	528.15	8	0.00855
0	495.52	0	0.000845
0	530.9278	7	0.014431
0	525.15	0	0.002997
0	535.15	7	0.00003
0	536.15	7	0.028469
0	273.15	5	0.000001

0	535.65	7	0.035694
0	536.15	7	0.036252
0	537.15	7	0.038498
0	537.15	0	0
0	541.6	7	0.016307
0	542.05	7	0.016541
0	538.75	7	0.007961
0	541.15	7	0.02178
0	545.85	8	0.03212
0	472.2	0	0.000031
0	540.95	8	0.022162
0	548.45	7	0.003546
0	543.75	0	0
0	543.75	0	0.000333
0	536.65	7	0.010955
0	536.65	0	0
0	536.65	0	0
0	540	0	0
0	540	7	0.007184
0	557.85	0	0
0	554.25	0	0
0	554.25	7	0.02284
0	563.45	7	0.043916
0	559.95	7	0.020586
0	540	7	0.009128
0	540	7	0.003821
0	559.95	7	0.009157
0	564.2	8	0.01253
0	564.2	0	0
0	562.4667	0	0
0	562.4667	8	0.03443
0	554	0	0
0	554	0	0
0	568	8	0.003658
0	567.75	7	0.008877
0	563.15	8	0.004343
0	554	8	0.012894
0	576.05	7	0.003708

3.) CE15 TR2339A

TIME	**CASNO**	**RI**	**GROUP**	**CARBON#**
6.527		186.68	Unidentified	0

6.71		191.92	Unidentified	0
8.248	75-28-5	371.24	I-Paraffins	4
8.35		375.16	Unidentified	0
8.928		393.27	Unidentified	0
9.197	106-97-8	400	Paraffin	4
9.667	463-82-1	415.55	I-Paraffins	5
11.723	64-17-5	462.11	Oxygenates	2
12.767	78-78-4	478.55	I-Paraffins	5
12.848	591-93-5	479.71	Di-Olefins	5
14.473	109-66-0	500	Paraffin	5
14.638	78-79-5	503.05	Di-Olefins	5
17.018	75-83-2	540.96	I-Paraffins	6
18.733	691-37-2	563.11	Iso-Olefins	6
19.16	287-92-3	568.13	Mono-Naphthenes	5
19.287		569.58	Unidentified	0
19.663	107-83-5	573.82	I-Paraffins	6
20.297	763-30-4	580.67	Di-Olefins	6
20.782		585.71	Unidentified	0
21.392	592-41-6	591.79	n-Olefins	6
22.257	110-54-3	600	Paraffin	6
22.51	13269-52-8	603.09	n-Olefins	6
22.727	4050-45-7	605.69	n-Olefins	6
23.172	922-62-3	610.92	Iso-Olefins	6
23.533	7688-21-3	615.06	n-Olefins	6
24.37		624.32	Unidentified	0
24.475		625.45	Unidentified	0
24.587	96-37-7	626.64	Mono-Naphthenes	6
24.973	108-08-7	630.72	I-Paraffins	7
25.417	594-56-9	635.29	Iso-Olefins	7
27.098		651.69	Unidentified	0
27.887	110-82-7	658.92	Mono-Naphthenes	6
28.883	591-76-4	667.67	I-Paraffins	7
29.057	565-59-3	669.15	I-Paraffins	7
29.883	589-34-4	676.06	I-Paraffins	7
30.658	1759-58-6	682.32	Mono-Naphthenes	7
31.012	2532-58-3	685.11	Mono-Naphthenes	7
31.538	540-84-1	689.18	I-Paraffins	8
32.992	142-82-5	700	Paraffin	7
35.947	108-87-2	718.82	Mono-Naphthenes	7
36.23	590-73-8	720.52	I-Paraffins	8

36.372	4516-69-2	721.37	Mono-Naphthenes	8
36.81		723.96	Unidentified	0
37.487		727.88	Unidentified	0
37.9	1640-89-7	730.24	Mono-Naphthenes	7
38.112	564-02-3	731.43	I-Paraffins	8
38.23	589-43-5	732.1	I-Paraffins	8
39.257	16883-48-0	737.75	Mono-Naphthenes	8
39.45	563-16-6	738.8	I-Paraffins	8
40.613	15890-40-1	744.96	Mono-Naphthenes	8
41.153	565-75-3	747.75	I-Paraffins	8
42.003	560-21-4	752.05	I-Paraffins	8
42.268	108-88-3	753.37	Mono-Aromatics	7
43.278	609-26-7	758.31	I-Paraffins	8
43.523	3404-78-2	759.49	Iso-Olefins	8
44.533	592-27-8	764.26	I-Paraffins	8
44.863	589-53-7	765.79	I-Paraffins	8
45.13	16747-28-7	767.02	I-Paraffins	9
45.25	583-48-2	767.57	I-Paraffins	8
45.863		770.35	Unidentified	0
46.22	2815-58-9	771.95	Mono-Naphthenes	8
46.65	619-99-8	773.86	I-Paraffins	8
47.083	638-04-0	775.76	Mono-Naphthenes	8
48.413	590-66-9	781.48	Mono-Naphthenes	8
48.86	3522-94-9	783.36	I-Paraffins	9
49.28	2613-66-3	785.1	Mono-Naphthenes	8
49.813	3726-47-4	787.3	Mono-Naphthenes	8
50.147	624-29-3	788.65	Mono-Naphthenes	8
50.49		790.04	I-Paraffins	9
51.425		793.77	Naphtheno-Olefins	8
53.035	111-65-9	800	Paraffin	8
53.42	589-90-2	801.53	Mono-Naphthenes	8
54.942	473-91-6	807.47	Naphtheno-Olefins	8

55.367	3404-79-3	809.09	Iso-Olefins	8
57.165		815.81	Unidentified	0
57.858	1462-07-3	818.33	Naphtheno-Olefins	8
58.552	3726-46-3	820.83	Mono-Naphthenes	8
58.99		822.38	Iso-Olefins	8
60.42		827.38	I-Paraffins	9
60.42		827.38	Naphtheno-Olefins	8
61.315		830.44	Mono-Naphthenes	9
62.24	2040-96-2	833.54	Mono-Naphthenes	8
62.67	1072-05-5	834.97	I-Paraffins	9
63.33	1068-19-5	837.14	Naphtheno-Olefins	9
64.075		839.56	Naphtheno-Olefins	8
65.055	2216-30-0	842.69	I-Paraffins	9
65.488	4032-86-4	844.06	I-Paraffins	9
65.967	7094-27-1	845.56	Mono-Naphthenes	9
66.433		847.01	Mono-Naphthenes	9
67.043		848.89	Mono-Naphthenes	9
68.625		853.68	Mono-Naphthenes	9
69.605	100-41-4	856.58	Mono-Aromatics	8
69.615		856.61	Unidentified	0
69.862	7667-60-9	857.34	Mono-Naphthenes	9
71.383	1795-27-3	861.74	Mono-Naphthenes	9
73.075	108-38-3	866.52	Mono-Aromatics	8
73.377	106-42-3	867.36	Mono-Aromatics	8
73.703	926-82-9	868.26	I-Paraffins	9
74.007	13151-04-7	869.1	Iso-Olefins	8
74.527		870.52	Mono-Naphthenes	9
74.84	2216-32-2	871.37	I-Paraffins	9
75.892	2216-34-4	874.2	I-Paraffins	9
76.24	3221-61-2	875.13	I-Paraffins	9

76.913	7145-23-5	876.91	Iso-Olefins	8
77.713	15869-80-4	879.01	I-Paraffins	9
78.265	922-28-1	880.44	I-Paraffins	9
78.693	61228-10-2	881.54	Iso-Olefins	10
79.038	16747-38-9	882.43	I-Paraffins	9
79.54	1795-26-2	883.71	Mono-Naphthenes	9
80.057	95-47-6	885.01	Mono-Aromatics	8
80.377	15869-92-8	885.82	I-Paraffins	10
80.652	14720-74-2	886.51	I-Paraffins	10
81.428	3728-57-2	888.44	Mono-Naphthenes	9
81.658	3728-56-1	889.01	Mono-Naphthenes	9
82.267	19489-10-2	890.5	Mono-Naphthenes	9
82.522	4110-44-5	891.12	I-Paraffins	10
83.098	20063-92-7	892.53	n-Olefins	9
83.505	4923-77-7	893.51	Mono-Naphthenes	9
84.862		896.74	Iso-Olefins	10
85.535	16993-86-5	898.33	Iso-Olefins	9
85.777	7154-80-5	898.9	I-Paraffins	10
86.25	111-84-2	900	Paraffin	9
86.678	4926-90-3	902.33	Mono-Naphthenes	9
87.23	1678-98-4	905.31	Mono-Naphthenes	10
87.433	6236-88-0	906.4	Mono-Naphthenes	9
88.867	98-82-8	914.02	Mono-Aromatics	9
89.233		915.95	Mono-Naphthenes	9
89.773	1678-92-8	918.78	Mono-Naphthenes	9
90.298	20278-85-7	921.51	I-Paraffins	10
90.688		923.52	I-Paraffins	10
90.852	2613-61-8	924.37	I-Paraffins	10
91.043	2539-75-5	925.35	Naphtheno-Olefins	9
91.313	68702-25-0	926.74	Iso-Olefins	10
91.795		929.2	Mono-Naphthenes	9
92.32		931.86	Mono-Naphthenes	9

92.477		932.65	I-Paraffins	10
93.342	4032-93-3	937	I-Paraffins	10
93.618	1072-16-8	938.38	I-Paraffins	10
94.097		940.76	Mono-Naphthenes	10
94.433	2051-30-1	942.42	I-Paraffins	10
94.79	16747-31-2	944.18	I-Paraffins	9
95.237		946.37	Unidentified	0
95.565	103-65-1	947.98	Mono-Aromatics	9
95.913	13475-78-0	949.67	I-Paraffins	10
96.455	32281-85-9	952.29	Mono-Naphthenes	10
96.723	13151-08-1	953.59	Iso-Olefins	9
97.29	620-14-4	956.31	Mono-Aromatics	9
97.637	622-96-8	957.96	Mono-Aromatics	9
97.938	6709-39-3	959.39	Di-Olefins	9
98.442		961.78	I-Paraffins	10
98.815	108-67-8	963.54	Mono-Aromatics	9
99.797	15869-85-9	968.13	I-Paraffins	10
100.212	17301-94-9	970.06	I-Paraffins	10
100.638	611-14-3	972.03	Mono-Aromatics	9
101.007	29053-04-1	973.72	Mono-Naphthenes	10
101.2	5881-17-4	974.61	I-Paraffins	10
101.47	19482-57-6	975.85	Iso-Olefins	10
101.815	4/6/5911	977.42	I-Paraffins	10
102.512	61868-42-6	980.58	I-Paraffins	11
102.693		981.4	Mono-Naphthenes	10
103.23	300-57-2	983.82	Mono-Aromatics	9
103.575	95-63-6	985.36	Mono-Aromatics	9
103.983		987.18	I-Paraffins	10
104.123		987.81	I-Paraffins	11
104.318		988.67	I-Paraffins	10
104.358	53771-88-3	988.85	Mono-Naphthenes	9
105.643	62016-30-2	994.51	I-Paraffins	11
105.895	62016-26-6	995.61	I-Paraffins	11

106.212	538-93-2	996.99	Mono-Aromatics	10
106.687	135-98-8	999.06	Mono-Aromatics	10
106.905	124-18-5	1000	Paraffin	10
107.18		1001.96	I-Paraffins	11
107.477	62016-19-7	1004.07	I-Paraffins	11
108.237	526-73-8	1009.45	Mono-Aromatics	9
108.547	535-77-3	1011.64	Mono-Aromatics	10
109.042	99-87-6	1015.11	Mono-Aromatics	10
109.342		1017.2	I-Paraffins	11
109.537		1018.56	Unidentified	0
109.73		1019.91	I-Paraffins	11
110.078	496-11-7	1022.32	Indanes	9
110.372		1024.35	I-Paraffins	11
110.858		1027.7	I-Paraffins	11
111.143	527-84-4	1029.66	Mono-Aromatics	10
111.362	62016-14-2	1031.16	I-Paraffins	11
111.652		1033.14	I-Paraffins	11
112.387	62199-06-8	1038.13	I-Paraffins	12
112.668	7045-71-8	1040.04	I-Paraffins	12
112.928	141-93-5	1041.79	Mono-Aromatics	10
113.305	1074-43-7	1044.33	Mono-Aromatics	10
113.873	1074-55-1	1048.13	Mono-Aromatics	10
114.032	105-05-5	1049.19	Mono-Aromatics	10
114.362	934-74-7	1051.39	Mono-Aromatics	10
114.695	135-01-3	1053.6	Mono-Aromatics	10
114.913		1055.05	Mono-Aromatics	10
115.35		1057.93	I-Paraffins	11
115.613	1074-17-5	1059.66	Mono-Aromatics	10
115.783		1060.78	I-Paraffins	10
115.952	13151-35-4	1061.88	I-Paraffins	11
116.242		1063.78	Mono-Aromatics	9
116.502	2847-72-5	1065.48	I-Paraffins	11

117.158	1758-88-9	1069.75	Mono-Aromatics	10
117.412	768-49-0	1071.39	Mono-Aromatics	10
117.925	13151-34-3	1074.7	I-Paraffins	11
118.31	934-80-5	1077.17	Mono-Aromatics	10
118.547	767-58-8	1078.69	Indanes	10
118.767		1080.09	Unidentified	0
119.15	98-51-1	1082.54	Mono-Aromatics	11
119.468		1084.56	I-Paraffins	11
119.668		1085.83	Unidentified	0
119.837	62238-04-4	1086.9	Mono-Naphthenes	10
120.013	74630-42-5	1088.01	Iso-Olefins	12
120.218	13151-10-5	1089.31	Iso-Olefins	9
120.483		1090.98	Iso-Olefins	9
120.833	20024-91-3	1093.18	Mono-Aromatics	11
121.132	933-98-2	1095.04	Mono-Aromatics	10
121.302		1096.11	Unidentified	0
121.418	16021-20-8	1096.84	Mono-Aromatics	11
121.688		1098.52	I-Paraffins	12
121.927	1120-21-4	1100	Paraffin	11
122.235	6004-38-2	1102.64	Indanes	10
122.807	4218-48-8	1107.53	Mono-Aromatics	11
123.318	95-93-2	1111.88	Mono-Aromatics	10
123.462	2547-27-5	1113.09	Di/Bicyclo-Naphthenes	11
123.602		1114.28	Mono-Aromatics	11
123.743	1074-92-6	1115.47	Mono-Aromatics	11
123.905		1116.84	Unidentified	0
124.123	20836-11-7	1118.68	Indanes	11
124.25		1119.75	I-Paraffins	11
124.418		1121.16	I-Paraffins	11
124.705	17302-23-7	1123.57	I-Paraffins	11
125.002		1126.05	Mono-Aromatics	11
125.145		1127.25	I-Paraffins	12

125.532	824-22-6	1130.47	Indanes	10
125.89		1133.45	Mono-Naphthenes	11
126.175	2050-24-0	1135.81	Mono-Aromatics	11
126.352		1137.28	Mono-Aromatics	11
126.518	1075-38-3	1138.65	Mono-Aromatics	11
126.705	767-59-9	1140.19	Indenes	10
126.895	824-63-5	1141.76	Indanes	10
127.407	4/4/2870	1145.96	Mono-Aromatics	10
127.738		1148.67	Mono-Naphthenes	11
127.96	4132-72-3	1150.48	Mono-Aromatics	11
128.147	538-68-1	1152.01	Mono-Aromatics	11
128.542	13632-94-5	1155.22	Mono-Aromatics	11
128.668	4920-99-4	1156.24	Mono-Aromatics	11
128.913		1158.23	I-Paraffins	10
129.095	2049-95-8	1159.7	Mono-Aromatics	11
129.345	1758-85-6	1161.72	Mono-Aromatics	11
129.543	1636-44-8	1163.32	I-Paraffins	12
129.863		1165.89	Mono-Aromatics	11
130.05	17301-24-5	1167.39	I-Paraffins	13
130.192	1595-16-0	1168.52	Mono-Aromatics	11
130.658	91-20-3	1172.25	Naphthalenes	10
130.84	98-19-1	1173.7	Mono-Aromatics	12
131.017		1175.11	I-Paraffins	12
131.167	4175-53-5	1176.3	Indanes	11
131.382		1178.01	I-Paraffins	12
131.708	6682-71-9	1180.6	Indanes	11
131.918	4912-92-9	1182.26	Indanes	11
132.368	7364-19-4	1185.8	Mono-Aromatics	12
132.638		1187.93	Indanes	12
132.997	99-62-7	1190.74	Mono-Aromatics	12

133.217	4706-90-5	1192.46	Mono-Aromatics	11
133.357	63830-66-0	1193.55	Iso-Olefins	12
133.643		1195.79	Mono-Aromatics	11
134.185	112-40-3	1200	Paraffin	12
134.59	17314-92-0	1203.91	Mono-Aromatics	12
134.885		1206.74	Mono-Aromatics	12
135.18	4706-89-2	1209.58	Mono-Aromatics	11
135.367	60584-82-9	1211.36	Indanes	12
135.945		1216.89	Mono-Aromatics	11
136.235	4/2/4810	1219.65	Mono-Aromatics	12
136.51		1222.26	Unidentified	0
136.898		1225.94	Unidentified	0
136.922	56147-63-8	1226.16	Indanes	11
137.173	4830-99-3	1228.54	Indanes	11
137.442		1231.07	Mono-Aromatics	12
137.598		1232.54	Mono-Aromatics	12
138.727	1985-97-3	1243.11	Mono-Aromatics	12
138.923		1244.95	Indanes	11
140.045	2/3/6031	1255.35	Mono-Aromatics	12
140.272	1077-16-3	1257.44	Mono-Aromatics	12
140.438	2177-48-2	1258.98	Indanes	11
140.838	1075-22-5	1262.66	Indanes	11
141.28		1266.7	Unidentified	0
141.775		1271.23	Mono-Aromatics	12
142.433	700-12-9	1277.21	Mono-Aromatics	11
143.052		1282.81	Indanes	12
143.497	90-12-0	1286.82	Naphthalenes	11
143.858		1290.07	Mono-Aromatics	12
145.213	91-57-6	1302.6	Naphthalenes	11
146.547	22531-20-0	1316.66	Mono-Aromatics	12

147.46	13556-58-6	1326.22	Mono-Aromatics	12
148.428	42775-77-9	1336.28	Mono-Aromatics	13
149.193		1344.18	Mono-Aromatics	12
149.62		1348.57	I-Paraffins	13
150.333	10222-95-4	1355.88	Mono-Aromatics	12
151.748	92-52-4	1370.27	Mono-Aromatics	12
153.622	62238-11-3	1389.1	I-Paraffins	13
153.86	939-27-5	1391.48	Naphthalenes	12
154.717	629-59-4	1400	Paraffin	14
154.717	581-42-0	1400	Naphthalenes	12
154.882	582-16-1	1401.88	Naphthalenes	12
155.935	14276-95-0	1413.81	Indanes	12
156.157	575-37-1	1416.31	Naphthalenes	12
156.157	575-41-7	1416.31	Naphthalenes	12
156.507	575-43-9	1420.25	Naphthalenes	12
158.063	571-58-4	1437.66	Naphthalenes	12
158.063	581-40-8	1437.66	Naphthalenes	12
158.308	571-61-9	1440.38	Naphthalenes	12
159.473	573-98-8	1453.27	Naphthalenes	12
161.748	643-93-6	1478.17	Mono-Aromatics	13
162.073	62185-21-1	1481.69	I-Paraffins	12
162.598	644-08-6	1487.37	Mono-Aromatics	13
163.213	2765-18-6	1494	Naphthalenes	13
163.533		1497.44	Unidentified	0
163.772	629-62-9	1500	Paraffin	15
164.047	829-26-5	1502.48	Naphthalenes	13
164.5		1506.57	Unidentified	0
164.933		1510.46	Unidentified	0
165.185		1512.72	Naphthalenes	13
165.59		1516.34	Unidentified	0
165.792		1518.14	Unidentified	0
165.99	2131-42-2	1519.91	Naphthalenes	13
166.483	2131-41-1	1524.3	Naphthalenes	13
167.862		1536.5	Naphthalenes	13
168.217		1539.62	Naphthalenes	13
169.207	2027-17-0	1548.3	Naphthalenes	13
169.405	2245-38-7	1550.03	Naphthalenes	13
169.567	5707-44-8	1551.44	Mono-Aromatics	14

170.643		1560.8	Unidentified	0
170.952	612-75-9	1563.47	Mono-Aromatics	14
171.502	611-61-0	1568.21	Mono-Aromatics	14
172.008		1572.57	Unidentified	0
172.402		1575.95	Unidentified	0
172.748	613-33-2	1578.91	Mono-Aromatics	14
172.94	59919-41-4	1580.55	Naphthalenes	14
174.482		1593.66	Mono-Aromatics	14
178.565	13764-18-6	1627.8	Naphthalenes	14

COMPONENT	**%WGT**	**%VOL**	**%MOL**	**AREA**	**AVERAGE_MW**
Unidentified	0.000	0.000	0.000	0.197	0.000
Unidentified	0.000	0.000	0.000	0.155	0.000
i-Butane	1.657	2.311	2.480	1940.647	1.442
Unidentified	0.006	0.005	0.003	6.786	0.005
Unidentified	0.000	0.000	0.000	0.360	0.000
n-Butane	0.009	0.012	0.013	10.147	0.008
2,2-Dimethylpropane	0.001	0.001	0.001	1.142	0.001
Ethanol	14.620	14.241	27.617	8216.046	12.723
i-Pentane	7.458	9.251	8.996	8797.495	6.491
1,4-Pentadiene	0.075	0.087	0.096	93.705	0.065
n-Pentane	0.104	0.128	0.126	123.181	0.091
2-Methyl-1,3-Butadiene	0.026	0.030	0.034	32.972	0.023
2,2-Dimethylbutane	3.246	3.871	3.278	3843.740	2.825
4-Methylpentene-1-trans	0.012	0.014	0.012	14.591	0.010
Cyclopentane	8.071	8.322	10.015	9792.754	7.024
Unidentified	0.034	0.032	0.020	40.390	0.030
2-Methylpentane	0.024	0.028	0.024	28.620	0.021
2-Methyl-1,4-pentadiene	0.002	0.002	0.002	2.640	0.002
Unidentified	0.012	0.011	0.007	14.138	0.010
Hexene-1	5.168	5.900	5.344	6269.969	4.497
n-Hexane	0.044	0.051	0.044	51.942	0.038
t-Hexene-3	0.003	0.003	0.003	3.655	0.003
t-Hexene-2	0.009	0.010	0.009	10.456	0.008
3-Methyl-c-pentene-2	0.004	0.004	0.004	4.533	0.003

c-Hexene-2	0.001	0.001	0.001	1.164	0.001
Unidentified	0.001	0.001	0.000	0.893	0.001
Unidentified	0.001	0.001	0.001	1.502	0.001
Methylcyclopentane	0.003	0.003	0.003	3.760	0.003
2,4-Dimethylpentane	0.004	0.004	0.003	4.208	0.003
2,3,3-Trimethylbutene-1	0.001	0.001	0.001	1.247	0.001
Unidentified	0.000	0.000	0.000	0.354	0.000
Cyclohexane	0.004	0.004	0.004	5.142	0.004
2-Methylhexane	0.008	0.009	0.007	9.752	0.007
2,3-Dimethylpentane	0.014	0.016	0.012	16.780	0.012
3-Methylhexane	0.008	0.009	0.007	10.037	0.007
1t,3-Dimethylcyclopentane	0.001	0.001	0.001	1.632	0.001
1c,3-Dimethylcyclopentane	0.001	0.001	0.001	1.291	0.001
2,2,4-Trimethylpentane	3.744	4.159	2.852	4460.542	3.258
n-Heptane	0.017	0.019	0.015	20.162	0.015
Methylcyclohexane	0.055	0.055	0.049	66.845	0.048
2,2-Dimethylhexane	0.019	0.020	0.014	22.261	0.016
1,1,3-Trimethylcyclopentane	0.007	0.007	0.005	7.974	0.006
Unidentified	0.015	0.014	0.009	17.883	0.013
Unidentified	0.002	0.002	0.001	2.622	0.002
Ethylcyclopentane	0.280	0.277	0.248	339.904	0.244
2,2,3-Trimethylpentane	0.182	0.197	0.139	216.886	0.158
2,4-Dimethylhexane	0.263	0.286	0.201	313.833	0.229
Cyclopentane, 1,2,4-trimethyl-, (1à,2á,4à)-	0.015	0.016	0.012	18.632	0.013
3,3-Dimethylhexane	0.002	0.003	0.002	2.788	0.002
1t,2c,3-Trimethylcyclopentane	0.017	0.018	0.014	21.214	0.015
2,3,4-Trimethylpentane	2.074	2.258	1.580	2471.152	1.805
2,3,3-Trimethylpentane	2.911	3.155	2.218	3467.868	2.533
Toluene	0.007	0.006	0.006	8.518	0.006
2-Methyl-3-ethylpentane	0.588	0.634	0.448	700.245	0.511
2-Hexene, 2,5-dimethyl-	0.032	0.034	0.025	38.844	0.028
2-Methylheptane	0.110	0.119	0.084	131.104	0.096
4-Methylheptane	0.034	0.037	0.026	40.206	0.029
Hexane, 2,3,3-trimethyl-	0.062	0.066	0.042	73.942	0.054
3,4-Dimethylhexane	0.076	0.083	0.058	91.063	0.067
Unidentified	0.004	0.004	0.002	4.583	0.003
1c,2c,4-Trimethylcyclopentane	0.076	0.076	0.059	91.704	0.066
3-Ethylhexane	0.239	0.259	0.182	285.110	0.208
1,3-dimethyl-c-cyclohexane	0.071	0.071	0.055	86.383	0.062
1,1-Dimethylcyclohexane	0.016	0.016	0.012	18.865	0.014
2,2,5-Trimethylhexane	1.931	2.056	1.310	2305.595	1.681

3c-Ethylmethylcyclopentane	0.016	0.016	0.012	19.480	0.014
3t-Ethylmethylcyclopentane	0.015	0.015	0.012	18.362	0.013
1c,4-Dimethylcyclohexane	0.030	0.030	0.023	36.475	0.026
C9_I-Paraffins(1)	0.024	0.025	0.016	28.671	0.021
C8_Naphtheno-Olefins(1)	0.115	0.110	0.091	142.339	0.100
n-Octane	0.263	0.290	0.201	313.592	0.229
Cyclohexane c&t, 1,4-dimethyl-	0.116	0.115	0.090	141.006	0.101
Cyclopentene, 1,2,3-trimethyl-	0.059	0.056	0.046	72.326	0.051
2-Hexene, 3,5-dimethyl-	0.015	0.015	0.012	18.654	0.013
Unidentified	0.008	0.007	0.004	8.982	0.007
Cyclopentene, 1-(1-methylethyl)-	0.347	0.320	0.275	428.797	0.302
Cyclopentane, 1-ethyl-2-methyl-	0.006	0.006	0.004	6.725	0.005
C8_Iso-Olefins(3)	0.005	0.005	0.004	6.428	0.005
C9_I-Paraffins(3)	0.067	0.073	0.046	80.319	0.059
C8_Naphtheno-Olefins(3)	0.065	0.068	0.051	80.319	0.057
C9_Mono-Naphthenes(3)	0.002	0.001	0.001	1.884	0.001
n-Propylcyclopentane	0.278	0.273	0.216	337.813	0.242
2,6-Dimethylheptane	0.137	0.146	0.093	163.257	0.119
1-Ethyl-2-Methylcyclopentene	0.007	0.008	0.005	8.758	0.006
C8_Naphtheno-Olefins(4)	0.144	0.151	0.114	174.616	0.125
2,5-Dimethylheptane	0.221	0.235	0.150	263.492	0.192
Heptane, 3,3-dimethyl-	0.022	0.024	0.015	26.727	0.019
1,1,4-Trimethylcyclohexane	0.016	0.016	0.011	19.144	0.014
C9_Mono-Naphthenes(9)	0.030	0.030	0.021	36.187	0.026
trans-1,3-Diethylcyclopentane	0.017	0.015	0.012	20.546	0.015
C9_Mono-Naphthenes(11)	0.010	0.008	0.007	11.729	0.008
Ethylbenzene	1.203	1.072	0.986	1543.435	1.047
Unidentified	0.702	0.658	0.407	834.340	0.611
1c,2t,4t-Trimethylcyclohexane	0.180	0.182	0.124	218.221	0.157
Cyclohexane, 1,3,5-trimethyl-, (1à,3à,5á)-	0.035	0.035	0.024	42.177	0.030
m-Xylene	5.394	4.766	4.422	6918.878	4.694
p-Xylene	2.149	1.919	1.762	2757.100	1.871
3,5-Dimethylheptane	0.040	0.043	0.027	47.622	0.035
1-Heptene, 5-methyl-	0.052	0.056	0.041	63.495	0.046
C9_Mono-Naphthenes(13)	0.013	0.013	0.009	15.441	0.011
4-Ethylheptane	0.027	0.029	0.018	31.970	0.023
4-Methyloctane	0.101	0.108	0.069	121.057	0.088
2-Methyloctane	0.121	0.129	0.082	144.792	0.106
3-Hexene, 2,3-dimethyl-	0.016	0.017	0.013	19.675	0.014
Heptane, 3-ethyl-	0.086	0.091	0.058	102.537	0.075

3,4-Dimethylheptane	0.231	0.246	0.157	275.697	0.201
3-Heptyne, 5-ethyl-5-methyl-	0.003	0.003	0.002	3.483	0.002
Pentane, 2,3,3,4-tetramethyl-	0.164	0.175	0.111	196.087	0.143
1c,2t,4c-Trimethylcyclohexane	0.039	0.040	0.027	47.490	0.034
o-Xylene	1.961	1.713	1.608	2515.787	1.707
Octane, 3,4-dimethyl-	0.106	0.112	0.065	127.379	0.093
2,2,4-trimethylheptane	0.216	0.227	0.132	258.759	0.188
Cyclopentane, 1-methyl-2-propyl-	0.059	0.059	0.041	72.178	0.052
1-Ethyl-4-methylcyclohexane	0.163	0.163	0.113	197.804	0.142
cis-1-Ethyl-3-methyl-cyclohexane	0.068	0.068	0.047	82.672	0.059
Octane, 3,3-dimethyl-	0.218	0.228	0.133	260.774	0.190
t-Nonene-3	0.011	0.012	0.008	13.809	0.010
Cyclohexane, 1-ethyl-2-methyl-, cis-	0.022	0.022	0.015	27.131	0.019
C10_Iso-Olefins(1)	0.006	0.006	0.004	7.173	0.005
2-Methyl-2-octene	0.020	0.021	0.014	24.034	0.017
Heptane, 3,3,5-trimethyl-	0.136	0.143	0.083	162.960	0.119
n-Nonane	0.471	0.505	0.320	562.868	0.410
1,1-Methylethylcyclohexane	0.100	0.099	0.069	120.980	0.087
i-Butylcyclohexane	0.006	0.006	0.004	7.390	0.005
Cyclohexane, 1-ethyl-4-methyl-, trans-	0.017	0.017	0.012	20.563	0.015
i-Propylbenzene	0.028	0.025	0.020	35.977	0.025
C9_Mono-Naphthenes(23)	0.061	0.061	0.042	73.824	0.053
Propylcyclohexane	0.021	0.020	0.014	25.054	0.018
Heptane, 2,3,5-trimethyl-	0.098	0.104	0.060	117.820	0.086
C10_I-Paraffins(5)	0.024	0.026	0.015	29.001	0.021
Heptane, 2,4,6-trimethyl-	0.019	0.020	0.012	23.084	0.017
Cyclohexene,1-propyl-	0.007	0.006	0.005	8.372	0.006
1,6-Octadiene, 2,5-dimethyl-, (E)-	0.004	0.004	0.002	4.546	0.003
C9_Mono-Naphthenes(25)	0.022	0.021	0.015	26.489	0.019
C9_Mono-Naphthenes(27)	0.051	0.048	0.035	61.329	0.044
C10_I-Paraffins(9)	0.039	0.042	0.024	47.131	0.034
2,3,6-trimethylheptane	0.084	0.088	0.051	100.106	0.073
2,7-dimethyloctane	0.009	0.009	0.005	10.536	0.008
C10_Mono-Naphthenes(1)	0.001	0.001	0.001	1.180	0.001
2,6-Dimethyloctane	0.043	0.045	0.026	51.726	0.038
Hexane, 3,3,4-trimethyl-	0.002	0.003	0.002	2.988	0.002
Unidentified	0.002	0.002	0.001	2.801	0.002
n-Propylbenzene	0.443	0.394	0.321	565.123	0.386
3-Methyl-5-ethylheptane	0.013	0.014	0.008	15.579	0.011

Cyclopentane, 2-isopropyl-1,3-dimethyl-	0.005	0.005	0.003	6.058	0.004
1-Octene, 3-methyl-	0.005	0.005	0.003	5.473	0.004
1-Methyl-3-ethylbenzene	1.610	1.427	1.165	2051.281	1.401
1-Methyl-4-ethylbenzene	0.758	0.677	0.549	965.971	0.660
1,5-Heptadiene, 2,6-dimethyl-	0.003	0.003	0.002	4.034	0.003
C10_I-Paraffins(13)	0.005	0.005	0.003	5.841	0.004
1,3,5-Trimethylbenzene	0.912	0.812	0.660	1162.488	0.794
5-Methylnonane	0.010	0.010	0.006	11.368	0.008
4-Methylnonane	0.925	0.503	0.566	1106.935	0.805
1-Methyl-2-ethylbenzene	0.663	0.579	0.480	845.081	0.577
Cyclopentane, 1-methyl-3-(2-methylpropyl)-	0.007	0.008	0.005	8.895	0.006
3-Ethyloctane	0.007	0.007	0.004	7.848	0.006
3-Octyne, 2,2-dimethyl-	0.000	0.000	0.000	0.421	0.000
3-Methylnonane	0.037	0.038	0.022	43.798	0.032
Heptane, 2,2,3,5-tetramethyl-	0.241	0.253	0.134	288.646	0.210
C10_Mono-Naphthenes(7)	0.007	0.007	0.004	8.599	0.006
Benzene, 2-propenyl-	0.082	0.070	0.061	106.713	0.072
1,2,4-Trimethylbenzene	3.014	2.645	2.182	3840.925	2.623
C10_I-Paraffins(17)	0.112	0.117	0.069	134.104	0.098
C11_I-Paraffins(2)	0.071	0.073	0.039	84.402	0.061
C10_I-Paraffins(18)	0.011	0.011	0.006	12.570	0.009
Cyclopentane, 1-methyl-3-(1-methylethyl)-	0.309	0.297	0.213	375.478	0.269
Octane, 2,3,3-trimethyl-	0.126	0.132	0.070	150.410	0.109
2,2,3-trimethyloctane	0.020	0.022	0.011	24.109	0.018
i-Butylbenzene	0.155	0.138	0.100	196.055	0.135
sec-Butylbenzene	0.071	0.064	0.046	90.096	0.062
n-Decane	0.043	0.045	0.026	50.976	0.037
C11_I-Paraffins(4)	0.038	0.041	0.021	45.091	0.033
Octane, 6-ethyl-2-methyl-	0.004	0.004	0.002	5.026	0.004
1,2,3-Trimethylbenzene	0.583	0.501	0.422	743.456	0.508
1-Methyl-3-i-propylbenzene	0.108	0.096	0.070	136.624	0.094
1-Methyl-4-i-propylbenzene	0.039	0.035	0.025	49.630	0.034
C11_I-Paraffins(7)	0.055	0.057	0.030	65.571	0.048
Unidentified	0.004	0.004	0.003	5.126	0.004
C11_I-Paraffins(8)	0.024	0.025	0.014	29.131	0.021
Indan	0.209	0.161	0.154	271.013	0.182
C11_I-Paraffins(10)	0.024	0.025	0.014	29.122	0.021
C11_I-Paraffins(12)	0.009	0.009	0.005	10.581	0.008
1-Methyl-2-i-propylbenzene	0.014	0.012	0.009	17.147	0.012

2,5,6-Trimethyloctane	0.226	0.233	0.126	270.278	0.196
C11_I-Paraffins(13)	0.010	0.010	0.005	11.796	0.009
Heptane, 5-ethyl-2,2,3-trimethyl-	0.049	0.051	0.025	59.123	0.043
Undecane, 2-methyl-	0.004	0.005	0.002	5.298	0.004
1,3-Diethylbenzene	0.242	0.216	0.157	307.136	0.211
1-Methyl-3-n-propylbenzene	0.372	0.331	0.241	472.066	0.324
1-Methyl-4-n-propylbenzene	0.257	0.229	0.167	326.159	0.224
1,4-Diethylbenzene	0.116	0.104	0.075	147.518	0.101
1,3-Dimethyl-5-ethylbenzene	0.381	0.338	0.247	482.646	0.331
1,2-Diethylbenzene	0.036	0.032	0.024	46.232	0.032
C10_Mono-Aromatics(2)	0.026	0.022	0.017	32.334	0.022
C11_I-Paraffins(17)	0.019	0.019	0.010	22.368	0.016
1-Methyl-2-n-propylbenzene	0.172	0.153	0.111	217.680	0.149
C10_I-Paraffins(20)	0.012	0.013	0.007	14.608	0.011
Decane, 5-methyl-	0.040	0.041	0.022	47.310	0.034
C9_Mono-Aromatics(1)	0.004	0.003	0.003	5.128	0.004
Decane, 4-methyl-	0.039	0.041	0.022	46.959	0.034
1,4,Dimethyl-2-ethylbenzene	0.456	0.404	0.296	578.327	0.397
Benzene, (2-methyl-1-propenyl)-	0.536	0.457	0.353	689.690	0.466
Decane, 3-methyl-	0.049	0.050	0.027	58.092	0.042
1,2-Dimethyl-4-ethylbenzene	1.148	1.017	0.744	1454.783	0.999
Indan, 1-methyl-	0.040	0.032	0.026	51.784	0.035
Unidentified	0.046	0.043	0.026	54.253	0.040
1-Methyl-4-t-butylbenzene	0.103	0.092	0.060	129.702	0.089
C11_I-Paraffins(22)	0.021	0.021	0.012	24.857	0.018
Unidentified	0.053	0.050	0.031	63.175	0.046
Cyclopropane, 1,2-dimethyl-1-pentyl-	0.033	0.031	0.020	39.969	0.029
1-Undecene, 7-methyl-	0.013	0.014	0.007	16.263	0.012
1-Octene, 6-methyl-	0.051	0.056	0.035	62.366	0.045
C9_Iso-Olefins(5)	0.062	0.068	0.043	75.125	0.054
1-Ethyl-3-i-propylbenzene	0.183	0.156	0.107	231.027	0.159
1,2-Dimethyl-3-ethylbenzene	0.599	0.531	0.388	759.049	0.521
Unidentified	0.037	0.035	0.022	44.464	0.033
1-Ethyl-2-i-propylbenzene	0.030	0.026	0.018	37.800	0.026
C12_I-Paraffins(2)	0.125	0.129	0.064	150.184	0.109
n-Undecane	0.575	0.597	0.320	688.397	0.500
4,7-Methano-1H-indene, octahydro-	0.021	0.017	0.014	27.474	0.018
1-Ethyl-4-i-propylbenzene	1.555	1.389	0.913	1962.519	1.353
1,2,4,5-Tetramethylbenzene	2.243	1.942	1.455	2843.259	1.952

trans-4a-Methyl-decahydronaphthalene	0.019	0.014	0.011	22.755	0.016
C11_Mono-Aromatics(2)	0.046	0.041	0.027	58.002	0.040
1-t-Butyl-2-methylbenzene	0.017	0.015	0.010	21.190	0.015
Unidentified	0.086	0.080	0.050	101.693	0.074
1H-Indene,2,3-dihydro-2,2-dime	0.045	0.037	0.027	57.874	0.039
C11_I-Paraffins(24)	0.026	0.027	0.014	30.607	0.022
C11_I-Paraffins(25)	0.085	0.088	0.047	101.184	0.074
Nonane, 4,5-dimethyl-	0.029	0.030	0.016	34.585	0.025
C11_Mono-Aromatics(4)	0.010	0.008	0.006	12.208	0.008
C12_I-Paraffins(4)	0.035	0.036	0.018	41.510	0.030
4-Methylindan	1.191	0.934	0.784	1533.942	1.037
C11_Mono-Naphthenes(1)	0.018	0.019	0.010	21.801	0.016
Benzene, 1,3-diethyl-5-methyl-	0.328	0.291	0.192	413.478	0.285
C11_Mono-Aromatics(5)	0.092	0.082	0.054	115.970	0.080
Benzene, 1-(1,1-dimethylethyl)-3-methyl-	0.523	0.468	0.307	659.793	0.455
1H-Indene, 1-methyl-	0.130	0.112	0.087	169.342	0.113
2-Methylindan	1.063	0.856	0.700	1368.638	0.925
1,3-Dimethyl-2-ethylbenzene	1.143	1.013	0.741	1448.466	0.994
C11_Mono-Naphthenes(2)	0.036	0.037	0.020	43.143	0.031
Benzene, 1,4-dimethyl-2-(1-methylethyl)-	0.105	0.093	0.061	132.515	0.091
n-Pentylbenzene	0.251	0.224	0.147	316.865	0.218
1,4-diethyl-2-methylbenzene	0.281	0.249	0.165	354.145	0.244
Benzene, 1-ethyl-3-(1-methylethyl)-	0.205	0.183	0.120	258.776	0.178
C10_I-Paraffins(21)	0.067	0.069	0.041	80.306	0.058
Benzene, (1,1-dimethylpropyl)-	0.249	0.223	0.146	313.974	0.216
2,4-diethyl-1-methylbenzene	0.290	0.258	0.170	366.513	0.253
Decane, 4-ethyl-	0.070	0.054	0.036	83.919	0.061
C11_Mono-Aromatics(8)	0.031	0.027	0.018	39.669	0.027
Undecane, 2,7-dimethyl-	0.054	0.055	0.025	64.396	0.047
1-methyl-4-(1-methylpropyl)be	0.372	0.333	0.219	470.120	0.324
Naphthalene	0.228	0.169	0.155	302.526	0.198
1-t-Butyl-3,5-dimethylbenzene	0.049	0.044	0.026	61.362	0.042
C12_I-Paraffins(9)	0.010	0.010	0.005	11.868	0.009
1H-Indene, 2,3-dihydro-1,3-dimethyl-	0.021	0.017	0.012	26.628	0.018
C12_I-Paraffins(10)	0.022	0.023	0.011	26.103	0.019
4,7-Dimethyl Indane	0.094	0.075	0.056	120.244	0.082
1,1-Dimethyl Indane	0.026	0.021	0.015	32.726	0.022

1t-Butyl-4-ethylbenzene	0.108	0.097	0.058	135.563	0.094
C12_Indanes(1)	0.006	0.005	0.003	7.687	0.005
1,3-Di-n-propylbenzene	0.183	0.164	0.098	229.673	0.159
Benzene, 1,3-dimethyl-5-(1-methylethyl)-	0.095	0.084	0.056	119.348	0.082
4-Octene, 2,3,6,7-tetramethyl-	0.018	0.019	0.009	22.028	0.016
C11_Mono-Aromatics(9)	0.004	0.003	0.002	4.910	0.003
n-Dodecane	0.241	0.248	0.123	289.408	0.210
Benzene, (3,3-dimethylbutyl)-	0.014	0.012	0.007	17.335	0.012
C12_Mono-Aromatics(4)	0.002	0.001	0.001	1.986	0.001
Benzene, 2,4-dimethyl-1-(1-methylethyl)-	0.003	0.003	0.002	4.127	0.003
n-propyl indane	0.013	0.011	0.007	17.149	0.012
C11_Mono-Aromatics(14)	0.035	0.032	0.021	44.463	0.031
1,3,5-trimethyl-2-propylbenze	0.007	0.007	0.004	9.246	0.006
Unidentified	0.003	0.003	0.002	3.693	0.003
Unidentified	0.005	0.005	0.003	6.187	0.005
2-Ethyl-2,3-dihydro-1H-indene	0.004	0.003	0.002	5.048	0.003
1H-Indene, 1-ethyl-2,3-dihydro-	0.008	0.007	0.005	10.393	0.007
C12_Mono-Aromatics(5)	0.003	0.002	0.002	3.630	0.003
C12_Mono-Aromatics(6)	0.003	0.003	0.002	3.657	0.003
Benzene, (1-ethyl-1-methylpropyl)-	0.004	0.004	0.002	5.368	0.004
C11_Indanes(1)	0.023	0.018	0.013	29.252	0.020
Benzene, (1-methylpentyl)-	0.001	0.001	0.000	1.084	0.001
n-Hexylbenzene	0.001	0.001	0.001	1.501	0.001
1-H-Indene,1-3-dimethyl	0.013	0.011	0.008	17.457	0.012
1H-Indene, 2,3-dihydro-5,6-dimethyl-	0.006	0.005	0.003	7.476	0.005
Unidentified	0.001	0.001	0.000	0.933	0.001
C12_Mono-Aromatics(10)	0.002	0.002	0.001	2.768	0.002
Pentamethylbenzene	0.058	0.052	0.034	73.778	0.051
C12_Indanes(6)	0.000	0.000	0.000	0.536	0.000
2-Methylnaphthalene	0.307	0.231	0.188	404.239	0.267
C12_Mono-Aromatics(16)	0.005	0.004	0.003	5.998	0.004
1-Methylnaphthalene	0.165	0.126	0.101	216.693	0.143
Naphthalene, 6-ethyl-1,2,3,4-tetrahydro-	0.002	0.002	0.001	2.971	0.002
Naphthalene, 1-ethyl-1,2,3,4-tetrahydro-	0.001	0.001	0.000	0.904	0.001
Naphthalene, 1,2,3,4-tetrahydro-6-propyl-	0.002	0.002	0.001	2.782	0.002
C12_Mono-Aromatics(17)	0.001	0.001	0.001	1.838	0.001
C13_I-Paraffins(4)	0.001	0.001	0.001	1.513	0.001

Benzene, 1,2,4-trimethyl-5-(1-methylethyl)-	0.001	0.001	0.000	0.946	0.001
1,1'-Biphenyl	0.008	0.006	0.005	10.608	0.007
Decane, 2,3,5-trimethyl-	0.018	0.018	0.009	21.804	0.016
2-Ethylnaphthalene	0.014	0.011	0.008	18.142	0.012
n-Tetradecane	0.027	0.027	0.012	32.323	0.023
Naphthalene,2,6 dimethyl	0.000	0.000	0.000	0.032	0.000
Naphthalene,2,7 dimethyl	0.023	0.018	0.013	30.094	0.020
1H-Indene, 2,3-dihydro-1,1,6-trimethyl-	0.001	0.001	0.000	1.102	0.001
Naphthalene,1,7-dimethyl	0.029	0.022	0.016	38.036	0.025
Naphthalene, 1,3-dimethyl-	0.029	0.022	0.016	38.036	0.025
Naphthalene, 1,6-dimethyl-	0.029	0.023	0.016	38.548	0.026
Naphthalene-1,4-dimethyl	0.011	0.009	0.006	14.681	0.010
Naphthalene, 2,3-dimethyl-	0.011	0.009	0.006	14.681	0.010
Naphthalene, 1,5-dimethyl-	0.006	0.005	0.003	7.718	0.005
Naphthalene, 1,2-dimethyl-	0.015	0.011	0.008	19.768	0.013
1,1'-Biphenyl, 3-methyl-	0.017	0.013	0.009	22.572	0.015
Octane, 3,4,5,6-tetramethyl-	0.002	0.002	0.001	2.196	0.002
1,1'-Biphenyl, 4-methyl-	0.014	0.011	0.007	18.283	0.012
Naphthalene, 1-propyl-	0.002	0.002	0.001	2.484	0.002
Unidentified	0.002	0.002	0.001	2.259	0.002
n-Pentadecane	0.002	0.002	0.001	2.032	0.001
Naphthalene, 2,3,6-trimethyl-	0.010	0.008	0.005	13.033	0.009
Unidentified	0.003	0.003	0.002	4.082	0.003
Unidentified	0.002	0.002	0.001	2.786	0.002
C13_Naphthalenes(1)	0.005	0.004	0.003	6.476	0.004
Unidentified	0.003	0.003	0.002	3.291	0.002
Unidentified	0.002	0.002	0.001	2.633	0.002
Naphthalene, 1,4,6-trimethyl-	0.010	0.008	0.005	13.482	0.009
Naphthalene, 1,4,5-trimethyl-	0.014	0.011	0.007	18.768	0.013
C13_Naphthalenes(4)	0.008	0.006	0.004	9.768	0.007
C13_Naphthalenes(5)	0.007	0.005	0.003	8.797	0.006
Naphthalene, 2-(1-methylethyl)-	0.003	0.002	0.001	3.698	0.003
Naphthalene, 1,6,7-trimethyl-	0.004	0.003	0.002	4.699	0.003
4-Ethylbiphenyl	0.006	0.005	0.003	8.336	0.006
Unidentified	0.003	0.003	0.002	3.974	0.003
3,3'-Dimethylbiphenyl	0.011	0.008	0.005	14.477	0.010
1,1'-Biphenyl, 2,4'-dimethyl-	0.002	0.002	0.001	2.603	0.002
Unidentified	0.009	0.008	0.005	10.702	0.008
Unidentified	0.000	0.000	0.000	0.399	0.000
4,4'-Dimethylbiphenyl	0.001	0.001	0.001	1.729	0.001
Naphthalene, 2,6-diethyl	0.003	0.002	0.001	3.974	0.003
C14_Mono-Aromatics(1)	0.006	0.005	0.003	8.447	0.006

1,4,6,7-tetramethylnaphthalene	0.001	0.001	0.000	1.312	0.001

AVERAGE_SG	BP(K)	DBE	PMI
0	111.65	0	0
0	111.65	0	0
0.013	261.45	0	0.000249
0	338.15	0	0
0	271.453	0	0
0	272.65	0	0.000002
0	280.35	0	0
0.112	351.65	0	0.01712
0.057	303.15	0	0.002956
0.001	302.25	2	0.000087
0.001	308.35	0	0.000047
0	307.25	2	0.000034
0.025	321.55	0	0.001943
0	331.5	1	0.000018
0.062	322.45	1	0.009859
0	331.85	0	0
0	332.75	0	0.000019
0	329.15	2	0.000005
0	335.85	0	0
0.04	335.15	1	0.008376
0	341.85	0	0.000041
0	338.75	1	0.000005
0	341.05	1	0.000016
0	340.85	1	0.000007
0	340.84	1	0.000002
0	351.05	0	0
0	351.05	0	0
0	344.95	1	0.000006
0	353.65	0	0.000004
0	352.45	1	0.000002
0	353.25	0	0
0	353.85	1	0.00001
0	363.25	0	0.000012
0	362.95	0	0.000021
0	363.85	0	0.000013
0	364.85	1	0.000004
0	363.95	1	0.000003
0.029	371.15	0	0.006797
0	371.55	0	0.000031
0	374.05	1	0.000214
0	378.85	0	0.00004

0	378.05	1	0.000028
0	379.95	0	0
0	399.85	0	0
0.002	376.65	1	0.001152
0.001	383.05	0	0.000433
0.002	382.55	0	0.00062
0	389.45	1	0.000085
0	384.25	0	0.000006
0	389.45	1	0.000096
0.016	386.65	0	0.005362
0.022	387.95	0	0.007753
0	383.75	4	0.00008
0.005	388.15	0	0.001573
0	387.45	1	0.000169
0.001	390.85	0	0.000313
0	390.15	0	0.000095
0	411.05	0	0.000283
0.001	389.75	0	0.000212
0	388.38	0	0
0.001	388.38	1	0.000407
0.002	390.65	0	0.000678
0.001	393.25	1	0.000429
0	391.15	1	0.000089
0.015	397.25	0	0.006378
0	393.05	1	0.000096
0	393.05	1	0.000091
0	399.047	1	0.000207
0	406.15	0	0.000098
0.001	403.95	2	0.001335
0.002	398.15	0	0.000888
0.001	394.25	1	0.000716
0	393.55	2	0.000532
0	386.04	1	0.000078
0	379.55	0	0
0.003	399.15	2	0.003594
0	397.25	1	0.000037
0	419.75	1	0.00006
0.001	405.85	0	0.000272
0	391.05	2	0.000558
0	402.85	1	0.000012
0.002	404.15	1	0.002161
0.001	408.35	0	0.000586
0	408.25	0	0.000031
0.001	391.05	2	0.001235
0.002	408.95	0	0.000959
0	410.25	0	0.0001

0	408.15	1	0.000135
0	408.15	1	0.000254
0	417.55	1	0.00018
0	417.55	1	0.000103
0.009	409.35	4	0.026383
0.005	409.35	0	0
0.001	416.15	1	0.001854
0	412.649	1	0.00033
0.041	411.15	4	0.123415
0.017	412.76	4	0.051093
0	409.15	0	0.000174
0	385.55	1	0.000264
0	408.15	1	0.000108
0	414.35	0	0.000132
0.001	414.75	0	0.000505
0.001	416.45	0	0.00063
0	387.45	1	0.000085
0.001	416.15	0	0.000443
0.002	413.75	0	0.001124
0	428.45	2	0.000059
0.001	414.45	0	0.000811
0	412.649	1	0.000371
0.015	416.15	4	0.050537
0.001	436.35	0	0.000895
0.002	422.35	0	0.001293
0	422.05	1	0.000706
0.001	423.95	1	0.002026
0.001	423.95	1	0.000847
0.002	434.15	0	0.001736
0	418.85	1	0.000125
0	429.15	1	0.000315
0	420.15	1	0.000067
0	420.15	1	0.000225
0.001	428.95	0	0.000956
0.004	424.85	0	0.002994
0.001	425.35	1	0.001282
0	444.45	1	0.000125
0	423.95	1	0.000211
0	425.55	4	0.000912
0	423.95	1	0.000756
0	428.15	1	0.000284
0.001	431.05	0	0.000727
0	419.8167	0	0.000136
0	422.15	0	0.000115
0	432.35	2	0.000155
0	428.48	2	0.000077

0	418.35	1	0.000237
0	425.35	1	0.00065
0	433.55	0	0.000309
0.001	430.05	0	0.000603
0	431.65	0	0.000066
0	444.45	1	0.00002
0	432.85	0	0.000334
0	412.75	0	0.000012
0	441.35	0	0
0.003	433.65	4	0.017444
0	432.55	0	0.0001
0	433.7	1	0.000079
0	410.75	1	0.000041
0.012	434.45	4	0.064572
0.006	435.15	4	0.030935
0	414.45	2	0.000049
0	436.35	0	0.000041
0.007	439.85	4	0.041808
0	438.25	0	0.000084
0.007	439.15	0	0.008337
0.005	437.15	4	0.02843
0	422.5945	1	0.000088
0	439.65	0	0.00006
0	428.45	2	0.000007
0	440.95	0	0.000345
0.002	446.97	0	0.002642
0	444.15	1	0.000145
0.001	440.65	5	0.004619
0.023	441.15	4	0.142665
0.001	440.95	0	0.001056
0.001	445.45	0	0.000744
0	440.95	0	0.000099
0.002	415.49	1	0.00314
0.001	447.41	0	0.001392
0	452.75	0	0.000255
0.001	448.55	4	0.00881
0.001	446.45	4	0.00384
0	448.05	0	0.000479
0	452.75	0	0.000477
0	450.2	0	0.00005
0.004	448.15	4	0.032896
0.001	448.25	4	0.006093
0	449.15	4	0.002264
0	457.15	0	0.000776
0	457.15	0	0
0	457.15	0	0.000345

0.002	449.65	5	0.014704
0	452.55	0	0.000307
0	457.15	0	0.000125
0	451.35	4	0.000827
0.002	449.76	0	0.002651
0	457.15	0	0.00014
0	469.85	0	0.000973
0	482.05	0	0.000121
0.002	454.85	4	0.016189
0.003	456.85	4	0.026186
0.002	457.35	4	0.018325
0.001	446.45	4	0.006288
0.003	457.75	4	0.027397
0	456.65	4	0.002551
0	456.65	4	0.001784
0	457.15	0	0.000265
0.001	459.65	4	0.012974
0	432.85	0	0.000094
0	459.25	0	0.000591
0	449.25	4	0.000233
0	460.55	0	0.000607
0.004	460.05	4	0.034827
0.004	461.05	5	0.050353
0	462.25	0	0.000784
0.009	462.65	4	0.093688
0	466.55	5	0.004334
0	466.55	0	0
0.001	465.95	4	0.009139
0	457.15	0	0.000294
0	430.51	0	0
0	430.51	1	0.00048
0	478.15	1	0.000658
0	410.75	1	0.000466
0	410.75	1	0.000561
0.001	476.35	4	0.021411
0.005	465.15	4	0.052159
0	476.35	0	0
0	476.35	4	0.003503
0.001	482.35	0	0.003447
0.004	469.05	0	0.01109
0	448.0167	3	0.000954
0.012	470.15	4	0.154354
0.017	469.15	4	0.216903
0	470.85	2	0.001138
0	463.45	4	0.00383
0	463.45	4	0.001399

0.001	472.05	0	0
0	474.25	5	0.006001
0	457.15	0	0.000362
0.001	457.15	0	0.001198
0	457.15	0	0.000409
0	467.15	4	0.000888
0	457.15	0	0.000491
0.009	479.25	5	0.180735
0	457.15	0	0.000258
0.003	475.95	4	0.037914
0.001	475.95	4	0.010634
0.004	461.95	4	0.041906
0.001	465.76	6	0.016049
0.008	467.65	5	0.118607
0.009	463.25	4	0.094742
0	457.15	0	0.000511
0.001	469.35	4	0.010162
0.002	478.55	4	0.031144
0.002	479.85	4	0.036043
0.002	465.65	4	0.018092
0.001	489.45	0	0.002238
0.002	463.15	4	0.020571
0.002	479.05	4	0.036509
0.001	473.52	0	0.001521
0	483.15	4	0.004413
0	495.96	0	0.002142
0.003	469.05	4	0.035923
0.002	494.65	7	0.070206
0	481.05	4	0.00647
0	470.15	0	0.000197
0	481.85	5	0.003383
0	470.15	0	0.000432
0.001	499.75	5	0.025018
0	464.15	5	0.002603
0.001	484.65	4	0.015756
0	451.05	5	0.000439
0.001	476.15	4	0.02124
0.001	467.05	4	0.008654
0	476.36	1	0.00085
0	467.05	4	0.000356
0.002	488.15	0	0.007769
0	497.41	4	0.002855
0	480.85	4	0.000208
0	472.55	4	0.000346
0	507.15	5	0.004423
0	465.95	4	0.003133

0	505.25	4	0.001907
0	453.45	0	0
0	488.35	0	0
0	488.35	5	0.000765
0	495.15	5	0.001901
0	477.15	4	0.000345
0	477.15	4	0.000347
0	478.15	4	0.000524
0	451.05	5	0.001644
0	481.15	4	0.000115
0	499.15	4	0.00026
0	502.05	6	0.00447
0	500.75	5	0.0016
0	495.52	0	0
0	493.45	5	0.000485
0	502.15	4	0.013885
0	451.05	5	0.00003
0.002	513.15	7	0.160045
0	477.15	4	0.00057
0.001	513.05	7	0.085543
0	519.75	5	0.001096
0	512.85	5	0.000272
0	537.95	5	0.00181
0	477.15	4	0.000175
0	495.52	0	0.00005
0	492.15	4	0.000135
0	528.15	8	0.00739
0	495.52	0	0.000717
0	530.9278	7	0.012299
0	525.15	0	0.002502
0	535.15	7	0.000025
0	536.15	7	0.023965
0	273.15	5	0.000001
0	535.65	7	0.029823
0	536.15	7	0.03029
0	537.15	7	0.031667
0	541.6	7	0.013866
0	542.05	7	0.014065
0	538.75	7	0.006665
0	541.15	7	0.018407
0	545.85	8	0.027287
0	472.2	0	0.000038
0	540.95	8	0.018919
0	548.45	7	0.002965
0	543.75	0	0
0	543.75	0	0.00028

0	536.65	7	0.010709
0	536.65	0	0
0	540	0	0
0	540	7	0.005909
0	557.85	0	0
0	554.25	0	0
0	554.25	7	0.019436
0	563.45	7	0.036385
0	559.95	7	0.017004
0	540	7	0.007948
0	540	7	0.003375
0	559.95	7	0.00818
0	564.2	8	0.018426
0	562.4667	0	0
0	562.4667	8	0.030182
0	554	8	0.004097
0	554	0	0
0	568	0	0
0	568	8	0.004349
0	567.75	7	0.009006
0	554	8	0.013293
0	576.05	7	0.003947

4.) CE30 TR2340A

TIME	CASNO	RI	GROUP	CARBON#
6.522		186.54	Unidentified	0
8.248	75-28-5	371.24	I-Paraffins	4
8.377		376.14	Unidentified	0
9.197	106-97-8	400	Paraffin	4
9.667	463-82-1	415.55	I-Paraffins	5
11.862	64-17-5	464.49	Oxygenates	2
12.762	78-78-4	478.48	I-Paraffins	5
12.847	591-93-5	479.69	Di-Olefins	5
14.473	109-66-0	500	Paraffin	5
14.578	78-79-5	501.95	Di-Olefins	5
15.948	513-35-9	525.15	Iso-Olefins	5
17.013	75-83-2	540.89	I-Paraffins	6
18.733	691-37-2	563.11	Iso-Olefins	6
19.15	287-92-3	568	Mono-Naphthenes	5
19.285		569.55	Unidentified	0
19.662	107-83-5	573.79	I-Paraffins	6
20.782		585.69	Unidentified	0

21.38	592-41-6	591.67	n-Olefins	6
22.258	110-54-3	600	Paraffin	6
22.512	13269-52-8	603.09	n-Olefins	6
22.727	4050-45-7	605.67	n-Olefins	6
23.17	922-62-3	610.88	Iso-Olefins	6
23.532	7688-21-3	615.03	n-Olefins	6
24.095	922-61-2	621.31	Iso-Olefins	6
24.403		624.67	Unidentified	0
24.583	96-37-7	626.6	Mono-Naphthenes	6
24.972	108-08-7	630.7	I-Paraffins	7
25.41	594-56-9	635.22	Iso-Olefins	7
27.093		651.65	Unidentified	0
27.445	562-49-2	654.91	I-Paraffins	7
27.887	110-82-7	658.92	Mono-Naphthenes	6
28.882	591-76-4	667.67	I-Paraffins	7
29.053	565-59-3	669.13	I-Paraffins	7
29.385	1638-26-2	671.94	Mono-Naphthenes	7
29.883	589-34-4	676.08	I-Paraffins	7
30.663	1759-58-6	682.38	Mono-Naphthenes	7
31.008	2532-58-3	685.1	Mono-Naphthenes	7
31.162	617-78-7	686.3	I-Paraffins	7
31.52	540-84-1	689.06	I-Paraffins	8
32.037		692.98	Unidentified	0
32.988	142-82-5	700	Paraffin	7
35.945	108-87-2	718.83	Mono-Naphthenes	7
36.225	590-73-8	720.52	I-Paraffins	8
36.373	4516-69-2	721.4	Mono-Naphthenes	8
36.775		723.78	Unidentified	0
37.453		727.72	Unidentified	0
37.895	1640-89-7	730.24	Mono-Naphthenes	7
38.095	564-02-3	731.36	I-Paraffins	8
38.23	589-43-5	732.12	I-Paraffins	8
39.255	16883-48-0	737.77	Mono-Naphthenes	8
39.46	563-16-6	738.88	I-Paraffins	8
40.605	15890-40-1	744.94	Mono-Naphthenes	8
41.132	565-75-3	747.66	I-Paraffins	8

41.975	560-21-4	751.93	I-Paraffins	8
42.265	108-88-3	753.38	Mono-Aromatics	7
43.27	609-26-7	758.3	I-Paraffins	8
43.52	3404-78-2	759.5	Iso-Olefins	8
44.528	592-27-8	764.26	I-Paraffins	8
44.86	589-53-7	765.8	I-Paraffins	8
45.108	16747-28-7	766.95	I-Paraffins	9
45.257	583-48-2	767.63	I-Paraffins	8
45.883		770.47	Unidentified	0
46.215	2815-58-9	771.96	Mono-Naphthenes	8
46.643	619-99-8	773.86	I-Paraffins	8
47.077	638-04-0	775.76	Mono-Naphthenes	8
48.412	590-66-9	781.5	Mono-Naphthenes	8
48.832	3522-94-9	783.27	I-Paraffins	9
49.268	2613-66-3	785.08	Mono-Naphthenes	8
49.808	3726-47-4	787.31	Mono-Naphthenes	8
50.143	624-29-3	788.67	Mono-Naphthenes	8
50.482		790.04	I-Paraffins	9
51.418		793.77	Naphtheno-Olefins	8
53.027	111-65-9	800	Paraffin	8
53.415	589-90-2	801.55	Mono-Naphthenes	8
54.932	473-91-6	807.46	Naphtheno-Olefins	8
55.363	3404-79-3	809.11	Iso-Olefins	8
57.175		815.88	Unidentified	0
57.853	1462-07-3	818.35	Naphtheno-Olefins	8
58.542	3726-46-3	820.82	Mono-Naphthenes	8
58.987		822.41	Iso-Olefins	8
60.413		827.39	I-Paraffins	9
60.413		827.39	Naphtheno-Olefins	8
61.305		830.44	Mono-Naphthenes	9
62.243	2040-96-2	833.59	Mono-Naphthenes	8
62.663	1072-05-5	834.98	I-Paraffins	9

63.31	1068-19-5	837.11	Naphtheno-Olefins	9
64.062		839.55	Naphtheno-Olefins	8
65.043	2216-30-0	842.69	I-Paraffins	9
65.502	4032-86-4	844.14	I-Paraffins	9
65.97	7094-27-1	845.6	Mono-Naphthenes	9
66.435		847.05	Mono-Naphthenes	9
67.043		848.93	Mono-Naphthenes	9
68.642		853.76	Mono-Naphthenes	9
69.567	100-41-4	856.5	Mono-Aromatics	8
69.865	7667-60-9	857.38	Mono-Naphthenes	9
71.368	1795-27-3	861.73	Mono-Naphthenes	9
72.988	108-38-3	866.31	Mono-Aromatics	8
73.3	106-42-3	867.17	Mono-Aromatics	8
73.675	926-82-9	868.21	I-Paraffins	9
73.98	13151-04-7	869.05	Iso-Olefins	8
74.502		870.48	Mono-Naphthenes	9
74.815	2216-32-2	871.33	I-Paraffins	9
75.865	2216-34-4	874.16	I-Paraffins	9
76.21	3221-61-2	875.08	I-Paraffins	9
76.88	7145-23-5	876.86	Iso-Olefins	8
77.685	15869-80-4	878.97	I-Paraffins	9
78.25	922-28-1	880.43	I-Paraffins	9
78.677	61228-10-2	881.53	Iso-Olefins	10
79.027	16747-38-9	882.43	I-Paraffins	9
79.52	1795-26-2	883.69	Mono-Naphthenes	9
80.008	95-47-6	884.92	Mono-Aromatics	8
80.36	15869-92-8	885.81	I-Paraffins	10
80.64	14720-74-2	886.51	I-Paraffins	10
81.392	3728-57-2	888.38	Mono-Naphthenes	9
81.647	3728-56-1	889.01	Mono-Naphthenes	9

82.242	19489-10-2	890.47	Mono-Naphthenes	9
82.508	4110-44-5	891.12	I-Paraffins	10
83.087	20063-92-7	892.53	n-Olefins	9
83.498	4923-77-7	893.52	Mono-Naphthenes	9
84.852		896.75	Iso-Olefins	10
85.52	16993-86-5	898.33	Iso-Olefins	9
85.77	7154-80-5	898.91	I-Paraffins	10
86.237	111-84-2	900	Paraffin	9
86.675	4926-90-3	902.38	Mono-Naphthenes	9
87.215	1678-98-4	905.3	Mono-Naphthenes	10
87.435	6236-88-0	906.48	Mono-Naphthenes	9
88.86	98-82-8	914.05	Mono-Aromatics	9
89.23		916	Mono-Naphthenes	9
89.768	1678-92-8	918.82	Mono-Naphthenes	9
90.293	20278-85-7	921.55	I-Paraffins	10
90.67		923.49	I-Paraffins	10
90.862	2613-61-8	924.48	I-Paraffins	10
91.775		929.15	Mono-Naphthenes	9
92.313		931.89	Mono-Naphthenes	9
92.485		932.75	I-Paraffins	10
93.335	4032-93-3	937.02	I-Paraffins	10
93.625	1072-16-8	938.47	I-Paraffins	10
94.1		940.83	Mono-Naphthenes	10
94.432	2051-30-1	942.47	I-Paraffins	10
94.793	16747-31-2	944.25	I-Paraffins	9
95.242		946.45	Unidentified	0
95.558	103-65-1	948	Mono-Aromatics	9
95.913	13475-78-0	949.72	I-Paraffins	10
96.442	32281-85-9	952.28	Mono-Naphthenes	10
96.725	13151-08-1	953.64	Iso-Olefins	9
97.26	620-14-4	956.21	Mono-Aromatics	9
97.612	622-96-8	957.89	Mono-Aromatics	9

98.79	108-67-8	963.46	Mono-Aromatics	9
99.78	15869-85-9	968.09	I-Paraffins	10
100.188	17301-94-9	969.99	I-Paraffins	10
100.622	611-14-3	971.99	Mono-Aromatics	9
101	29053-04-1	973.73	Mono-Naphthenes	10
101.193	5881-17-4	974.62	I-Paraffins	10
101.808	4/6/5911	977.43	I-Paraffins	10
102.5	61868-42-6	980.57	I-Paraffins	11
103.205	300-57-2	983.74	Mono-Aromatics	9
103.532	95-63-6	985.2	Mono-Aromatics	9
103.963		987.13	I-Paraffins	10
104.122		987.83	I-Paraffins	11
104.318		988.71	I-Paraffins	10
104.358	53771-88-3	988.88	Mono-Naphthenes	9
105.627	62016-30-2	994.47	I-Paraffins	11
105.873	62016-26-6	995.55	I-Paraffins	11
106.203	538-93-2	996.99	Mono-Aromatics	10
106.675	13837-67-7	999.03	Mono-Naphthenes	10
106.898	124-18-5	1000	Paraffin	10
107.173		1001.96	I-Paraffins	11
107.478	62016-19-7	1004.14	I-Paraffins	11
108.217	526-73-8	1009.37	Mono-Aromatics	9
108.538	535-77-3	1011.63	Mono-Aromatics	10
109.035	99-87-6	1015.12	Mono-Aromatics	10
109.332		1017.19	I-Paraffins	11
109.54		1018.65	Unidentified	0
109.722		1019.91	I-Paraffins	11
110.068	496-11-7	1022.32	Indanes	9
110.373		1024.43	I-Paraffins	11
110.847		1027.69	I-Paraffins	11
111.125	527-84-4	1029.6	Mono-Aromatics	10
111.355	62016-14-2	1031.18	I-Paraffins	11
111.643		1033.15	I-Paraffins	11
112.383	62199-06-8	1038.19	I-Paraffins	12

112.658	7045-71-8	1040.05	I-Paraffins	12
112.925	141-93-5	1041.85	Mono-Aromatics	10
113.297	1074-43-7	1044.35	Mono-Aromatics	10
113.865	1074-55-1	1048.16	Mono-Aromatics	10
114.027	105-05-5	1049.24	Mono-Aromatics	10
114.353	934-74-7	1051.42	Mono-Aromatics	10
114.683	135-01-3	1053.61	Mono-Aromatics	10
114.907		1055.09	Mono-Aromatics	10
115.33		1057.89	I-Paraffins	11
115.605	1074-17-5	1059.7	Mono-Aromatics	10
115.787		1060.9	I-Paraffins	10
115.947	13151-35-4	1061.95	I-Paraffins	11
116.233		1063.82	Mono-Aromatics	9
116.49	2847-72-5	1065.5	I-Paraffins	11
117.143	1758-88-9	1069.75	Mono-Aromatics	10
117.397	768-49-0	1071.39	Mono-Aromatics	10
117.915	13151-34-3	1074.74	I-Paraffins	11
118.287	934-80-5	1077.13	Mono-Aromatics	10
118.543	767-58-8	1078.77	Indanes	10
118.758		1080.15	Unidentified	0
119.138	98-51-1	1082.58	Mono-Aromatics	11
119.445		1084.53	I-Paraffins	11
119.66		1085.89	Unidentified	0
119.835	62238-04-4	1087	Mono-Naphthenes	10
120.012	74630-42-5	1088.12	Iso-Olefins	12
120.212	13151-10-5	1089.38	Iso-Olefins	9
120.48		1091.07	Iso-Olefins	9
120.82	20024-91-3	1093.21	Mono-Aromatics	11
121.12	933-98-2	1095.09	Mono-Aromatics	10
121.297		1096.2	Unidentified	0

121.428	16021-20-8	1097.02	Mono-Aromatics	11
121.672		1098.54	I-Paraffins	12
121.907	1120-21-4	1100	Paraffin	11
122.235	6004-38-2	1102.81	Indanes	10
122.773	4218-48-8	1107.4	Mono-Aromatics	11
123.283	95-93-2	1111.73	Mono-Aromatics	10
123.452	2547-27-5	1113.16	Di/Bicyclo-Naphthenes	11
123.595		1114.37	Mono-Aromatics	11
123.732	1074-92-6	1115.52	Mono-Aromatics	11
123.895	17312-50-4	1116.9	I-Paraffins	12
124.11	20836-11-7	1118.71	Indanes	11
124.25		1119.89	I-Paraffins	11
124.407		1121.21	I-Paraffins	11
124.705	17302-23-7	1123.71	I-Paraffins	11
124.982		1126.02	Mono-Aromatics	11
125.135		1127.3	I-Paraffins	12
125.513	824-22-6	1130.45	Indanes	10
125.87		1133.41	Mono-Naphthenes	11
126.155	2050-24-0	1135.77	Mono-Aromatics	11
126.317		1137.1	Mono-Aromatics	11
126.497	1075-38-3	1138.59	Mono-Aromatics	11
126.675	767-59-9	1140.06	Indenes	10
126.873	824-63-5	1141.69	Indanes	10
127.378	4/4/2870	1145.83	Mono-Aromatics	10
127.733		1148.73	Mono-Naphthenes	11
127.945	4132-72-3	1150.46	Mono-Aromatics	11
128.135	538-68-1	1152.01	Mono-Aromatics	11
128.528	13632-94-5	1155.2	Mono-Aromatics	11
128.668	4920-99-4	1156.33	Mono-Aromatics	11
128.902		1158.22	I-Paraffins	10

129.083	2049-95-8	1159.69	Mono-Aromatics	11
129.333	1758-85-6	1161.7	Mono-Aromatics	11
129.537	1636-44-8	1163.34	I-Paraffins	12
129.855		1165.9	Mono-Aromatics	11
130.032	17301-24-5	1167.31	I-Paraffins	13
130.18	1595-16-0	1168.5	Mono-Aromatics	11
130.645	91-20-3	1172.21	Naphthalenes	10
130.837	98-19-1	1173.74	Mono-Aromatics	12
131.01		1175.12	I-Paraffins	12
131.157	4175-53-5	1176.28	Indanes	11
131.382		1178.07	I-Paraffins	12
131.705	6682-71-9	1180.62	Indanes	11
131.912	4912-92-9	1182.26	Indanes	11
132.36	7364-19-4	1185.79	Mono-Aromatics	12
132.638		1187.97	Indanes	12
132.992	99-62-7	1190.74	Mono-Aromatics	12
133.208	4706-90-5	1192.43	Mono-Aromatics	11
133.637		1195.77	Mono-Aromatics	11
134.182	112-40-3	1200	Paraffin	12
134.6	17314-92-0	1204.04	Mono-Aromatics	12
134.888		1206.81	Mono-Aromatics	12
135.167	4706-89-2	1209.48	Mono-Aromatics	11
135.362	60584-82-9	1211.35	Indanes	12
135.943		1216.91	Mono-Aromatics	11
136.237	4/2/4810	1219.7	Mono-Aromatics	12
136.508	62016-33-5	1222.28	I-Paraffins	11
136.923	56147-63-8	1226.21	Indanes	11
137.178	4830-99-3	1228.62	Indanes	11
137.44		1231.09	Mono-Aromatics	12
137.595		1232.55	Mono-Aromatics	12

138.182	55669-88-0	1238.06	Mono-Aromatics	12
138.712	1985-97-3	1243.01	Mono-Aromatics	12
138.918		1244.94	Indanes	11
140.047	2/3/6031	1255.41	Mono-Aromatics	12
140.437	2177-48-2	1259	Indanes	11
140.832	1075-22-5	1262.64	Indanes	11
141.293	62238-14-6	1266.87	I-Paraffins	13
141.775		1271.27	Mono-Aromatics	12
142.422	700-12-9	1277.15	Mono-Aromatics	11
143.045		1282.8	Indanes	12
143.485	90-12-0	1286.76	Naphthalenes	11
143.858		1290.12	Mono-Aromatics	12
145.207	91-57-6	1302.59	Naphthalenes	11
145.68		1307.59	Indanes	12
146.54	22531-20-0	1316.65	Mono-Aromatics	12
147.458	13556-58-6	1326.26	Mono-Aromatics	12
148.425	42775-77-9	1336.3	Mono-Aromatics	13
149.025		1342.5	Indanes	12
149.187		1344.17	Mono-Aromatics	12
150.333	10222-95-4	1355.93	Mono-Aromatics	12
151.748	92-52-4	1370.32	Mono-Aromatics	12
152.732		1380.23	I-Paraffins	13
153.62	62238-11-3	1389.14	I-Paraffins	13
153.862	939-27-5	1391.55	Naphthalenes	12
154.712	629-59-4	1400	Paraffin	14
154.712	581-42-0	1400	Naphthalenes	12
154.88	582-16-1	1401.91	Naphthalenes	12
155.935	14276-95-0	1413.85	Indanes	12
156.155	575-37-1	1416.33	Naphthalenes	12
156.155	575-41-7	1416.33	Naphthalenes	12
156.502	575-43-9	1420.22	Naphthalenes	12
158.06	571-58-4	1437.63	Naphthalenes	12
158.06	581-40-8	1437.63	Naphthalenes	12
158.308	571-61-9	1440.39	Naphthalenes	12

159.47	573-98-8	1453.23	Naphthalenes	12
161.153	643-58-3	1471.67	Mono-Aromatics	13
161.745	643-93-6	1478.1	Mono-Aromatics	13
162.097	62185-21-1	1481.91	I-Paraffins	12
162.6	644-08-6	1487.35	Mono-Aromatics	13
163.21	2765-18-6	1493.92	Naphthalenes	13
163.517		1497.21	Unidentified	0
163.777	629-62-9	1500	Paraffin	15
164.047	829-26-5	1502.44	Naphthalenes	13
164.49		1506.43	Unidentified	0
164.938		1510.46	Unidentified	0
165.19		1512.71	Naphthalenes	13
165.603	941-81-1	1516.41	Naphthalenes	13
165.788		1518.06	Naphthalenes	13
165.992	2131-42-2	1519.88	Naphthalenes	13
166.488	2131-41-1	1524.29	Naphthalenes	13
167.018		1529	Unidentified	0
167.855		1536.38	Naphthalenes	13
168.22		1539.59	Naphthalenes	13
169.203	2027-17-0	1548.21	Naphthalenes	13
169.392	2245-38-7	1549.85	Naphthalenes	13
169.56	5707-44-8	1551.32	Mono-Aromatics	14
170.638		1560.69	Unidentified	0
170.955	612-75-9	1563.43	Mono-Aromatics	14
171.513	611-61-0	1568.24	Mono-Aromatics	14
172		1572.43	Unidentified	0
172.748	613-33-2	1578.84	Mono-Aromatics	14
172.937	59919-41-4	1580.45	Naphthalenes	14
174.493		1593.68	Mono-Aromatics	14
178.565	13764-18-6	1627.71	Naphthalenes	14

COMPONENT	**%WGT**	**%VOL**	**%MOL**	**AREA**	**AVERAGE_MW**
Unidentified	0.000	0.000	0.000	0.128	0.000
i-Butane	2.239	3.077	3.419	1702.965	1.987
Unidentified	0.003	0.002	0.002	2.025	0.002
n-Butane	0.013	0.017	0.019	9.607	0.011

2,2-Dimethylpropane	0.002	0.003	0.002	1.516	0.002
Ethanol	10.110	9.702	19.482	16006.511	8.976
i-Pentane	9.363	11.442	11.520	7171.911	8.312
1,4-Pentadiene	0.003	0.003	0.003	2.071	0.002
n-Pentane	0.224	0.270	0.275	171.315	0.199
2-Methyl-1,3-Butadiene	0.018	0.020	0.024	14.687	0.016
2-Methylbutene-2	0.000	0.000	0.000	0.207	0.000
2,2-Dimethylbutane	3.998	4.698	4.119	3074.880	3.550
4-Methylpentene-1-trans	0.010	0.012	0.011	8.133	0.009
Cyclopentane	9.816	9.971	12.426	7734.275	8.715
Unidentified	0.002	0.002	0.001	1.855	0.002
2-Methylpentane	0.059	0.068	0.061	45.565	0.053
Unidentified	0.043	0.039	0.025	33.024	0.038
Hexene-1	6.288	7.073	6.633	4954.283	5.582
n-Hexane	0.091	0.105	0.094	70.338	0.081
t-Hexene-3	0.002	0.002	0.002	1.631	0.002
t-Hexene-2	0.010	0.012	0.011	7.960	0.009
3-Methyl-c-pentene-2	0.006	0.006	0.006	4.432	0.005
c-Hexene-2	0.001	0.001	0.001	0.966	0.001
2-Pentene, 3-methyl-	0.000	0.000	0.000	0.152	0.000
Unidentified	0.006	0.005	0.003	4.292	0.005
Methylcyclopentane	0.006	0.006	0.006	4.791	0.005
2,4-Dimethylpentane	0.006	0.007	0.005	4.712	0.005
2,3,3-Trimethylbutene-1	0.001	0.002	0.001	1.115	0.001
Unidentified	0.001	0.001	0.001	0.969	0.001
3,3-Dimethylpentane	0.001	0.001	0.001	0.927	0.001
Cyclohexane	0.010	0.009	0.010	7.681	0.009
2-Methylhexane	0.019	0.021	0.017	14.843	0.017
2,3-Dimethylpentane	0.018	0.020	0.016	14.168	0.016
1,1-Dimethylcyclopentane	0.001	0.001	0.001	0.607	0.001
3-Methylhexane	0.020	0.022	0.018	15.720	0.018
1t,3-Dimethylcyclopentane	0.002	0.002	0.002	1.828	0.002
1c,3-Dimethylcyclopentane	0.002	0.002	0.002	1.387	0.002
3-Ethylpentane	0.001	0.001	0.001	0.666	0.001
2,2,4-Trimethylpentane	4.420	4.837	3.435	3419.939	3.924
Unidentified	0.005	0.005	0.003	3.980	0.005
n-Heptane	0.029	0.033	0.026	22.568	0.026
Methylcyclohexane	0.075	0.073	0.067	58.753	0.066
2,2-Dimethylhexane	0.016	0.017	0.012	12.307	0.014
1,1,3-Trimethylcyclopentane	0.003	0.003	0.002	2.105	0.002
Unidentified	0.045	0.042	0.027	34.914	0.040
Unidentified	0.007	0.006	0.004	5.255	0.006
Ethylcyclopentane	0.288	0.280	0.260	226.612	0.255
2,2,3-Trimethylpentane	0.055	0.059	0.043	42.680	0.049
2,4-Dimethylhexane	0.112	0.120	0.087	86.643	0.099

Cyclopentane, 1,2,4-trimethyl-,(1à,2á,4à)-	0.017	0.017	0.013	13.017	0.015
3,3-Dimethylhexane	0.002	0.002	0.001	1.165	0.001
1t,2c,3-Trimethylcyclopentane	0.021	0.021	0.017	16.441	0.019
2,3,4-Trimethylpentane	2.413	2.588	1.875	1866.777	2.142
2,3,3-Trimethylpentane	3.378	3.607	2.625	2613.417	2.999
Toluene	0.009	0.008	0.008	7.196	0.008
2-Methyl-3-ethylpentane	0.661	0.702	0.513	511.071	0.586
2-Hexene, 2,5-dimethyl-	0.021	0.022	0.017	16.746	0.019
2-Methylheptane	0.128	0.137	0.100	99.362	0.114
4-Methylheptane	0.032	0.034	0.025	24.818	0.028
Hexane, 2,3,3-trimethyl-	0.016	0.017	0.011	12.537	0.014
3,4-Dimethylhexane	0.021	0.022	0.016	16.032	0.018
Unidentified	0.003	0.003	0.002	2.285	0.003
1c,2c,4-Trimethylcyclopentane	0.080	0.079	0.063	62.893	0.071
3-Ethylhexane	0.253	0.270	0.197	195.722	0.225
1,3-dimethyl-c-cyclohexane	0.077	0.076	0.061	60.971	0.069
1,1-Dimethylcyclohexane	0.015	0.015	0.012	11.965	0.013
2,2,5-Trimethylhexane	2.209	2.317	1.529	1712.829	1.961
3c-Ethylmethylcyclopentane	0.019	0.019	0.015	15.137	0.017
3t-Ethylmethylcyclopentane	0.014	0.014	0.011	11.177	0.013
1c,4-Dimethylcyclohexane	0.029	0.028	0.023	22.461	0.025
C9_I-Paraffins(1)	0.023	0.024	0.016	17.958	0.021
C8_Naphtheno-Olefins(1)	0.133	0.126	0.107	106.699	0.118
n-Octane	0.289	0.313	0.225	223.504	0.256
Cyclohexane c&t, 1,4-dimethyl-	0.119	0.117	0.094	93.944	0.106
Cyclopentene, 1,2,3-trimethyl-	0.065	0.062	0.053	52.285	0.058
2-Hexene, 3,5-dimethyl-	0.015	0.015	0.012	11.682	0.013
Unidentified	0.006	0.005	0.003	4.329	0.005
Cyclopentene, 1-(1-methylethyl)-	0.394	0.358	0.318	316.549	0.350
Cyclopentane, 1-ethyl-2-methyl-	0.007	0.006	0.005	5.143	0.006
C8_Iso-Olefins(3)	0.006	0.006	0.005	4.747	0.005
C9_I-Paraffins(3)	0.076	0.081	0.053	59.041	0.068
C8_Naphtheno-Olefins(3)	0.074	0.076	0.059	59.041	0.065
C9_Mono-Naphthenes(3)	0.001	0.001	0.001	0.800	0.001
n-Propylcyclopentane	0.283	0.273	0.224	223.093	0.251
2,6-Dimethylheptane	0.128	0.135	0.089	99.411	0.114
1-Ethyl-2-Methylcyclopentene	0.008	0.008	0.006	6.293	0.007
C8_Naphtheno-Olefins(4)	0.161	0.167	0.130	127.028	0.143
2,5-Dimethylheptane	0.227	0.239	0.157	176.191	0.202
Heptane, 3,3-dimethyl-	0.009	0.010	0.006	7.085	0.008
1,1,4-Trimethylcyclohexane	0.013	0.013	0.009	10.389	0.012
C9_Mono-Naphthenes(9)	0.029	0.029	0.020	22.968	0.026
trans-1,3-Diethylcyclopentane	0.016	0.014	0.011	12.803	0.014

C9_Mono-Naphthenes(11)	0.010	0.009	0.007	8.221	0.009
Ethylbenzene	1.711	1.502	1.430	1424.818	1.519
1c,2t,4t-Trimethylcyclohexane	0.043	0.043	0.030	33.882	0.038
Cyclohexane, 1,3,5-trimethyl-, (1à,3à,5á)-	0.040	0.040	0.028	31.694	0.036
m-Xylene	4.370	3.804	3.654	3640.062	3.880
p-Xylene	1.639	1.442	1.371	1365.411	1.455
3,5-Dimethylheptane	0.013	0.014	0.009	10.410	0.012
1-Heptene, 5-methyl-	0.029	0.030	0.023	22.654	0.026
C9_Mono-Naphthenes(13)	0.006	0.006	0.004	4.474	0.005
4-Ethylheptane	0.018	0.019	0.013	14.198	0.016
4-Methyloctane	0.096	0.101	0.067	74.614	0.085
2-Methyloctane	0.118	0.124	0.082	91.758	0.105
3-Hexene, 2,3-dimethyl-	0.018	0.019	0.014	14.271	0.016
Heptane, 3-ethyl-	0.096	0.101	0.066	74.339	0.085
3,4-Dimethylheptane	0.259	0.272	0.179	200.489	0.230
3-Heptyne, 5-ethyl-5-methyl-	0.003	0.003	0.002	2.083	0.002
Pentane, 2,3,3,4-tetramethyl-	0.182	0.191	0.126	141.133	0.161
1c,2t,4c-Trimethylcyclohexane	0.039	0.039	0.028	31.112	0.035
o-Xylene	2.170	1.867	1.815	1807.764	1.927
Octane, 3,4-dimethyl-	0.058	0.060	0.036	44.980	0.051
2,2,4-trimethylheptane	0.175	0.180	0.109	135.569	0.155
Cyclopentane, 1-methyl-2-propyl-	0.013	0.012	0.009	9.897	0.011
1-Ethyl-4-methylcyclohexane	0.115	0.114	0.081	91.025	0.103
cis-1-Ethyl-3-methyl-cyclohexane	0.029	0.029	0.021	23.066	0.026
Octane, 3,3-dimethyl-	0.186	0.192	0.116	144.532	0.165
t-Nonene-3	0.013	0.013	0.009	9.883	0.011
Cyclohexane, 1-ethyl-2-methyl-, cis-	0.023	0.023	0.016	18.102	0.020
C10_Iso-Olefins(1)	0.006	0.007	0.004	5.031	0.006
2-Methyl-2-octene	0.009	0.010	0.007	7.439	0.008
Heptane, 3,3,5-trimethyl-	0.112	0.116	0.070	87.367	0.100
n-Nonane	0.483	0.509	0.334	374.259	0.429
1,1-Methylethylcyclohexane	0.104	0.101	0.073	81.822	0.092
i-Butylcyclohexane	0.003	0.002	0.002	2.016	0.002
Cyclohexane, 1-ethyl-4-methyl-, trans-	0.013	0.013	0.009	10.018	0.011
i-Propylbenzene	0.024	0.021	0.018	19.957	0.021
C9_Mono-Naphthenes(23)	0.051	0.050	0.036	39.937	0.045
Propylcyclohexane	0.020	0.019	0.014	15.505	0.017
Heptane, 2,3,5-trimethyl-	0.106	0.110	0.066	82.012	0.094
C10_I-Paraffins(5)	0.009	0.010	0.006	7.148	0.008
Heptane, 2,4,6-trimethyl-	0.003	0.003	0.002	2.489	0.003
C9_Mono-Naphthenes(25)	0.021	0.020	0.015	16.536	0.019

C9_Mono-Naphthenes(27)	0.022	0.020	0.015	17.167	0.019
C10_I-Paraffins(9)	0.008	0.008	0.005	5.861	0.007
2,3,6-trimethylheptane	0.085	0.088	0.053	66.034	0.075
2,7-dimethyloctane	0.004	0.004	0.003	3.301	0.004
C10_Mono-Naphthenes(1)	0.001	0.001	0.001	0.744	0.001
2,6-Dimethyloctane	0.047	0.049	0.029	36.616	0.042
Hexane, 3,3,4-trimethyl-	0.005	0.005	0.003	3.876	0.004
Unidentified	0.002	0.002	0.001	1.885	0.002
n-Propylbenzene	0.480	0.420	0.355	397.588	0.427
3-Methyl-5-ethylheptane	0.002	0.003	0.002	1.906	0.002
Cyclopentane, 2-isopropyl-1,3-dimethyl-	0.006	0.006	0.004	4.557	0.005
1-Octene, 3-methyl-	0.001	0.002	0.001	1.129	0.001
1-Methyl-3-ethylbenzene	1.759	1.537	1.300	1456.152	1.562
1-Methyl-4-ethylbenzene	0.816	0.719	0.603	675.389	0.725
1,3,5-Trimethylbenzene	1.018	0.893	0.752	842.757	0.904
5-Methylnonane	0.010	0.010	0.006	7.665	0.009
4-Methylnonane	1.014	0.542	0.633	787.388	0.900
1-Methyl-2-ethylbenzene	0.730	0.627	0.539	603.776	0.648
Cyclopentane, 1-methyl-3-(2-methylpropyl)-	0.003	0.004	0.002	2.665	0.003
3-Ethyloctane	0.004	0.005	0.003	3.464	0.004
3-Methylnonane	0.040	0.041	0.025	31.112	0.036
Heptane, 2,2,3,5-tetramethyl-	0.274	0.283	0.156	213.196	0.244
Benzene, 2-propenyl-	0.040	0.034	0.030	34.060	0.036
1,2,4-Trimethylbenzene	3.210	2.775	2.371	2656.779	2.850
C10_I-Paraffins(17)	0.058	0.060	0.036	45.267	0.052
C11_I-Paraffins(2)	0.024	0.024	0.014	18.649	0.021
C10_I-Paraffins(18)	0.006	0.006	0.004	4.383	0.005
Cyclopentane, 1-methyl-3-(1-methylethyl)-	0.471	0.446	0.331	370.939	0.418
Octane, 2,3,3-trimethyl-	0.131	0.136	0.074	101.634	0.116
2,2,3-trimethyloctane	0.009	0.010	0.005	7.082	0.008
i-Butylbenzene	0.147	0.129	0.097	121.154	0.131
1-Isopropyl-3-MECY6	0.063	0.059	0.040	48.812	0.056
n-Decane	0.030	0.031	0.019	23.484	0.027
C11_I-Paraffins(4)	0.038	0.041	0.021	29.263	0.033
Octane, 6-ethyl-2-methyl-	0.004	0.004	0.002	2.966	0.003
1,2,3-Trimethylbenzene	0.638	0.540	0.471	527.618	0.566
1-Methyl-3-i-propylbenzene	0.109	0.096	0.072	89.802	0.097
1-Methyl-4-i-propylbenzene	0.037	0.032	0.024	30.227	0.033
C11_I-Paraffins(7)	0.052	0.053	0.029	40.132	0.046
Unidentified	0.001	0.001	0.000	0.596	0.001
C11_I-Paraffins(8)	0.019	0.020	0.011	15.016	0.017
Indan	0.219	0.166	0.164	184.021	0.194
C11_I-Paraffins(10)	0.018	0.018	0.010	13.635	0.016

C11_I-Paraffins(12)	0.009	0.009	0.005	6.923	0.008
1-Methyl-2-i-propylbenzene	0.006	0.005	0.004	5.192	0.006
2,5,6-Trimethyloctane	0.231	0.235	0.131	179.621	0.205
C11_I-Paraffins(13)	0.008	0.008	0.005	6.168	0.007
Heptane, 5-ethyl-2,2,3-trimethyl-	0.051	0.052	0.027	40.028	0.046
Undecane, 2-methyl-	0.003	0.003	0.002	2.289	0.003
1,3-Diethylbenzene	0.255	0.225	0.169	210.040	0.227
1-Methyl-3-n-propylbenzene	0.397	0.347	0.262	326.621	0.352
1-Methyl-4-n-propylbenzene	0.176	0.154	0.117	145.065	0.156
1,4-Diethylbenzene	0.057	0.050	0.038	47.113	0.051
1,3-Dimethyl-5-ethylbenzene	0.400	0.349	0.264	329.006	0.355
1,2-Diethylbenzene	0.024	0.021	0.016	19.714	0.021
C10_Mono-Aromatics(2)	0.019	0.016	0.012	15.479	0.017
C11_I-Paraffins(17)	0.008	0.008	0.004	6.036	0.007
1-Methyl-2-n-propylbenzene	0.165	0.144	0.109	135.748	0.146
C10_I-Paraffins(20)	0.001	0.001	0.001	0.933	0.001
Decane, 5-methyl-	0.027	0.028	0.016	21.361	0.024
C9_Mono-Aromatics(1)	0.002	0.002	0.002	1.826	0.002
Decane, 4-methyl-	0.023	0.024	0.013	17.941	0.020
1,4,Dimethyl-2-ethylbenzene	0.399	0.348	0.264	328.130	0.354
Benzene, (2-methyl-1-propenyl)-	0.506	0.425	0.340	423.099	0.449
Decane, 3-methyl-	0.034	0.035	0.020	26.656	0.030
1,2-Dimethyl-4-ethylbenzene	1.212	1.058	0.801	997.473	1.076
Indan, 1-methyl-	0.013	0.010	0.009	11.114	0.012
Unidentified	0.014	0.013	0.008	10.647	0.012
1-Methyl-4-t-butylbenzene	0.094	0.083	0.056	77.111	0.084
C11_I-Paraffins(22)	0.006	0.006	0.004	4.897	0.006
Unidentified	0.030	0.027	0.018	22.850	0.026
Cyclopropane, 1,2-dimethyl-1-pentyl-	0.012	0.012	0.008	9.747	0.011
1-Undecene, 7-methyl-	0.003	0.003	0.001	2.045	0.002
1-Octene, 6-methyl-	0.030	0.033	0.021	24.024	0.027
C9_Iso-Olefins(5)	0.032	0.035	0.023	25.471	0.029
1-Ethyl-3-i-propylbenzene	0.148	0.125	0.089	121.421	0.132
1,2-Dimethyl-3-ethylbenzene	0.577	0.504	0.382	474.943	0.512
Unidentified	0.004	0.003	0.002	2.774	0.003
1-Ethyl-2-i-propylbenzene	0.002	0.002	0.001	1.640	0.002
C12_I-Paraffins(2)	0.042	0.042	0.022	32.410	0.037
n-Undecane	0.497	0.509	0.282	386.575	0.441
4,7-Methano-1H-indene, octahydro-	0.006	0.004	0.004	4.698	0.005
1-Ethyl-4-i-propylbenzene	1.611	1.418	0.965	1320.450	1.430
1,2,4,5-Tetramethylbenzene	2.349	2.004	1.555	1933.575	2.085

trans-4a-Methyl-decahydronaphthalene	0.002	0.002	0.001	1.562	0.002
C11_Mono-Aromatics(2)	0.016	0.014	0.010	13.464	0.015
1-t-Butyl-2-methylbenzene	0.001	0.001	0.001	0.886	0.001
Decane, 2,5-dimethyl-	0.051	0.052	0.027	39.977	0.046
1H-Indene,2,3-dihydro-2,2-dime	0.015	0.012	0.009	12.725	0.014
C11_I-Paraffins(24)	0.004	0.004	0.002	2.851	0.003
C11_I-Paraffins(25)	0.047	0.048	0.027	36.742	0.042
Nonane, 4,5-dimethyl-	0.008	0.008	0.005	6.455	0.007
C11_Mono-Aromatics(4)	0.002	0.002	0.001	1.794	0.002
C12_I-Paraffins(4)	0.012	0.012	0.006	9.201	0.011
4-Methylindan	1.246	0.963	0.837	1041.892	1.106
C11_Mono-Naphthenes(1)	0.002	0.002	0.001	1.550	0.002
Benzene, 1,3-diethyl-5-methyl-	0.254	0.223	0.152	208.520	0.226
C11_Mono-Aromatics(5)	0.005	0.004	0.003	3.932	0.004
Benzene, 1-(1,1-dimethylethyl)-3-methyl-	0.356	0.314	0.213	291.975	0.316
1H-Indene, 1-methyl-	0.028	0.024	0.019	23.942	0.025
2-Methylindan	1.026	0.814	0.689	857.709	0.911
1,3-Dimethyl-2-ethylbenzene	1.185	1.034	0.783	975.084	1.052
C11_Mono-Naphthenes(2)	0.011	0.011	0.006	8.460	0.010
Benzene, 1,4-dimethyl-2-(1-methylethyl)-	0.037	0.033	0.022	30.521	0.033
n-Pentylbenzene	0.107	0.094	0.064	87.544	0.095
1,4-diethyl-2-methylbenzene	0.140	0.123	0.084	114.893	0.124
Benzene, 1-ethyl-3-(1-methylethyl)-	0.082	0.073	0.049	67.534	0.073
C10_I-Paraffins(21)	0.029	0.030	0.018	22.884	0.026
Benzene, (1,1-dimethylpropyl)-	0.207	0.183	0.124	169.718	0.184
2,4-diethyl-1-methylbenzene	0.244	0.213	0.146	199.823	0.216
Decane, 4-ethyl-	0.031	0.024	0.016	24.226	0.028
C11_Mono-Aromatics(8)	0.011	0.009	0.006	8.691	0.009
Undecane, 2,7-dimethyl-	0.010	0.010	0.005	7.492	0.009
1-methyl-4-(1-methylpropyl)be	0.294	0.259	0.176	241.085	0.261
Naphthalene	0.197	0.143	0.136	169.357	0.174
1-t-Butyl-3,5-dimethylbenzene	0.025	0.022	0.014	20.342	0.022
C12_I-Paraffins(9)	0.001	0.001	0.000	0.530	0.001
1H-Indene, 2,3-dihydro-1,3-dimethyl-	0.007	0.006	0.005	6.206	0.007
C12_I-Paraffins(10)	0.007	0.007	0.004	5.280	0.006
4,7-Dimethyl Indane	0.076	0.059	0.046	63.088	0.067
1,1-Dimethyl Indane	0.011	0.009	0.007	9.454	0.010
1t-Butyl-4-ethylbenzene	0.087	0.077	0.048	71.466	0.078
C12_Indanes(1)	0.001	0.001	0.000	0.720	0.001
1,3-Di-n-propylbenzene	0.165	0.146	0.090	134.598	0.146

Benzene, 1,3-dimethyl-5-(1-methylethyl)-	0.094	0.083	0.056	76.926	0.083
C11_Mono-Aromatics(9)	0.002	0.002	0.001	1.949	0.002
n-Dodecane	0.243	0.245	0.126	188.864	0.215
Benzene, (3,3-dimethylbutyl)-	0.008	0.007	0.004	6.359	0.007
C12_Mono-Aromatics(4)	0.002	0.002	0.001	1.506	0.002
Benzene, 2,4-dimethyl-1-(1-methylethyl)-	0.002	0.002	0.001	1.485	0.002
n-propyl indane	0.010	0.009	0.006	8.539	0.009
C11_Mono-Aromatics(14)	0.035	0.031	0.021	28.305	0.031
1,3,5-trimethyl-2-propylbenze	0.004	0.004	0.002	3.410	0.004
Octane, 2,3,6-trimethyl-	0.001	0.001	0.001	1.019	0.001
2-Ethyl-2,3-dihydro-1H-indene	0.009	0.007	0.005	7.126	0.008
1H-Indene, 1-ethyl-2,3-dihydro-	0.008	0.006	0.005	6.346	0.007
C12_Mono-Aromatics(5)	0.001	0.001	0.001	0.889	0.001
C12_Mono-Aromatics(6)	0.002	0.002	0.001	1.485	0.002
Benzene, 1,4-dimethyl-2-(2-methylpropyl)-	0.001	0.001	0.001	1.019	0.001
Benzene, (1-ethyl-1-methylpropyl)-	0.002	0.002	0.001	1.879	0.002
C11_Indanes(1)	0.021	0.017	0.013	17.907	0.019
Benzene, (1-methylpentyl)-	0.005	0.004	0.003	3.876	0.004
1-H-Indene,1-3-dimethyl	0.014	0.011	0.009	11.914	0.013
1H-Indene, 2,3-dihydro-5,6-dimethyl-	0.006	0.004	0.003	4.648	0.005
Decane, 2,3,8-trimethyl-	0.001	0.001	0.001	0.863	0.001
C12_Mono-Aromatics(10)	0.001	0.001	0.001	1.041	0.001
Pentamethylbenzene	0.063	0.055	0.038	51.334	0.056
C12_Indanes(6)	0.000	0.000	0.000	0.304	0.000
2-Methylnaphthalene	0.336	0.249	0.210	287.294	0.298
C12_Mono-Aromatics(16)	0.003	0.003	0.002	2.458	0.003
1-Methylnaphthalene	0.182	0.137	0.114	155.614	0.162
C12_Indanes(7)	0.000	0.000	0.000	0.248	0.000
Naphthalene, 6-ethyl-1,2,3,4-tetrahydro-	0.002	0.001	0.001	1.539	0.002
Naphthalene, 1-ethyl-1,2,3,4-tetrahydro-	0.001	0.001	0.000	0.615	0.001
Naphthalene, 1,2,3,4-tetrahydro-6-propyl-	0.002	0.001	0.001	1.313	0.001
C12_Indanes(8)	0.001	0.001	0.000	0.561	0.001
C12_Mono-Aromatics(17)	0.001	0.001	0.001	0.971	0.001
Benzene, 1,2,4-trimethyl-5-(1-methylethyl)-	0.001	0.001	0.001	0.862	0.001
1,1'-Biphenyl	0.009	0.006	0.005	7.568	0.008
C13_I-Paraffins(5)	0.002	0.002	0.001	1.899	0.002
Decane, 2,3,5-trimethyl-	0.018	0.018	0.009	13.984	0.016

2-Ethylnaphthalene	0.013	0.010	0.007	11.028	0.012
n-Tetradecane	0.021	0.020	0.009	16.001	0.018
Naphthalene,2,6 dimethyl	0.000	0.000	0.000	0.016	0.000
Naphthalene,2,7 dimethyl	0.017	0.013	0.010	14.265	0.015
1H-Indene, 2,3-dihydro-1,1,6-trimethyl-	0.001	0.001	0.001	0.837	0.001
Naphthalene,1,7-dimethyl	0.032	0.024	0.018	27.059	0.028
Naphthalene, 1,3-dimethyl-	0.032	0.024	0.018	27.059	0.028
Naphthalene, 1,6-dimethyl-	0.032	0.024	0.018	26.894	0.028
Naphthalene-1,4-dimethyl	0.012	0.009	0.007	9.886	0.010
Naphthalene, 2,3-dimethyl-	0.012	0.009	0.007	9.886	0.010
Naphthalene, 1,5-dimethyl-	0.005	0.004	0.003	4.606	0.005
Naphthalene, 1,2-dimethyl-	0.015	0.011	0.009	12.930	0.014
1,1'-Biphenyl, 2-methyl-	0.001	0.001	0.000	0.800	0.001
1,1'-Biphenyl, 3-methyl-	0.019	0.014	0.010	15.846	0.016
Octane, 3,4,5,6-tetramethyl-	0.002	0.002	0.001	1.191	0.001
1,1'-Biphenyl, 4-methyl-	0.015	0.011	0.008	12.496	0.013
Naphthalene, 1-propyl-	0.002	0.002	0.001	1.759	0.002
Unidentified	0.002	0.002	0.001	1.731	0.002
n-Pentadecane	0.002	0.002	0.001	1.524	0.002
Naphthalene, 2,3,6-trimethyl-	0.008	0.006	0.004	6.810	0.007
Unidentified	0.004	0.004	0.003	3.304	0.004
Unidentified	0.002	0.002	0.001	1.724	0.002
C13_Naphthalenes(1)	0.006	0.004	0.003	4.598	0.005
Azulene, 4,6,8-trimethyl-	0.002	0.002	0.001	1.943	0.002
C13_Naphthalenes(3)	0.001	0.001	0.001	1.035	0.001
Naphthalene, 1,4,6-trimethyl-	0.011	0.008	0.006	8.874	0.009
Naphthalene, 1,4,5-trimethyl-	0.016	0.012	0.008	13.475	0.014
Unidentified	0.000	0.000	0.000	0.212	0.000
C13_Naphthalenes(4)	0.009	0.007	0.005	7.331	0.008
C13_Naphthalenes(5)	0.007	0.006	0.004	6.021	0.006
Naphthalene, 2-(1-methylethyl)-	0.003	0.002	0.001	2.193	0.002
Naphthalene, 1,6,7-trimethyl-	0.002	0.002	0.001	1.721	0.002
4-Ethylbiphenyl	0.004	0.003	0.002	3.572	0.004
Unidentified	0.003	0.003	0.002	2.123	0.002
3,3'-Dimethylbiphenyl	0.010	0.008	0.005	8.754	0.009
1,1'-Biphenyl, 2,4'-dimethyl-	0.002	0.002	0.001	1.858	0.002
Unidentified	0.009	0.009	0.005	7.127	0.008
4,4'-Dimethylbiphenyl	0.001	0.001	0.000	0.573	0.001
Naphthalene, 2,6-diethyl	0.002	0.002	0.001	1.870	0.002
C14_Mono-Aromatics(1)	0.005	0.004	0.003	4.533	0.005
1,4,6,7-tetramethylnaphthalene	0.001	0.001	0.000	0.724	0.001

AVERAGE_SG	BP(K)	DBE	PMI
0	111.65	0	0
0.017	261.45	0	0.000336
0	338.15	0	0
0	272.65	0	0.000002
0	280.35	0	0
0.077	351.65	0	0.011839
0.071	303.15	0	0.00371
0	302.25	2	0.000003
0.002	308.35	0	0.0001
0	307.25	2	0.000024
0	308.15	1	0
0.03	321.55	0	0.002393
0	331.5	1	0.000015
0.074	322.45	1	0.01199
0	331.85	0	0
0	332.75	0	0.000046
0	335.85	0	0
0.048	335.15	1	0.010192
0.001	341.85	0	0.000086
0	338.75	1	0.000004
0	341.05	1	0.000019
0	340.85	1	0.00001
0	340.84	1	0.000002
0	337.75	1	0
0	351.05	0	0
0	344.95	1	0.000012
0	353.65	0	0.000007
0	352.45	1	0.000003
0	353.25	0	0
0	359.25	0	0.000002
0	353.85	1	0.000024
0	363.25	0	0.000029
0	362.95	0	0.000028
0	360.65	1	0.000002
0	363.85	0	0.000031
0	364.85	1	0.000007
0	363.95	1	0.000005
0	365.45	0	0.000001
0.033	371.15	0	0.008025
0	366.55	0	0
0	371.55	0	0.000054
0.001	374.05	1	0.000289
0	378.85	0	0.000034
0	378.05	1	0.000011
0	379.95	0	0

0	399.85	0	0
0.002	376.65	1	0.001183
0	383.05	0	0.000131
0.001	382.55	0	0.000264
0	389.45	1	0.000091
0	384.25	0	0.000004
0	389.45	1	0.000115
0.018	386.65	0	0.006237
0.026	387.95	0	0.008997
0	383.75	4	0.000104
0.005	388.15	0	0.001767
0	387.45	1	0.000112
0.001	390.85	0	0.000366
0	390.15	0	0.00009
0	411.05	0	0.000074
0	389.75	0	0.000058
0	388.38	0	0
0.001	388.38	1	0.000429
0.002	390.65	0	0.000717
0.001	393.25	1	0.000466
0	391.15	1	0.000087
0.017	397.25	0	0.007297
0	393.05	1	0.000115
0	393.05	1	0.000085
0	399.047	1	0.000196
0	406.15	0	0.000094
0.001	403.95	2	0.001541
0.002	398.15	0	0.000974
0.001	394.25	1	0.000735
0	393.55	2	0.000592
0	386.04	1	0.000076
0	379.55	0	0
0.003	399.15	2	0.004085
0	397.25	1	0.000043
0	419.75	1	0.000068
0.001	405.85	0	0.000308
0.001	391.05	2	0.000631
0	402.85	1	0.000008
0.002	404.15	1	0.002197
0.001	408.35	0	0.000549
0	408.25	0	0.000035
0.001	391.05	2	0.001384
0.002	408.95	0	0.000987
0	410.25	0	0.000041
0	408.15	1	0.000112
0	408.15	1	0.000249

0	417.55	1	0.000173
0	417.55	1	0.000111
0.013	409.35	4	0.037506
0	416.15	1	0.000443
0	412.649	1	0.000381
0.033	411.15	4	0.099985
0.012	412.76	4	0.038964
0	409.15	0	0.000059
0	385.55	1	0.000145
0	408.15	1	0.000048
0	414.35	0	0.00009
0.001	414.75	0	0.00048
0.001	416.45	0	0.000614
0	387.45	1	0.000095
0.001	416.15	0	0.000494
0.002	413.75	0	0.001259
0	428.45	2	0.000054
0.001	414.45	0	0.000899
0	412.649	1	0.000374
0.016	416.15	4	0.055921
0	436.35	0	0.000487
0.001	422.35	0	0.001043
0	422.05	1	0.000149
0.001	423.95	1	0.001435
0	423.95	1	0.000364
0.001	434.15	0	0.001482
0	418.85	1	0.000138
0	429.15	1	0.000324
0	420.15	1	0.000072
0	420.15	1	0.000107
0.001	428.95	0	0.000789
0.004	424.85	0	0.003066
0.001	425.35	1	0.001335
0	444.45	1	0.000053
0	423.95	1	0.000158
0	425.55	4	0.000779
0	423.95	1	0.00063
0	428.15	1	0.000271
0.001	431.05	0	0.000779
0	419.8167	0	0.000052
0	422.15	0	0.000019
0	418.35	1	0.000228
0	425.35	1	0.00028
0	433.55	0	0.000059
0.001	430.05	0	0.000612
0	431.65	0	0.000032

0	444.45	1	0.000019
0	432.85	0	0.000364
0	412.75	0	0.000024
0	441.35	0	0
0.004	433.65	4	0.018898
0	432.55	0	0.000019
0	433.7	1	0.000091
0	410.75	1	0.000013
0.013	434.45	4	0.070586
0.006	435.15	4	0.033307
0.008	439.85	4	0.046673
0	438.25	0	0.000087
0.008	439.15	0	0.009132
0.006	437.15	4	0.031278
0	422.5945	1	0.000041
0	439.65	0	0.000041
0	440.95	0	0.000377
0.002	446.97	0	0.003005
0	440.65	5	0.00227
0.024	441.15	4	0.15196
0	440.95	0	0.000549
0	445.45	0	0.000253
0	440.95	0	0.000053
0.004	415.49	1	0.004776
0.001	447.41	0	0.001448
0	452.75	0	0.000115
0.001	448.55	4	0.008383
0	442.64	1	0.00123
0	448.05	0	0.00034
0	452.75	0	0.000477
0	450.2	0	0.000045
0.005	448.15	4	0.03595
0.001	448.25	4	0.006167
0	449.15	4	0.002123
0	457.15	0	0.000731
0	457.15	0	0
0	457.15	0	0.000274
0.002	449.65	5	0.015374
0	452.55	0	0.000221
0	457.15	0	0.000126
0	451.35	4	0.000386
0.002	449.76	0	0.002713
0	457.15	0	0.000112
0	469.85	0	0.001014
0	482.05	0	0.00008
0.002	454.85	4	0.017048

0.003	456.85	4	0.0279
0.001	457.35	4	0.012551
0	446.45	4	0.003092
0.003	457.75	4	0.028759
0	456.65	4	0.001675
0	456.65	4	0.001315
0	457.15	0	0.00011
0.001	459.65	4	0.012459
0	432.85	0	0.000009
0	459.25	0	0.000411
0	449.25	4	0.000128
0	460.55	0	0.000357
0.003	460.05	4	0.030428
0.004	461.05	5	0.047567
0	462.25	0	0.000554
0.009	462.65	4	0.098919
0	466.55	5	0.001432
0	466.55	0	0
0.001	465.95	4	0.008367
0	457.15	0	0.000089
0	430.51	0	0
0	430.51	1	0.00018
0	478.15	1	0.000127
0	410.75	1	0.000276
0	410.75	1	0.000293
0.001	476.35	4	0.017328
0.004	465.15	4	0.050257
0	476.35	0	0
0	476.35	4	0.000234
0	482.35	0	0.001145
0.004	469.05	0	0.00959
0	448.0167	3	0.000251
0.012	470.15	4	0.159925
0.018	469.15	4	0.227144
0	470.85	2	0.00012
0	463.45	4	0.001369
0	463.45	4	0.00009
0	472.05	0	0.001073
0	474.25	5	0.002032
0	457.15	0	0.000052
0	457.15	0	0.00067
0	457.15	0	0.000118
0	467.15	4	0.000201
0	457.15	0	0.000168
0.009	479.25	5	0.189038
0	457.15	0	0.000028

0.002	475.95	4	0.029443
0	475.95	4	0.000555
0.003	461.95	4	0.028557
0	465.76	6	0.003494
0.008	467.65	5	0.11446
0.009	463.25	4	0.098213
0	457.15	0	0.000154
0	469.35	4	0.003604
0.001	478.55	4	0.01325
0.001	479.85	4	0.018006
0.001	465.65	4	0.007271
0	489.45	0	0.000982
0.002	463.15	4	0.017123
0.002	479.05	4	0.030652
0	473.52	0	0.000676
0	483.15	4	0.001489
0	495.96	0	0.000384
0.002	469.05	4	0.028367
0.001	494.65	7	0.060521
0	481.05	4	0.003303
0	470.15	0	0.000014
0	481.85	5	0.001214
0	470.15	0	0.000135
0.001	499.75	5	0.020213
0	464.15	5	0.001158
0.001	484.65	4	0.012791
0	451.05	5	0.000063
0.001	476.15	4	0.019168
0.001	467.05	4	0.00859
0	467.05	4	0.000218
0.002	488.15	0	0.007807
0	497.41	4	0.001613
0	480.85	4	0.000242
0	472.55	4	0.000191
0	507.15	5	0.003392
0	465.95	4	0.003071
0	505.25	4	0.001083
0	453.45	0	0.000017
0	488.35	5	0.001664
0	495.15	5	0.001788
0	477.15	4	0.00013
0	477.15	4	0.000217
0	495.65	4	0.000247
0	478.15	4	0.000282
0	451.05	5	0.00155
0	481.15	4	0.000631

0	502.05	6	0.004697
0	500.75	5	0.001532
0	495.52	0	0.000044
0	493.45	5	0.000281
0	502.15	4	0.014877
0	451.05	5	0.000026
0.003	513.15	7	0.175155
0	477.15	4	0.000359
0.001	513.05	7	0.094597
0	451.05	5	0.000021
0	519.75	5	0.000874
0	512.85	5	0.000285
0	537.95	5	0.001316
0	451.05	5	0.000049
0	477.15	4	0.000142
0	492.15	4	0.00019
0	528.15	8	0.008118
0	495.52	0	0.000096
0	495.52	0	0.000708
0	530.9278	7	0.011512
0	525.15	0	0.001907
0	535.15	7	0.000019
0	536.15	7	0.017493
0	273.15	5	0.000001
0	535.65	7	0.032671
0	536.15	7	0.033182
0	537.15	7	0.034021
0	541.6	7	0.014379
0	542.05	7	0.014584
0	538.75	7	0.006125
0	541.15	7	0.01854
0	528.45	8	0.000866
0	545.85	8	0.029498
0	472.2	0	0.000032
0	540.95	8	0.019912
0	548.45	7	0.003233
0	543.75	0	0
0	543.75	0	0.000323
0	536.65	7	0.008618
0	536.65	0	0
0	540	0	0
0	540	7	0.006461
0	557.85	7	0.004856
0	554.25	7	0.002298
0	554.25	7	0.019699
0	563.45	7	0.040228

0	563.45	0	0
0	559.95	7	0.019653
0	540	7	0.008376
0	540	7	0.003082
0	559.95	7	0.004614
0	564.2	8	0.012158
0	562.4667	0	0
0	562.4667	8	0.028104
0	554	8	0.004503
0	554	0	0
0	568	8	0.002222
0	567.75	7	0.006526
0	554	8	0.010985
0	576.05	7	0.003353