CRC Report No. E-91

EVAPORATIVE EMISSIONS DURABILITY TESTING

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COORDINATING RESEARCH COUNCIL, INC.
3650 MANSELL ROAD·SUITE 140·ALPHARETTA, GA 30022

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CRC Project No. E-91

Evaporative Emissions Durability Testing

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Abbreviations and Acronyms

A/C	Air Conditioning
CFR	Code of Federal Regulations
CO	Carbon monoxide
CO2	Carbon dioxide
CPG	Chrysler Chelsea Proving Grounds
CRC	Coordinating Research Council
DTC	Diagnostic Trouble Code
DOE	U.S. Department of Energy
E0	Ethanol-free gasoline
E20	20%volume ethanol blended into ethanol-free gasoline
ECM	Engine Electronic Control Module
EPA	U.S. Environmental Protection Agency
FID	Flame Ionization Detector
FTP75	Federal Test Procedure consisting of a 3-phase drive cycle
HC	Hydrocarbons
LA4	2-phase drive cycle also known as the FTP72 or Urban Dynamometer Driving Schedule
LA92	2-phase drive cycle also known as the California Unified Cycle
LDT	Light Duty Truck
LDV	Light Duty Vehicle
MIL	Malfunction Indicator Lamp
mg	Milligrams
NOx	Oxides of nitrogen
OBD	On Board Diagnostics
OEM	Original Equipment Manufacturer
PCV	Positive crankcase ventilation (valve)
ppm	Parts per million, single carbon equivalent basis (ppmC1)
Q1-Q4	First to fourth quarter aging periods, each quarter equivalent to 180 drives per car
R134a	Vehicle air conditioning system refrigerant
RE0	Road aging fuel containing <0.1%vol ethanol
RE20	Road aging fuel containing 20%vol ethanol blended into gasoline
RVP	Reid Vapor Pressure

SGS	SGS Environmental Testing Corporation
SHED	Sealed Housing for Evaporative Determination
SRC	EPA Standard Road Cycle
TE0	Test fuel with no ethanol, meeting EPA Tier2 EEE specification for certification gasoline
TE0_Alt	Test fuel with no ethanol, meeting EPA specification for certification gasoline for altitudes >4000feet
TE20	Test fuel containing 20% ethanol splash blended into TE0_Alt certification gasoline

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1.0 Executive Summary

Federal and state legislation has been enacted to promote the use of alternative fuels, including ethanol. The Energy Independence and Security Act passed into law in December 2007 mandates the use of 36 billion ethanol equivalent gallons per year of renewable fuel by 2022. Subsequent to the Act, the U.S. Environmental Protection Agency granted partial waivers to allow fuel and fuel additive manufacturers to introduce E15 fuel (15% by volume ethanol blended in gasoline) into commerce for use in model year 2001 and newer light-duty motor vehicles.

There is very little data available showing the impact that higher ethanol blended gasoline may have on the evaporative emissions of motor vehicles. The objective of the CRC E-91 study was to assess the long-term effects of E20 fuel exposure (20% by volume ethanol blended into gasoline) on vehicle evaporative emissions.

Because evaporative emission system designs, materials, purge strategy controls, and on-board diagnostics vary widely, ten different vehicle models were chosen for study. The vehicle model years ranged from 2002 to 2010. Five of these vehicle models were certified to the Federal Enhanced Evaporative Emissions Standard, three models were certified to the Tier 2 2004 LDV/LLDT Standard, and two models were certified to the Tier 2 2009 LDV Standard.

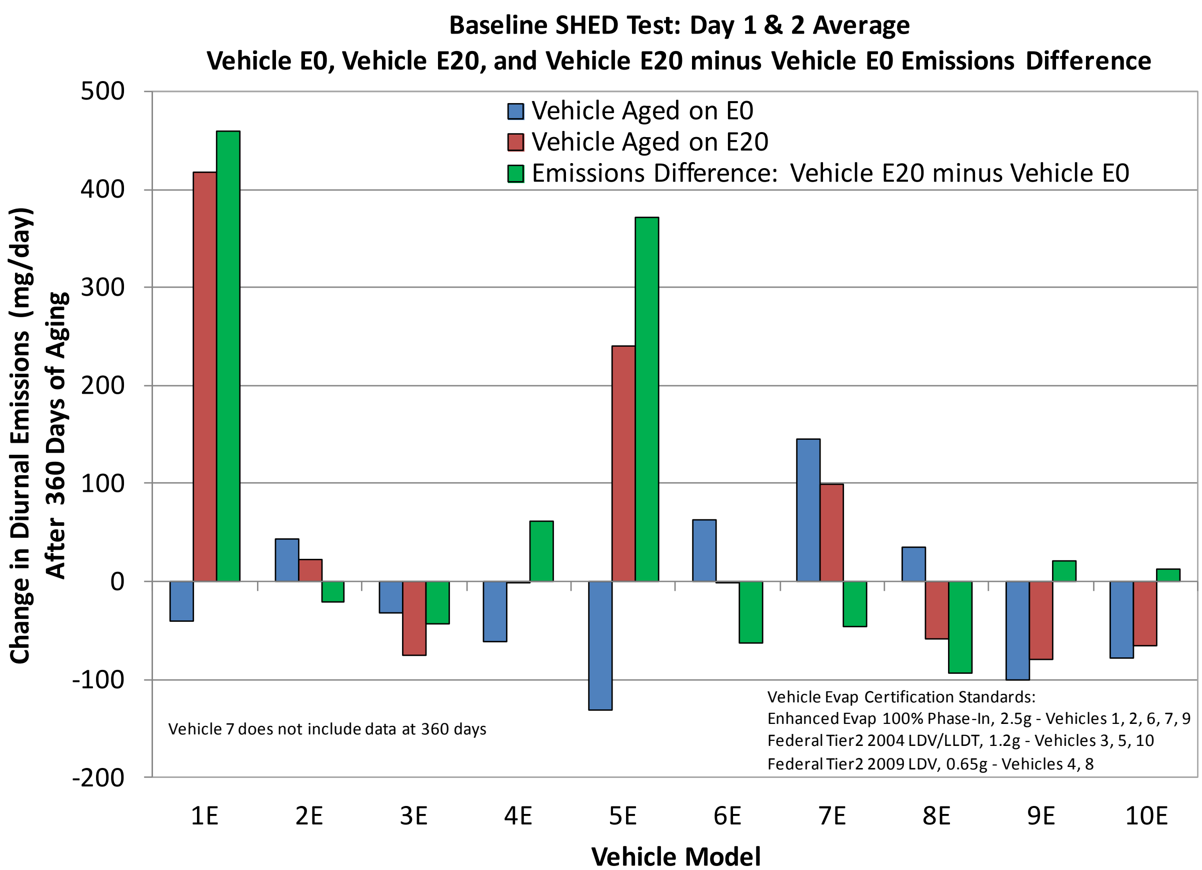
For each vehicle model, two closely matched vehicles were recruited. One vehicle was aged on ethanol-free (RE0) fuel, and the other was aged on 20% ethanol splash-blended into ethanol-free gasoline (RE20) for approximately 18,650 miles. The vehicles in each pair were of the same engine family and evaporative emissions family, had the same ECM calibration software and similar mileage in order to minimize any vehicle differences. The study was designed to discern the effects the fuels had on the evaporative emission system performance, permeability and durability.

All twenty vehicles were driven on road twice per day for 360 days, with eight hour minimum soak time between drives. The vehicles were parked outdoors during the aging period. At quarterly intervals, the vehicles were tested using two SHED procedures:

- The "Baseline Test" was similar to a two-day diurnal supplemental certification test sequence. The Baseline Test was always performed using ethanol-free certification gasoline. Results from this test provided information on how E20 fuel substitution and vehicle aging may affect the vehicle's compliance with EPA evaporative emissions standards.

- The "Permeation Test" quantified the amount of permeation that contributed to evaporative emissions. Vehicles road-aged on RE0 fuel were tested using ethanol-free certification fuel, and vehicles aged on RE20 fuel were tested using 20% ethanol splash-blended into certification gasoline. Permeation Tests always had the vehicle canister vent port routed outside of the SHED. Results from this test provided information on the possible sources of the permeation, vapor leaks and fuel pressure driven leaks. The Permeation Test procedure was adapted from the CRC E-77 study.

Over 600 individual SHED tests were performed to assess the effect of aging and fuel exposure on permeation and evaporative emissions. Results from the two-day diurnal Baseline Test are summarized for each of the ten vehicle models in the figure below. The positive values in the figure indicate an increase in diurnal evaporative emissions over the 360 day aging period, and negative values indicate an evaporative emissions decrease. The green bars represent the difference in evaporative emissions between the vehicle aged on E20 fuel and the matched vehicle aged on E0 fuel.



The following conclusions were made:

- Each vehicle model in the study had unique permeation and evaporative emissions characteristics that were revealed by SHED testing. Vehicle models certified to the same federal evaporative emissions standard responded much differently to the fuel exposure and also trended differently over time.
- Vehicle models 1E and 5E showed a pronounced increase in evaporative emissions following E20 fuel exposure, compared to control vehicles operated on E0 fuel. The evaporative emission rates of Vehicles 1E20 and 5E20 were 459 and 372 mg/day higher, respectively, than the E0-fueled control vehicles following 360 days of aging. The same vehicles also had increased permeation rates following exposure to E20 fuel. Model 1E was certified to the Federal Enhanced Evaporative Emissions Standard, and model 5E was certified to the Federal Tier2 2004 LDV/LLDT Standard.
- Evaporative emissions from vehicle models 3E, 9E and 10E decreased over the 360 day aging period, for both fuels tested. The cause for this decrease cannot be determined with certainty

because of the many factors and mechanisms associated with the vehicle technology and SHED testing. Since the recruited vehicles had prior real-world exposure, the evaporative emissions decrease may be related to street fuel carry-over effects, “off-gassing” effects of car surface treatments, the repetitious two-a-day driving schedule, or other unknown mechanisms.

- There is evidence that ethanol may not be readily removed from some fuel systems and evaporative emissions systems, even after more than 14 days of conditioning on ethanol-free fuel. Ethanol mass estimates for vehicles 8E0 and 10E0 averaged 22 and 55 mg/day respectively for pre-aging Baseline Tests, despite the vehicles being conditioned on ethanol-free fuel. The ethanol mass for these vehicles was reduced by 37% and 71% respectively following an additional 90 days of operation on ethanol-free fuel.

- SHED testing revealed some durability issues with evaporative emission system components. These durability issues were not related to the fuels or presence of ethanol in the fuels.
    - The canisters from both Vehicles 5E0 and 5E20 were found to be contaminated with fine dirt. Contamination occurred prior to recruitment and was due to the lack of an effective vent filter. The MIL was set and a DTC identified by an OBD scan.
    - The purge valves from both Vehicles 7E0 and 7E20 did not fully seat over the course of the aging period. There was no MIL or pending DTC detecting this problem. Baseline test data taken after 360 days of aging were excluded from the statistical analysis because of persistent vapor leaks caused by the unseated purge valves.
    - A leaking gas cap seal on Vehicle 8E20 was detected using a sensitive hydrocarbon sniffer. The leak was sufficient to impact SHED testing. There was no MIL or pending DTC detecting this problem.

- Evaporative emissions from all of the vehicles in the study were below the federal certification standards. Vehicle 5E20 was very near the standard for one test, due to a low canister purge volume encountered for that test.

- Information was gathered to identify the source of evaporative emissions, including permeation, fuel vapor leaks, fuel pressure driven leaks, refrigerant leaks, tire contribution, and windshield sealant contribution. Tires, tested in isolation, off-gassed at a rate of 5 to 78 mg/day. Tires are therefore an important consideration for testing future low emitting vehicles, because off-gassing could be a large percentage of the total evaporative emission measurement. R134a refrigerant was also found to be a significant contributor to SHED emissions, especially for vehicles needing to meet more stringent certification standards. R134a refrigerant emission estimates ranged from 17 to 92 mg/day for the vehicle fleet.

- Sixteen of the vehicles were tested in each laboratory, located at 5440 feet and at 930 feet elevation above sea level, respectively, to quantify the impact of altitude on evaporative emissions. Diurnal evaporative emissions measured at the high altitude and low altitude labs correlated to within 10%.

2.0 Introduction

Federal and state legislation has been enacted to promote the use of alternative fuels, including ethanol. The Energy Independence and Security Act passed into law in December 2007 mandates the use of 36 billion ethanol equivalent gallons per year of renewable fuel by 2022. Based largely on U.S. Department of Energy test data, on October 13, 2010 the Environmental Protection Agency granted a partial waiver to allow fuel and fuel additive manufacturers to introduce E15 into commerce for use in model year 2007 and newer light-duty motor vehicles [1]. On January 21, 2011, EPA took further action to allow the introduction of E15 into commerce for use in model year 2001 and newer light-duty motor vehicles if certain waiver conditions were met [2]. In Minnesota, a bill was signed into law that could result in a requirement that the state's gasoline supply includes 20 percent ethanol.

Previous studies have investigated the effects of E15 and E20 fuel substitution on light-duty vehicle exhaust emissions [3,4,5]. However, there was very little data available in the automotive community that quantifies the impact that E15 or E20 may have on evaporative emissions. Some exploratory research was performed using a rig testing methodology (CRC Project E-65, [6,7]). Those results showed E20 increased fuel permeation through evaporative emission system components, whereas E85 had lower permeation rate compared to an ethanol-free fuel. A methodology was developed to isolate the permeation mechanism contributing to evaporative emissions [8], and demonstrated higher permeation rates for ethanol-blended fuel compared to ethanol-free gasoline for a small set of vehicles [9,10,11]. More recently, evaporative emissions were compared for model year 2009 vehicles aged on E0 and E15 fuels [5]. The limited data from this testing suggested the evaporative emissions were very similar for matched vehicles aged on E0 and E15 fuels, but the evaporative emissions systems were not exercised in manner representing real-world operation during the aging process.

A new study was warranted to better quantify the effects of long term ethanol exposure on the evaporative emissions of motor vehicles. Exposing vehicle components to E20, when they were only designed to operate on E10 fuel, may cause degradation to evaporative system components and could have implications on complying with EPA and California evaporative emissions standards.

The objective of the CRC E-91 study was to assess the long-term effects of E20 fuel exposure on vehicle evaporative emissions. Because evaporative emission system designs, materials, purge strategy controls, and on-board diagnostics vary widely, ten different vehicle models were chosen for study. The vehicle model years ranged from 2002 to 2010.

For each vehicle model, two closely matched vehicles were recruited. One vehicle was aged on ethanol-free (RE0) fuel, and the other was aged on 20% ethanol splash-blended into ethanol-free gasoline (RE20) for approximately 18,650 miles. The vehicles in each pair were of the same engine family and evaporative emissions family, had the same ECM calibration software and similar mileage in order to minimize any vehicle differences. The study was designed to discern the effects the fuels had on the evaporative emission system performance, permeability and durability.

The vehicles were periodically tested to quantify fuel permeation and evaporative emissions as the vehicles aged. Data were collected to compare evaporative emissions to federal standards, to determine any differences between E0 and E20 fueled vehicles, and to isolate parameters for possible inclusion in future evaporative emissions and inventory models.

3.0 Approach and Test Procedures

SGS Environmental Testing Corporation (SGS) and its subcontractors, Revecorp and Chrysler Chelsea Proving Grounds (CPG), collaborated with CRC to develop the project approach and test procedures. Vehicle aging and lab testing were performed at SGS's Aurora, Colorado laboratory (5440 feet above sea level) and at Chrysler's Chelsea Proving Grounds (930 feet above sea level).

This report assumes the reader has some familiarity with vehicle evaporative control systems. Most vehicles tested in this study had an evaporative system design and function similar to that shown in Figure 1. The technical discussion refers to the system components illustrated in Figure 1.

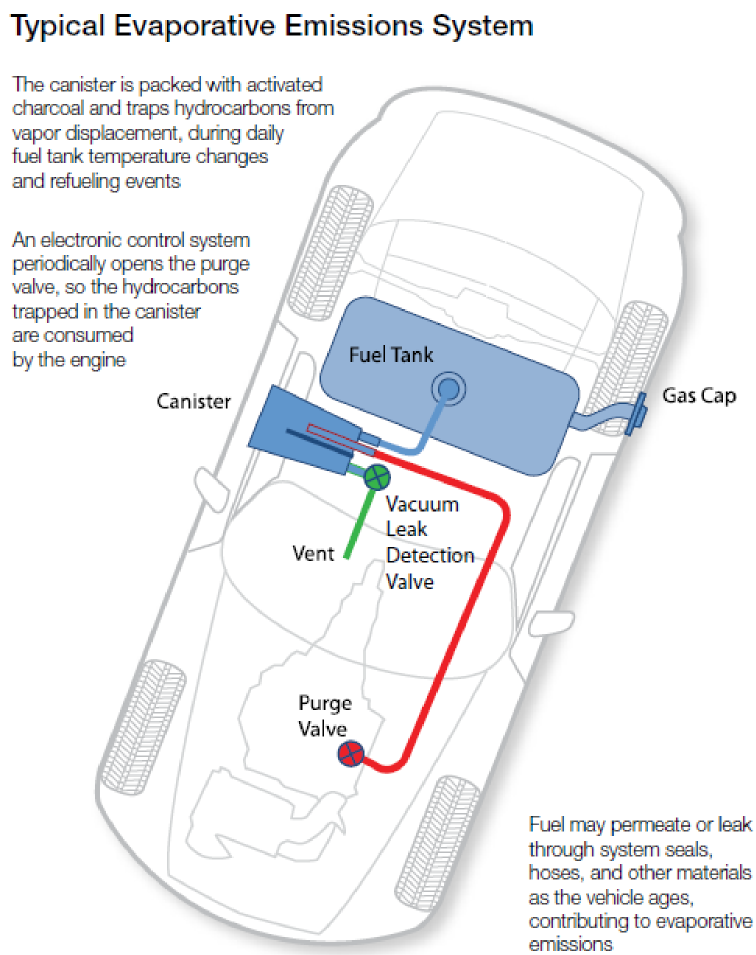


Figure 1. Typical Vehicle Evaporative System Design and Function

3.1 Vehicle Models and Recruitment

Because evaporative emission system designs, materials, purge strategy controls, and on-board diagnostics vary widely, ten different vehicle models were chosen for study. The vehicle model years ranged from 2002 to 2010. Five of these vehicle models were certified to the Federal Enhanced Evaporative Emissions Standard, three models were certified to the Tier 2 2004 LDV/LLDT Standard, and two models were certified to the Tier 2 2009 LDV Standard.

For each vehicle model, two closely matched vehicles were recruited. One vehicle was aged on ethanol-free (RE0) fuel, and the other was aged on 20% ethanol splash-blended into ethanol-free gasoline (RE20) for approximately 18650 miles. The vehicles in each pair were of the same engine family, evaporative emissions family, had the same ECM calibration software and similar mileage in order to minimize any vehicle differences. The study was designed to discern the effects the fuels had on the evaporative emission system performance, permeability and durability.

The following criteria were used for vehicle recruitment:

INDIVIDUAL VEHICLE REQUIREMENTS:

- Minimum of 4,000 miles
- Maximum of 100,000 miles (by adding 20,000 miles, vehicles remain under 120,000 mile emissions equipment warranty)
- Never been in an accident and clean CarFax history
- No active or pending MILs/DTCs
- No repairs on the evaporative emissions control system
- No major repairs on AC system
- Serviceable and safe tires, but not new tires
- Manufacturer fuel cap, and not aftermarket cap, if that can be determined
- No significant modifications by previous owner and no aftermarket equipment
- Passes evaporative emissions inspection, including pressure decay check (Section 3.3)
- VIN, ECM calibration, and emissions certification family check by participating manufacturer

REQUIREMENTS FOR BOTH VEHICLES IN THE PAIR:

- Same or comparable ECM calibration as determined by OEM
- Same engine emissions certification family
- Same evaporative emissions certification family
- Production dates are within six months of each other
- Odometer within 20,000 miles of each other

Candidate vehicles also completed an abbreviated screening test to ensure emissions were within applicable standards, as follows:

- Road Load Derivation
- Drain and Refuel with TE0_Alt (High Altitude Certification Gasoline)
- Soak 12-36 hrs
- Canister Purge
- Canister Load, 2g break through
- FTP-75 Bag Only
- SHED one-hour hot soak

The twenty vehicles participating in the study are summarized in Table 1. The vehicles were recruited from the public fleet. The inspections described above provided some safeguard against owner tampering and vehicle abuse. The vehicle history with regards to fueling or misfueling with unapproved fuels was unknown, with the exception of the Toyota Prius vehicles that were purchased new.

The vehicles were given unique ID numbers and large color-coded labeling to ensure positive identification and proper refueling. The vehicles were labeled in pairs, and there were ten pairs in the study. A pair consisted of two vehicles of the same make and model. For example, one vehicle was identified as “6E0” with white labeling to designate RE0 road fuel was to be used for aging, and a closely matched vehicle was identified as “6E20” with yellow labeling to designate RE20 fuel was to be used for aging. The results from this study are presented in blind fashion, so the vehicle ID numbers do not coincide with the vehicle order presented in Table 1.

Table 1. Vehicles Participating in CRC E-91 Study

Model Year	Make	Model	Engine Size (L)	# of Cylinders	Fuel Tank Size (Gal)	Fuel Tank Material	Fuel for Aging	Miles Driven/Year	Engine Family	Evap Family	Exhaust Emissions Standard	Federal Evaporative Emissions Standards
2004	Chrysler	PT Cruiser	2.4	4	15	Plastic	E0	13000	4CRXV02.4VE0	4CRXR0101GBB	T2B5	Enhanced Evap 100% Phase-In, 2.5g
							E20	14000	4CRXV02.4VE0	4CRXR0101GBB		
2003	Buick	LeSabre	3.8	6	18	Plastic	E0	11000	3GMXV03.8044	3GMXR0133910	T2B8	Enhanced Evap 100% Phase-In, 2.5g
							E20	9000	3GMXV03.8044	3GMXR0133910		
2009	Toyota	Corolla	1.8	4	13.2	Plastic	E0	23000	9TYXV01.8BEA	9TYXR0115P12	T2B5	Federal Tier2 2009 LDV, 0.65g
							E20	19000	9TYXV01.8BEA	9TYXR0115P12		
2002	VW	Jetta	2	4	14.5	Plastic	E0	10000	2VWXV02.0223	2VWXR0110234	ULEV	Enhanced Evap 100% Phase-In, 2.5g
							E20	8000	2VWXV02.0223	2VWXR0110234		
2007	Honda	CRV	2.4	4	15.3	Plastic	E0	13000	7HNXT02.4FKR	7HNXR0140BBA	T2B5	Federal Tier2 2004 LDV/LLDT, 1.2g
							E20	11000	7HNXT02.4FKR	7HNXR0140BBA		
2007	Nissan	Pathfinder	4	6	21.1	Plastic	E0	23000	7NSXTO4.0G6A	7NSXR0132PBA	T2B5	Federal Tier2 2004 LDV/LLDT, 1.2g
							E20	23000	7NSXTO4.0G6A	7NSXR0132PBA		
2010	Toyota	Prius	1.8	4	11.9	Plastic	E0	8000	ATYXV01.8HC3	ATYXR0110P42	CA LEV-II SULEV	Federal Tier2 2009 LDV, 0.65g
							E20	8000	ATYXV01.8HC3	ATYXR0110P42		
2008	Ford	Taurus	3.5	6	20	Plastic	E0	21000	8FMXV03.5VEP	8FMXR0145KBK	T2B5	Federal Tier2 2004 LDV/LLDT, 1.2g
							E20	14000	8FMXV03.5VEP	8FMXR0145KBK		
2004	Pontiac	Grand Am	3.4	6	14.1	Plastic	E0	7000	4GMXV03.8042	4GMXR0124919	T2B5	Enhanced Evap 100% Phase-In, 2.5g
							E20	7000	4GMXV03.8042	4GMXR0124919		
2004	Dodge	Neon	2	4	12.5	Plastic	E0	12000	4CRXV02.0VH0	4CRXR0101GBA	T2B8	Enhanced Evap 100% Phase-In, 2.5g
							E20	13000	4CRXV02.0VH0	4CRXR0101GBA		

3.2 Vehicle Preparation

Following recruitment, the vehicles were conditioned for evaporative emissions testing. The conditioning process was necessary to remove or otherwise “off-gas” interior surface treatments (e.g., “Armor All”), tire treatments, and vehicle finish polishes, and to minimize any street fuel carry-over effects. Conditioning included the following tasks:

- Washed vehicle with degreaser
- Removed windshield washer and flushed washer bottle with water
- Baked the vehicle at 120°F in a ventilated environment for 48 to 72 hours

- Completed a Standard Road Cycle (SRC) drive on the chassis dynamometer every other day, for a total of 7 drives over a 14 day period using high altitude certification fuel TE0_Alt
- Soaked vehicle in a temperature and humidity-controlled indoor environment over this duration

A previous study has shown that fuel carry-over can occur when changing fuel types, and that permeation emissions generally reached stabilized levels after about 1 to 2 weeks following a fuel change [6]. In consideration of this, 14 days of conditioning was performed following fuel changes as a practical means to reduce fuel carry-over effects on the emissions measurements.

The 2010 Toyota Prius vehicles were purchased new. In order to "off-gas" hydrocarbons associated with new car production, the vehicles were baked and driven on the chassis dynamometer using the following conditioning procedure:

- Washed car with degreaser
- Mileage accumulation to 1000 miles using SRC and ethanol-free road fuel
- Baked vehicle in environmental chamber at 120°F for 2 weeks. Windows down, trunk and hood open and a fan blowing across the interior of the vehicle.
- Repeated mileage accumulation and baking cycle until 4000 miles and 8 weeks of baking was reached
- Completed one SRC drive every other day for 14 days on the chassis dynamometer using high altitude certification fuel TE0_Alt
- Soaked vehicle in temperature and humidity-controlled indoor environment over this duration

3.3 Overall Test Plan and Test Procedure Sequence

The test plan was designed to compare the evaporative emissions from ethanol-free gasoline (E0) fueled vehicles to their counterparts fueled on 20%vol ethanol in gasoline blend (E20). Each vehicle was tested in the SHED to establish a benchmark for evaporative emissions and permeation rates. The vehicles were then aged over four quarterly driving periods spanning the four seasons. Each vehicle was nominally driven twice per day and parked outdoors for a minimum of 8 hours between drives. Each vehicle accumulated approximately 18,650 miles over a duration exceeding 18 months. The vehicles were re-tested at the end of each quarterly aging period where fuel exposure had occurred. By virtue of having nominally equivalent vehicles in each pair, the data were used to determine if the type of fuel had an impact on permeation and evaporative emissions over time. Exhaust emissions were also measured for each vehicle using ethanol-free certification fuel over the FTP-75 certification cycle.

The test sequence and fuel used for each test procedure is summarized in Table 2. Due to budget considerations, different fuels were used for road aging and for the SHED testing. The fuels used in the study are described in Section 4.0. The road fuels (also known as aging fuels, designated with "R" prefix) were based on market fuels obtained in bulk quantities from local fuel distributors. The test fuels (designated with a "T" prefix) were based on emissions certification gasoline. Fuels designated RE0, TE0, and TE0_Alt were all ethanol-free fuels. Fuels designated RE20 and TE20 contained 20%vol ethanol.

The vehicles identified as ID#E0 (example: Vehicle 2E0 and Vehicle 10E0 have E0 suffix) were exposed only to ethanol-free fuels. The vehicles identified as ID#E20 (example: Vehicle 1E20 and Vehicle 10E20 have E20 suffix) were aged on 20% ethanol-containing fuel, but were emissions tested on both ethanol-free fuel and fuel containing 20% ethanol.

Table 2. Test Sequence and Fuel Summary for CRC E-91

	SGS Environmental Testing Laboratory, Colorado 5440 Feet Above Sea Level			Chrysler Chelsea Proving Grounds, Michigan 930 Feet Above Sea Level		
Days of On-Road Aging / Fuel Exposure	Test Sequence	Fuel for Car ID#E0	Fuel for Car ID#E20	Test Sequence	Fuel for Car ID#E0	Fuel for Car ID#E20
0 Days	14 Day Fuel Conditioning - 7 SRCs	TE0_Alt	TE0_Alt	Performed at SGS		
0 Days	Baseline #1 - 0 Days	TE0_Alt	TE0_Alt	Performed at SGS		
0 Days	Cars Modified for Permeation Test			Performed at SGS		
0 Days	Baseline #2 - 0 Days	TE0_Alt	TE0_Alt	Performed at SGS		
0 Days				Baseline #3 - 0 Days	TE0	TE0
0 Days				Baseline #4 - 0 Days	TE0	TE0
0 Days	Permeation #1 - 0 Days	TE0	TE20	Permeation #1 - 0 Days	TE0	TE20
	Maintenance, Oil Change			Maintenance, Oil Change		
	Q1 76 Day On-Road SRC Aging	RE0	RE20	Q1 76 Day On-Road SRC Aging	RE0	RE20
	Q1 14 Day On-Road SRC Aging	TE0	TE20	Q1 14 Day On-Road SRC Aging	TE0	TE20
90 Days	Inspection, Prep for Testing			Inspection, Prep for Testing		
90 Days	Permeation #2 - 90 Days	TE0	TE20	Permeation #2 - 90 Days	TE0	TE20
90 Days	14 Day Fuel Conditioning - 7 SRCs	TE0_Alt	TE0_Alt	14 Day Fuel Conditioning - 7 SRCs	TE0	TE0
90 Days	Baseline #5 - 90 Days	TE0_Alt	TE0_Alt	Baseline #5 - 90 Days	TE0	TE0
	Maintenance, Oil Change			Maintenance, Oil Change		
	Q2 76 Day On-Road SRC Aging	RE0	RE20	Q2 76 Day On-Road SRC Aging	RE0	RE20
	Q2 14 Day On-Road SRC Aging	TE0	TE20	Q2 14 Day On-Road SRC Aging	TE0	TE20
180 Days	Inspection, Prep for Testing			Inspection, Prep for Testing		
180 Days	Permeation #3 - 180 Days	TE0	TE20	Permeation #3 - 180 Days	TE0	TE20
180 Days	14 Day Fuel Conditioning - 7 SRCs	TE0_Alt	TE0_Alt	14 Day Fuel Conditioning - 7 SRCs	TE0	TE0
180 Days	Baseline #6 - 180 Days	TE0_Alt	TE0_Alt	Baseline #6 - 180 Days	TE0	TE0
	Maintenance, Oil Change			Maintenance, Oil Change		
	Q3 76 Day On-Road SRC Aging	RE0	RE20	Q3 76 Day On-Road SRC Aging	RE0	RE20
	Q3 14 Day On-Road SRC Aging	TE0	TE20	Q3 14 Day On-Road SRC Aging	TE0	TE20
270 Days	Inspection, Prep for Testing			Inspection, Prep for Testing		
270 Days	Permeation #4 - 270 Days	TE0	TE20	Permeation #4 - 270 Days	TE0	TE20
270 Days	14 Day Fuel Conditioning - 7 SRCs	TE0_Alt	TE0_Alt	14 Day Fuel Conditioning - 7 SRCs	TE0	TE0
270 Days	Baseline #7 - 270 Days	TE0_Alt	TE0_Alt	Baseline #7 - 270 Days	TE0	TE0
	Maintenance, Oil Change			Maintenance, Oil Change		
	Q4 76 Day On-Road SRC Aging	RE0	RE20	Q4 76 Day On-Road SRC Aging	RE0	RE20
	Q4 14 Day On-Road SRC Aging	TE0	TE20	Q4 14 Day On-Road SRC Aging	TE0	TE20
360 Days	Inspection, Prep for Testing			Inspection, Prep for Testing		
360 Days	Permeation #5 - 360 Days	TE0	TE20	Permeation #5 - 360 Days	TE0	TE20
360 Days	14 Day Fuel Conditioning - 7 SRCs	TE0_Alt	TE0_Alt	14 Day Fuel Conditioning - 7 SRCs	TE0	TE0
360 Days	Baseline #8 - 360 Days	TE0_Alt	TE0_Alt	Baseline #8 - 360 Days	TE0	TE0

Care was taken to condition the vehicles prior to SHED testing to reduce any fuel carryover or off-gassing effects that may impact SHED results (Section 3.2). SHED testing was then performed to establish a benchmark for evaporative emissions and permeation before the aging process began. Two types of SHED test sequences were performed for each vehicle:

- The "Baseline Test" was similar to a supplemental certification test sequence consisting of a LA4 prep cycle, soak and canister load, FTP75 cycle, one-hour hot soak SHED test and two-day diurnal SHED test. The Baseline Test was always performed using the ethanol-free certification gasoline compliant with 40CFR86.113-04. Results from this test provided information on how

E20 fuel substitution may affect compliance with EPA evaporative emissions standards. The Baseline Test procedure is further discussed in Section 3.4.

- The "Permeation Test" quantified the amount of permeation that contributed to evaporative emissions. The Permeation Test sequence included a two-hour modal SHED test, one-hour hot soak SHED test and a two-day diurnal SHED test. Vehicles aged on E0 fuel were tested using TE0 fuel, and vehicles aged on E20 fuel were tested using TE20 fuel. The vehicles required small modifications to perform the Permeation Tests, including a modified gas cap for fuel tank pressurization, a Schrader valve to efficiently drain the fuel system, and a relay to activate the fuel pump in the SHED. Permeation Tests always had the vehicle canister vent port routed outside of the SHED. Results from this test provided information on the possible sources of permeation, vapor leaks and fuel pressure driven leaks. The Permeation Test procedure was adapted from CRC E-77 [8], and is further discussed in Section 3.5.

All twenty vehicles were conditioned and initially tested in SHEDs in Colorado. Two Baseline Tests were performed, one test before (Baseline #1, Table 2) and one test after the vehicle modifications were made (Baseline #2, Table 2). The intent of performing the two Baseline Tests was to demonstrate that the vehicle modifications had no impact on the evaporative emissions of the vehicles.

Following Baseline Testing, 16 of the vehicles were shipped to Michigan using enclosed vehicle carriers. Closed carriers were used to eliminate possible road contamination of the vehicles. Four vehicles remained in Colorado, Vehicle IDs # 4E0, 4E20, 8E0 and 8E20. The fleet was split in order to collect data at low and high altitudes, since evaporative emissions systems must be designed to meet EPA standards from 0 to 5500 feet elevation above sea level.

Upon arrival in Michigan, the 16 vehicles were driven on a track to adapt their control systems to low altitude operation. Two Baseline Tests were then performed to establish an evaporative emissions benchmark and to allow a direct comparison of the SHED and exhaust emissions results between the high altitude and low altitude emissions laboratories.

Permeation Tests were also performed for all vehicles to establish a benchmark for permeation leak rates. The vehicles were then serviced, including an oil change and safety inspection.

Next the vehicles were aged over four quarterly driving periods spanning the four seasons. Each vehicle was nominally driven twice per day and parked outdoors for a minimum of eight hours between drives.

The vehicles were aged on the road using a driver's aid (verbal instructions recorded on an audio compact disk) to approximate the EPA's Standard Road Cycle (SRC). The SRC is a lap-based track cycle with an average speed of 46.3mph over a 25.9 mile distance, lasting about 33.4 minutes (Figure 2).

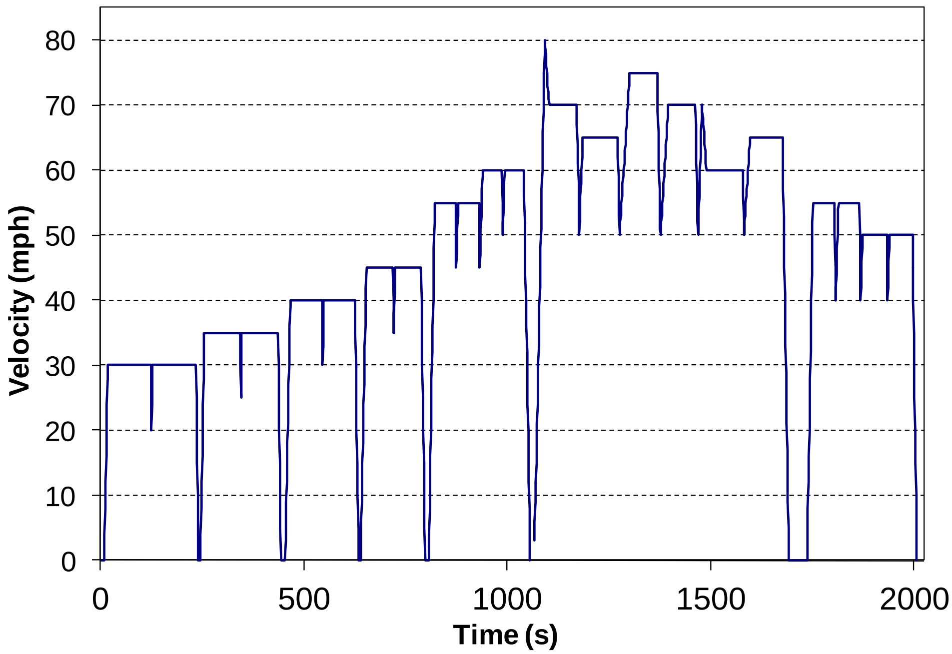


Figure 2. Standard Road Cycle

Each quarterly aging period consisted of 180 drives per vehicle, nominally performed at the rate of two SRC drives per day over 90 days. Frequently, it was not possible to complete 180 drives in 90 days, due to vehicle repairs, inclement weather, holiday interruptions, or driver availability. The vehicles were parked outdoors for the entire aging process, and a soak time of at least eight hours was required between drives. The aging process was considered to be representative of real-world operation, in the sense that the number of daily trips, trip lengths, annual mileage accumulation, and outdoor exposure were somewhat comparable to the experience of a typical suburban commuter.

Within each aging period, the vehicles used road fuel (RE0 or RE20) for the first 76 days of aging and then switched to SHED test fuel (TE0 or TE20) for the remaining 14 days of on-road aging. This approach allowed economical aging of the vehicles using lower-priced road fuel and also allowed sufficient time to condition the vehicles on the test fuel before SHED testing.

The E0 and E20 fueled vehicles were aged simultaneously. If one vehicle needed repair during aging, mileage accumulation was also halted for the other vehicle in that pair. Each vehicle accumulated approximately 4662 miles per quarter, or about 18648 miles over a duration exceeding 18 months.

After the 180 drives were completed, the following preparations were made prior to testing:

- Vehicle washed without soap
- Vehicle washer bottle inspected for washer fluid, drained and flushed with water if necessary
- Basic maintenance checks performed (fluids, hoses, belts)
- Vehicle exhaust system leak checked

- Vehicle evaporative emissions system integrity check performed. At soak conditions, the vehicle's evaporative emissions system was pressurized with shop air through the canister vent to 13" H_2O. Pressure should not decay over 5 minutes.
- Vehicle was stored in temperature and humidity-controlled soak area until testing completed

The Permeation Test sequence was then performed. The vehicle was subsequently refueled with certification gasoline and conditioned by driving one SRC on the chassis dynamometer every other day for 14 days. The Baseline SHED test sequence was then performed. Vehicle maintenance was completed, including an oil and filter change. The vehicle was returned to the track to begin the next quarterly aging period.

Over 600 individual SHED tests and 152 FTP75 exhaust emissions tests were performed for the study.

3.4 Baseline Test Procedure

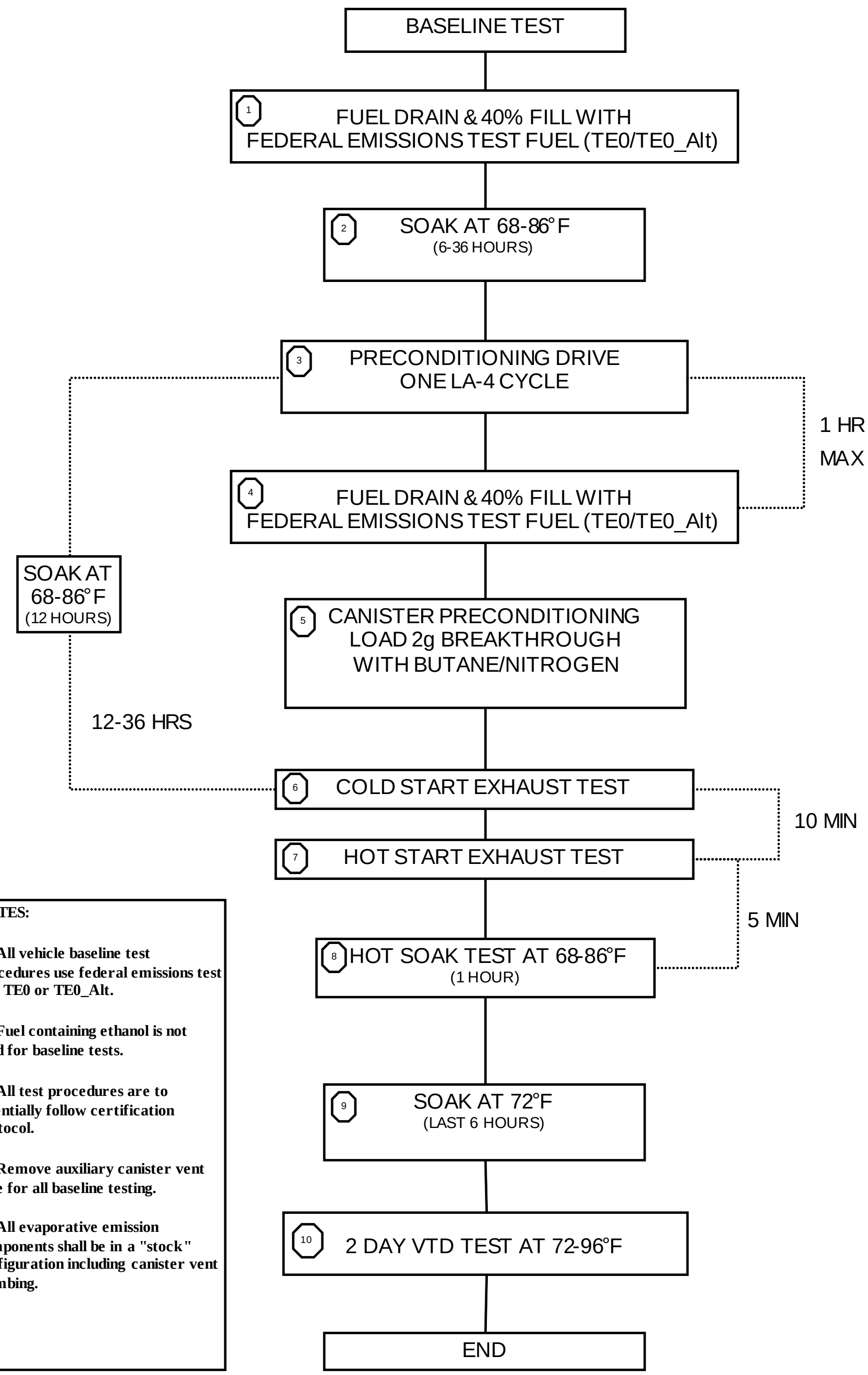
The "Baseline Test" was similar to the federal supplemental evaporative certification test sequence, also known as the two-day diurnal per 40CFR86 Subpart B. The major steps in the procedure are shown in flowchart format in Figure 3. The Baseline Test was always performed using the ethanol-free certification gasoline compliant with 40CFR86.113-04.

The procedure consisted of an initial drain-and-refuel procedure to purge the previous fuel. Complete fuel drains were aided by a Schrader valve installed in the fuel rail of each vehicle. Following the LA-4 prep cycle, another drain-and-refuel was performed to introduce fresh fuel into the fuel tank as required by the 40CFR Part 86 standard.

Canister loads were performed using automated load stations. 50% butane/50% nitrogen gas mixtures were introduced through the service port of the evaporative emissions system, if equipped. For vehicles without a service port, canister loads were performed by introducing the butane/nitrogen gas through a modified gas cap that was only installed for the canister loading portion of the sequence. The vent of the canister was connected to a slave canister. Canister loading was completed when a 2g breakthrough was measured on the slave canister scale. A minimum 12 hour soak allowed time for any minor fuel spills associated with the drain-and-refuel procedure to evaporate before testing.

A FTP75 certification test procedure was performed following the soak period using certification-compliant chassis dynamometer laboratories (Figure 4). Ambient and vehicle exhaust samples were collected for each phase using 3-bag sampling. Simultaneous collection of ambient and dilute emissions samples ensured accurate quantification of cycle average exhaust mass emissions. For normally functioning vehicles, the purge valve opens during the cycle to reduce the canister load. If this purge did not occur, evaporative emissions would be extremely high during subsequent SHED testing due to displacement of canister vapors into the SHED.

CRC E-91 BASELINE TEST PROCEDURE



NOTES:

1. All vehicle baseline test procedures use federal emissions test fuel TE0 or TE0_Alt.
2. Fuel containing ethanol is not used for baseline tests.
3. All test procedures are to essentially follow certification protocol.
4. Remove auxiliary canister vent hose for all baseline testing.
5. All evaporative emission components shall be in a "stock" configuration including canister vent plumbing.

Figure 3. CRC E-91 Baseline Test Procedure

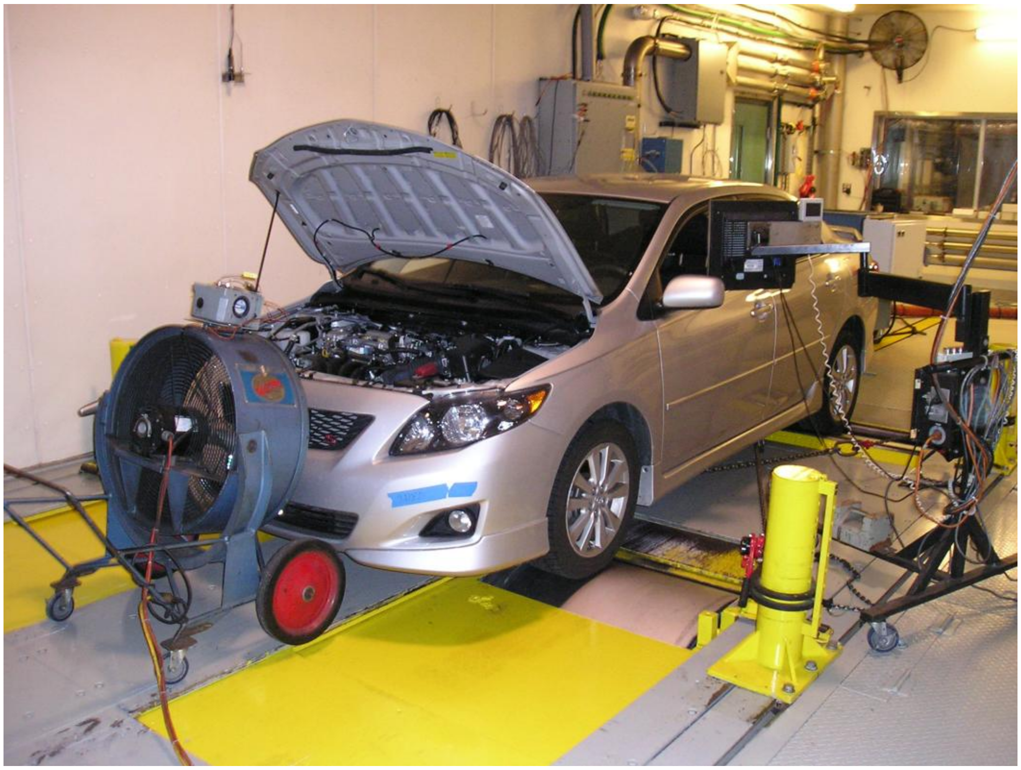


Figure 4. Corolla Tested on 48" Burke Porter Dynamometer, at SGS Emissions Laboratory

Within five minutes after the FTP75 drive cycle, the vehicle was loaded into the SHED, where a one-hour hot soak SHED test was performed. The hydrocarbon mass from the one-hour hot soak was reviewed before proceeding to the two-day diurnal, because high emissions can be an indicator of fuel contamination, evaporative system failure, or an inadequate canister purge.

A six hour stabilization at 72°F was then followed by a two-day diurnal test, from 72°-96°-72°F. The evaporative emissions were determined for each day.

The primary results from the Baseline SHED test sequence were:

- Hydrocarbon mass (g/hour) from the one-hour hot soak SHED
- Hydrocarbon mass (g/day) from the first diurnal
- Hydrocarbon mass (g/day) from the second diurnal
- Hydrocarbon mass (grams) equal to the highest daily mass emission plus the one-hour hot soak mass. This is the relevant metric used for comparison to the EPA certification standard.

The Baseline Tests performed for this study should not be considered certification tests. The test vehicles were recruited from the public fleet and had significant aging and unknown maintenance and fueling history. Also some liberties were taken such as reclaiming the refrigerant from vehicles with leaking A/C systems prior to SHED testing as described in Section 7.9.

The SHEDs used for the study were compliant with certification standards (Figure 5). The SHEDs had fully automated control systems and were equipped with fill and evacuation functions, including measurement of hydrocarbon in the evacuated gas. In addition to the FID used for hydrocarbon measurement, an Innova photoacoustic analyzer was used to measure ethanol, methanol and refrigerant as described in the following section.

Figure 5. Jetta Loaded in the Chrysler CPG SHED

3.5 Permeation Test Sequence

The Permeation Test sequence was adopted from the procedure developed in the CRC E-77 study [8], which sought to isolate the mechanisms of evaporative emissions:

- Permeation through various elastomers, effected by material, fuel composition, and temperature
- Vapor leaks driven by fuel tank pressurization
- Liquid fuel leaks driven by fuel system activation
- Fuel tank vapor venting normally through the canister vent port

In order to perform the Permeation Tests, modifications were made to the vehicles. Baseline SHED tests were run before and after the modifications were made to confirm that these modifications did not impact SHED results:

- A modified gas cap was constructed to allow for fuel tank pressurization and to load the canister for the Baseline test sequence for vehicles not equipped with an evaporative emissions system service port. The gas cap was modified in a manner that allowed normal function during installation (Figure 6). The modified gas cap was used only for the two-hour Permeation SHED test. The original stock gas cap was used for all on-road aging and all other SHED test procedures.

- If a vehicle was not already equipped with a fuel rail service valve, a Schrader valve was added to facilitate complete fuel drains. This modification used all-metallic components to ensure no permeable materials were added. A pipe thread fitting was metal-bonded to the fuel rail, and a nickel-plated Schrader valve was used in favor of brass for ethanol compatibility.
- An electrical relay was added to allow fuel pump activation from inside the SHED without starting the vehicle.
- A non-permeable line was run from the canister vent port to the back of the vehicle. This line allowed the technician to connect a non-permeable hose from the vent line to the slave canister outside of the SHED without crawling under the vehicle. An easy hose connection was imperative, as the vehicle needed to be configured for testing in less than seven minutes between the end of dyno testing and the beginning of the one-hour hot soak segment of the Permeation Test.
- A surface mount thermocouple was added externally to the fuel tank, below the liquid level for fuel temperature measurement.

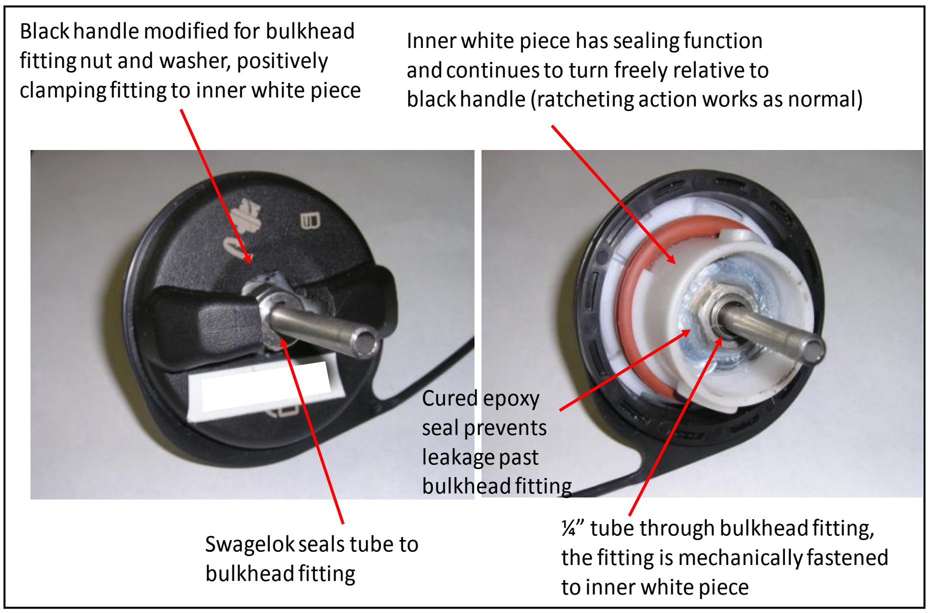


Figure 6. Modified Gas Cap for Two-Hour Permeation Test in SHED

The Permeation Test sequence is summarized in Figure 7. The control vehicles (ID#E0) were tested using TE0 fuel, and the vehicles aged on E20 (ID#E20) were tested using TE20 fuel. The Permeation Test Sequence included three different SHED tests: a two-hour modal SHED, a one-hour hot soak at 86°F, and a two-day diurnal test. The vehicle canister was vented to a slave canister outside the SHED for all three SHED tests, so that fuel tank gases venting through the canister were not included in the SHED hydrocarbon measurement. This was designed to isolate permeation sources from the fuel tank venting mechanism of evaporative emissions. The SHED was modified to perform the Permeation sequence, and the process was completely automated (Figure 8).

CRC E-91 PERMEATION TEST PROCEDURE

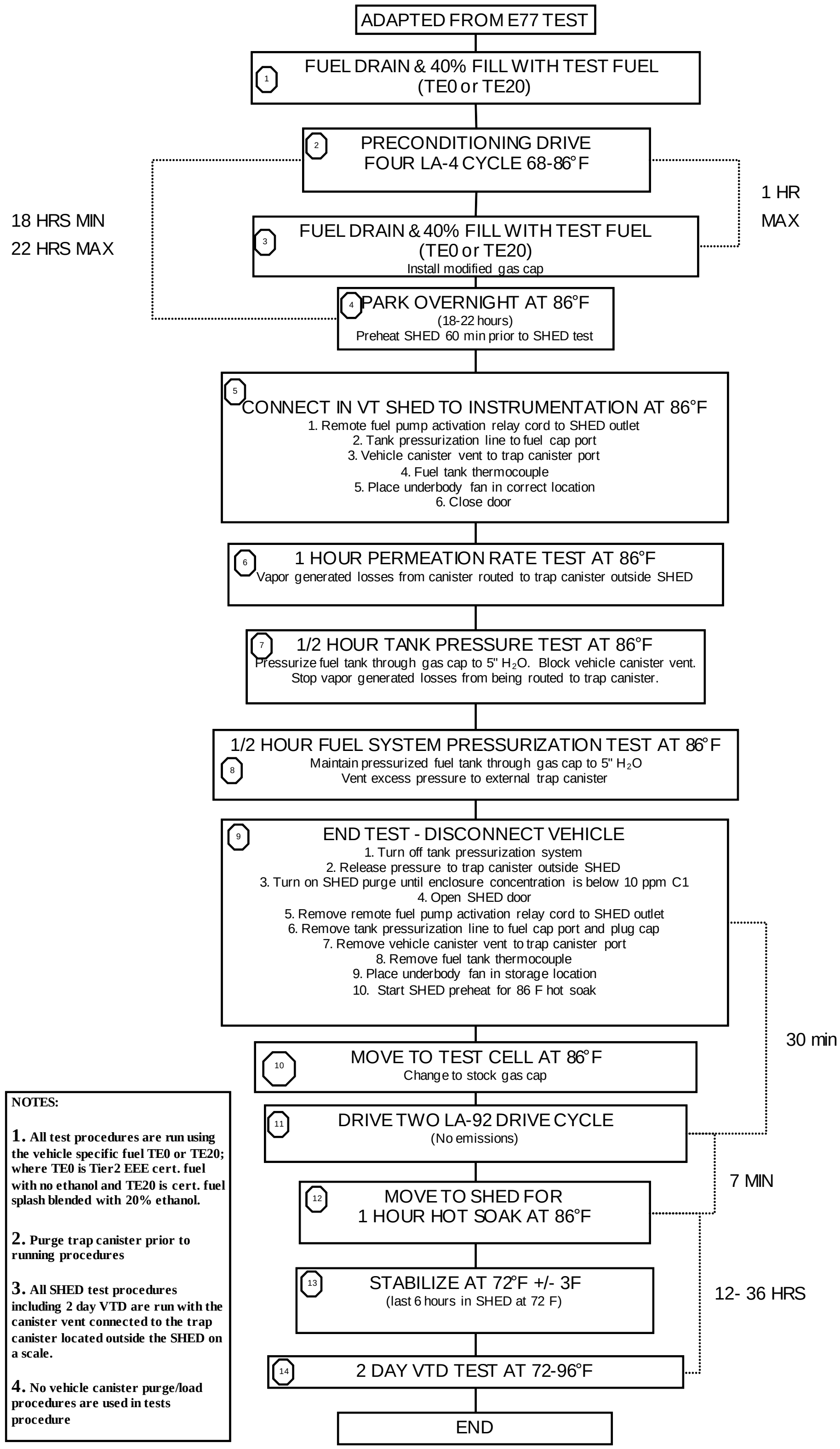


Figure 7. CRC E-91 Permeation Test Procedure

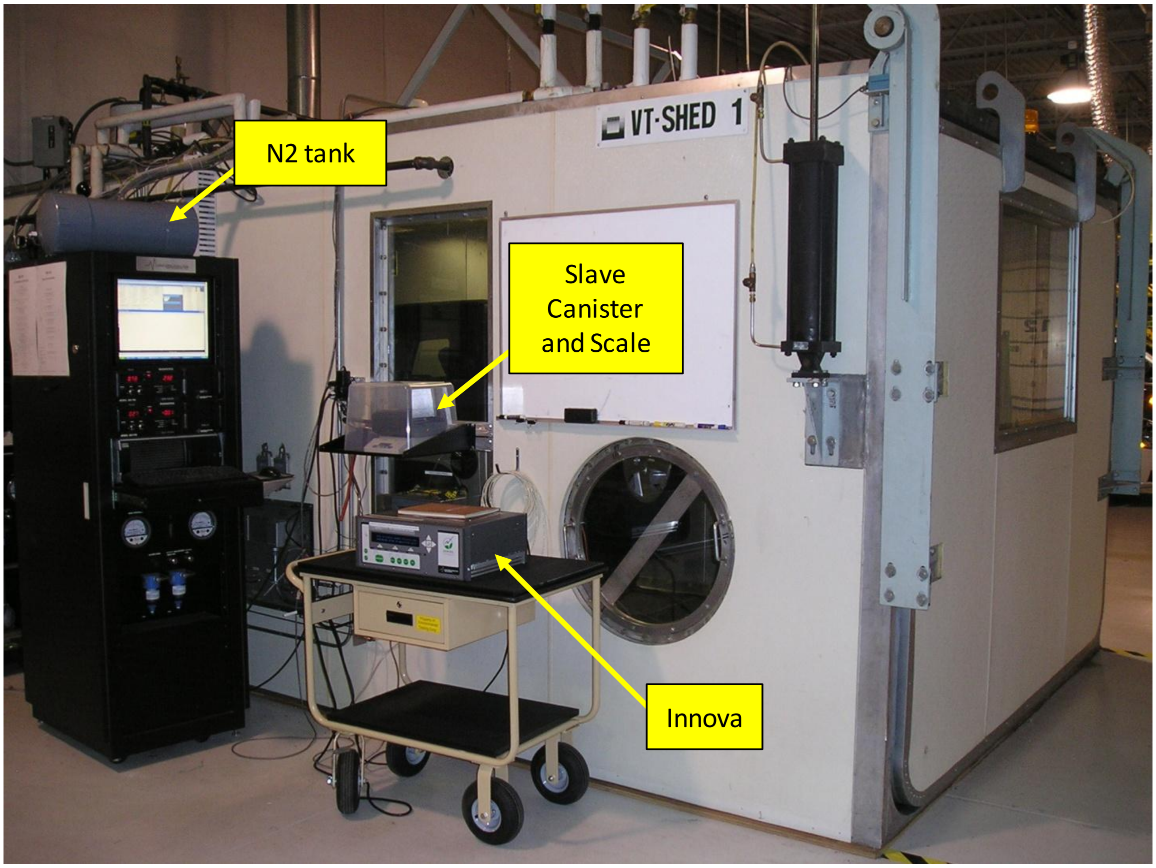


Figure 8. SHED Features for Permeation Test

The two-hour modal SHED test was useful for determining the presence or absence of leaks, and also for diagnosing the cause of vehicle problems. Hydrocarbon concentration was measured continuously using a flame ionization detector, with data logged at 1Hz. The two-hour Permeation Test included three modes.

- For the first mode lasting 60 minutes, the vehicle soaked at 86°F to establish the permeation rate. The emissions measured during this period were considered to be due to permeation only, provided any off-gassing of the tires, adhesives, and plastics were considered negligible. Actions were taken to quantify and minimize off-gassing effects (per Section 3.2, Appendix 12.1, Appendix 12.2).
- For the second mode lasting 30 minutes, the fuel tank was pressurized to 5” H_2O through the modified gas cap by closing a solenoid valve on the canister vent line (SV5). The fuel tank pressurization system is depicted in Figure 9. This mode was intended to expose any vapor leaks in the vehicle’s evaporative emissions control system. If the hydrocarbon “leak rate” did not change relative to the first mode, it was deduced that no vapor leak was present.
- For the third mode lasting 30 minutes, the fuel tank remained pressurized and the fuel pump was activated. The fuel tank temperature increased during fuel pump activation and was monitored as a quality check to ensure the pump was truly energized. Any changes to the hydrocarbon “leak rate” were attributed to either a liquid leak or an increase in the vapor leak caused by the increased fuel tank temperature.

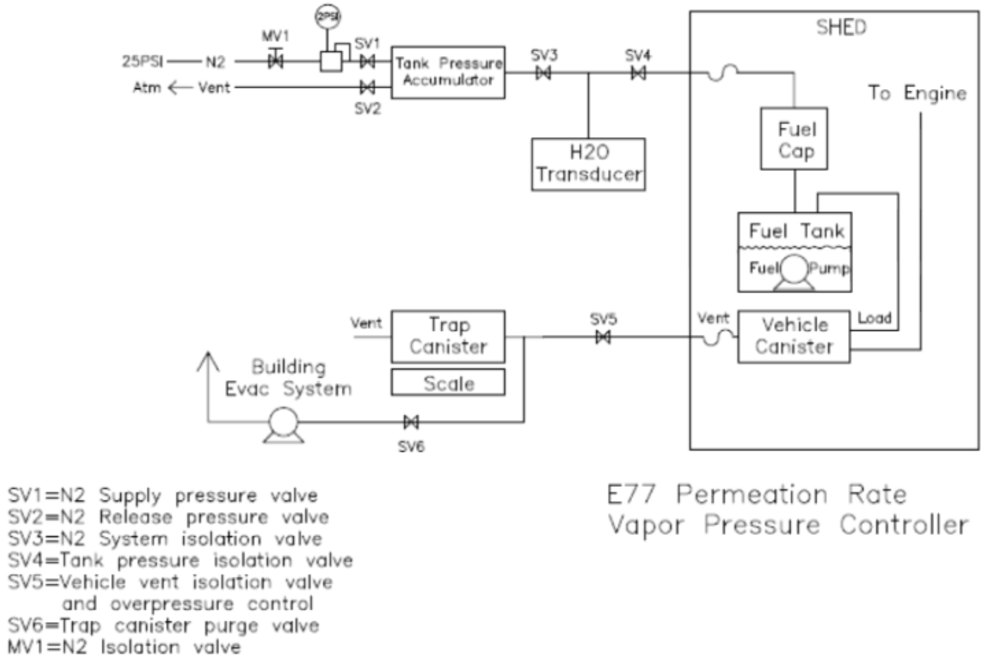


Figure 9. Control Schematic Used for E-91 SHED Permeation Test

The permeation leak rates were determined by analyzing the continuous hydrocarbon mass throughout the two-hour test (Figure 10). The absolute leak rate was determined by linear regression, over the last 30 minutes of Mode 1, and over the last 15 minutes of Modes 2 and 3 respectively. The permeation rate was not calculated over the duration of the entire mode, because some period of time was needed to promote mixing in the SHED after each event was triggered. The absolute permeation rates were calculated using 1Hz data in the present study, compared to the use of 30 second data in the E-77 study.

Following the two-hour test, the vehicle was moved to the chassis dynamometer laboratory and the modified gas cap was replaced with the stock gas cap. Two consecutive LA-92 driving cycles were driven with the test cell temperature held to 86°F. Underbody heating was not used for the procedure. The driving procedure was performed only for vehicle and fuel conditioning, and not for the purposes of performing running loss measurements as was done in the E-77 study.

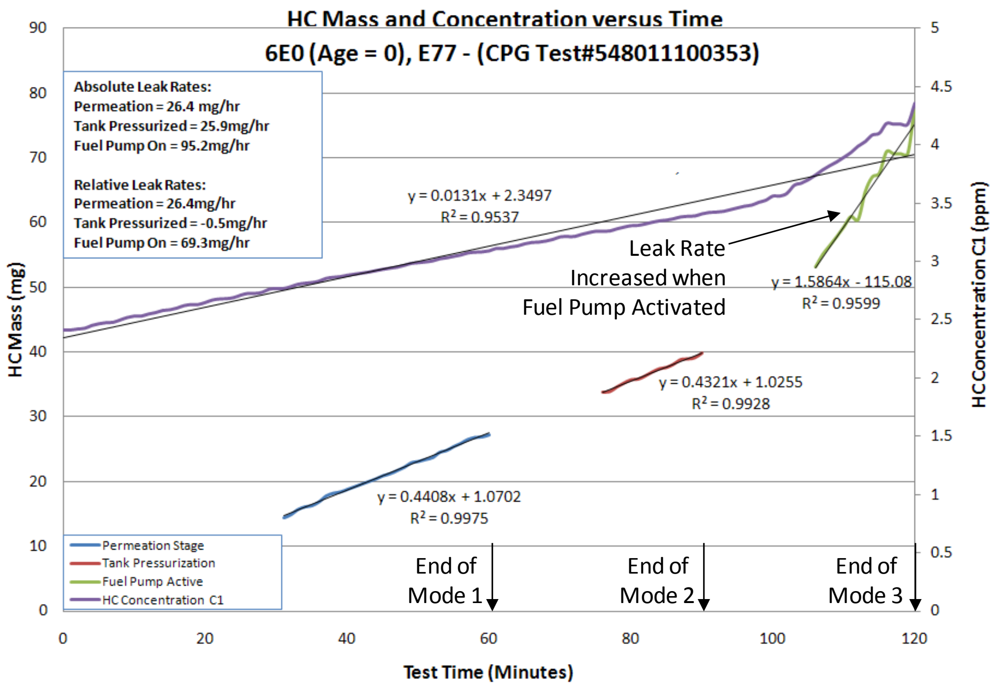


Figure 10. Example of a Two-Hour Permeation Test Result

Following the driving procedure, the vehicle was quickly loaded into the SHED and a one-hour hot soak test was performed at 86°F. A six-hour stabilization at 72°F was then followed by a two-day diurnal test, from 72-96-72°F. Once again, during these Permeation Tests, the vehicle canister was vented to a slave canister outside the SHED, in order to isolate the permeation sources from the fuel tank venting mechanism of evaporative emissions.

The primary results from the Permeation SHED test sequence were:

- Hydrocarbon permeation rate (g/hour) from Mode 1, 2 and 3 of the Two-Hour Permeation Test
- Hydrocarbon mass (g/hour) from the one-hour hot soak SHED
- Hydrocarbon mass (g/day) from the first diurnal
- Hydrocarbon mass (g/day) from the second diurnal

The primary differences between the E-91 Permeation Test procedure and the E-77 procedure were:

- The E-91 Study pressurized the fuel tank with nitrogen for safety for the two-hour SHED test, while E-77 used shop air.
- The E-91 Study measured hydrocarbons continuously and logged data at 1Hz for the two-hour SHED test, where E-77 had 30 second logs.
- Prior to the one-hour hot soak SHED test, each E-91 vehicle was driven on two consecutive LA92 cycles for vehicle and fuel conditioning purposes, and running loss and underbody heating was not performed. The E-77 Study performed running loss tests.
- The E-91 Study used an Innova photoacoustic analyzer to measure ethanol, methanol and R134a refrigerant concentrations in the SHED.

Innova data were useful to monitor possible causes for unexpected hydrocarbon emissions for both the Permeation and Baseline Tests. The Innova was set to run in loop sampling mode. The Innova instrument had inherent noise associated with measuring the extremely low concentrations of ethanol, methanol and R134a. Innova measurement noise was also evident in previous studies [9,10,11]. Because the Innova instrument is not compared to a known reference standard prior to each SHED test (unlike virtual zero-spans done with the FID), the Innova may be more prone to measurement anomalies. To avoid confounding the FID HC data with this noisy data, no attempt was made to use the Innova measurements to make response factor corrections to the FID hydrocarbon measurement. Rather, care was taken to minimize contributors to methanol and R134a emissions similar to the approach taken in the CRC E-77 pilot study [8]. Methanol and R134a masses were quantified and monitored, and outlier measurements triggered an investigation to explore possible causes. Windshield washer bottles were flushed prior to all tests (Section 3.2) and refrigerant leaks were repaired (Section 7.3), or for one vehicle model refrigerant was reclaimed prior to SHED testing (Section 7.9).

Linearity verification of the Innova instruments was performed using working gases at least monthly. The Innova results were used for trend analysis and for estimating ethanol, methanol and refrigerant mass emissions.

4.0 Fuels

Different fuels were used for aging the vehicles on-road and for SHED testing for economical reasons. Some test fuel quotes exceeded $35/gallon, so it was necessary to consider a variety of fuel sourcing and fuel preparation options to meet the overall project objectives at a reasonable cost.

The road fuels, also known as aging fuels, were designated RE0 for ethanol-free gasoline, and RE20 for 20%vol ethanol splash-blended into gasoline. The fuels used for aging were market fuels obtained in bulk quantities from local fuel distributors. The RVP of the road fuels varied seasonally, which was desirable for a real-world fuel exposure study. Due to the length of the study, testing at two different locations, and cost considerations, it was not possible to maintain a common batch of fuel for the on road aging.

- In Colorado, the ethanol-free gasoline RE0 had an anti-knock index ((R+M)/2) of 85, the standard for regular unleaded gasoline for the Denver area. This same base fuel was splash-blended with 20%vol fuel grade ethanol for aging the E20 vehicles. The fuel grade ethanol was denatured with approximately 3% isopentane.
- In Michigan, the source of the ethanol-free fuel RE0 changed during the study because ethanol-free fuel was being phased out of commercial markets. Due to the scarcity of ethanol-free fuel in the marketplace, the RE20 fuel was prepared by splash-blending fuel-grade ethanol into E10 fuel from the local market. The E10 base fuel had an anti-knock index of 87, the standard for regular unleaded gasoline in southeast Michigan.

Ethanol content for RE20 was held to a tolerance of ±1%vol (Figure 11). The ethanol content of RE0 was verified to be less than 0.1%.

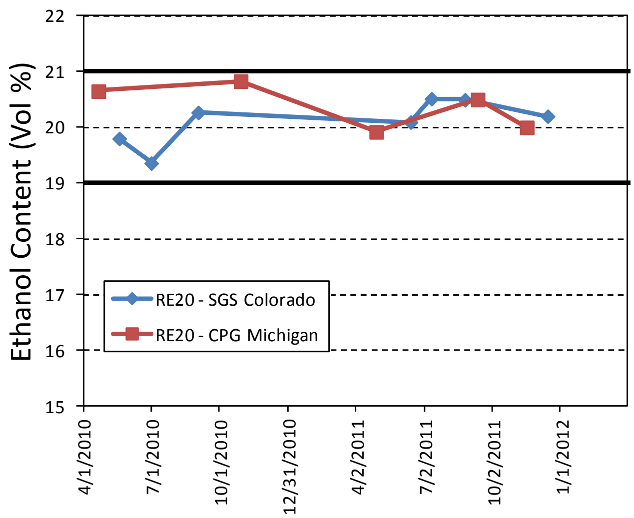


Figure 11. Ethanol Content for Bulk Deliveries of Road Aging Fuels

The test fuels, designated with a "T" prefix, were used for the 14 day conditioning process, the SHED tests and the exhaust emissions tests. The tests fuels were selected and prepared so the RVP was the same for both the E0 and E20 fueled vehicles. RVP was controlled so any differences in the test results would not be attributed to differences in fuel RVP. The fuels and fuel properties are summarized in Table 3.

For the Permeation Test, the test fuel used for control vehicles aged on RE0 was designated TE0, and the test fuel used for vehicles aged on RE20 was designated TE20 (also see Table 2). The TE0 fuel was Tier 2 EEE certification gasoline in compliance with 40CFR86.113-04 with a nominal RVP of 9.0psi.

- The TE20 fuel was prepared by splash-blending 20%vol fuel grade ethanol into high-altitude certification gasoline. The base fuel had a RVP of about 8.0psi, and the blended fuel RVP increased by about 1psi due to the addition of ethanol.
- Both TE0 and TE20 fuels had nominally about the same RVP as confirmed by measurement using the ASTM D5191 method (Table 3).
- The Baseline Test required certification fuels containing no ethanol. Vehicles aged on RE0 and RE20 were both tested using the same certification fuel. In Colorado, the vehicles were tested using TE0_Alt; in Michigan the vehicles were tested using TE0.

Fuels TE0 and TE0_Alt were delivered with a certificate of analysis containing additional fuel properties as shown in Appendix 12.3.

Table 3. Fuels Used for Conditioning and SHED Testing

Location	SGS	SGS	SGS	CPG	CPG
Fuel Designation	TE0_Alt	TE0	TE20	TE0	TE20
Test Used + Conditioning	Baseline	Permeation	Permeation	Baseline & Permeation	Permeation
Quantity, gallons	985	660	660	3515	2200
Storage	Tank	12 drums	12 drums	Tank	40 drums
Details	"High Altitude" cert fuel meeting 40CFR86.113-04	"Sea Level" cert fuel meeting 40CFR86.113-04	Ethanol 95+% purity with isopentane denaturant splash blended into "High Altitude" cert fuel meeting 40CFR86.113-04.	"Sea Level" cert fuel meeting 40CFR86.113-04	Ethanol 95+% purity with isopentane denaturant splash blended into "High Altitude" cert fuel meeting 40CFR86.113-04.
RVP, psi	7.89	8.9	9.08	9.1	9.08
Ethanol content, %vol	<0.1	<0.1	20.04	<0.1	20.04
Specific Gravity	0.7416	0.743	0.7485	0.741	0.7485
Distillation, 10%, deg. F	129	124	125.7	121	125.7
Distillation, 50%, deg. F	215	223	163.5	221	163.5
Distillation, 90%, deg. F	311	317	282.5	320	282.5
Aromatics, %	30.2	28	26.3	27.1	26.3

A detailed hydrocarbon analysis was performed for the TE0_Alt and TE0 certification fuels per ASTM D6729. The analysis was performed to determine if the chemical make-up of the certification fuels differed considerably from market fuels. The constituents greater than 1%vol are shown in Table 4, and chemical groups are shown in Table 5. The highest volume constituents, isopentane and toluene, are known to be highly permeable based on speciation from previous SHED tests [7]. The certification fuels have a higher composition of isopentane and toluene compared to typical market gasoline [12]. The concentrations of toluene and isopentane are necessarily lower in the TE20 fuel compared to TE0 and TE0_Alt due to the addition of ethanol; this could potentially be a confounding factor with regards to permeability.

Table 4. Chemical Components for TE0_Alt and TE0 Fuels, from ASTM D6729.

TE0_Alt			TE0 Tier2 EEE		
COMPONENT	**%WGT**	**%VOL**	**COMPONENT**	**%WGT**	**%VOL**
i-Pentane	18.643	22.138	i-Pentane	16.455	19.617
Toluene	21.379	18.142	Toluene	21.945	18.697
2,2,4-Trimethylpentane	7.92	8.422	2,2,4-Trimethylpentane	8.896	9.497
2-Methylhexane	3.301	3.579	1,2,4-Trimethylbenzene	5.837	4.923
2-Methylpentane	2.09	2.355	2,3,4-Trimethylpentane	3.919	4.026
2,3,4-Trimethylpentane	2.201	2.252	n-Pentane	2.938	3.466
m-Xylene	2.452	2.088	2,3,3-Trimethylpentane	3.173	3.227
2,4-Dimethylpentane	1.7	1.859	1-Methyl-3-ethylbenzene	3.231	2.761
3-Methylpentane	1.317	1.459	2-Methylpentane	1.629	1.842
n-Butane	1.053	1.338	2,3-Dimethylbutane	1.646	1.837
1,2,4-Trimethylbenzene	1.536	1.29	2,2,5-Trimethylhexane	1.544	1.613
Ethylbenzene	1.478	1.254	1,3,5-Trimethylbenzene	1.811	1.546
2,4-Dimethylhexane	1.09	1.146	n-Hexane	1.361	1.524
2,3-Dimethylbutane	1.003	1.115	i-Butane	1.107	1.468
3-Methylhexane	1.016	1.088	2-Methylhexane	1.328	1.446
o-Xylene	1.268	1.06	2,5-Dimethylhexane	1.298	1.383
Methylcyclopentane	1.064	1.046	1-Methyl-4-ethylbenzene	1.54	1.321
2,5-Dimethylhexane	0.865	0.918	2,4-Dimethylpentane	1.2	1.317
1-Methyl-3-ethylbenzene	1.055	0.897	2,4-Dimethylhexane	1.074	1.132
3-Methylheptane	0.798	0.832	1-Methyl-2-ethylbenzene	1.342	1.125

Table 5. Chemical Groups for TE0_Alt and TE0 Fuels, from ASTM D6729.

TE0_Alt			TE0 Tier2 EEE		
GROUP	**%WGT**	**%VOL**	**GROUP**	**%WGT**	**%VOL**
Paraffin	3.386	3.871	Paraffin	6.082	7.079
I-Paraffins	48.231	53.644	I-Paraffins	48.632	54.075
Aromatics	38.264	32.202	Aromatics	41.012	34.737
Mono-Aromatics	35.992	30.477	Mono-Aromatics	39.815	33.84
Naphthalenes	0.855	0.616	Naphthalenes	0.577	0.422
Naphtheno/Olefino-Benzs	0.205	0.169	Naphtheno/Olefino-Benzs	0.006	0.005
Indenes	1.211	0.939	Indenes	0.614	0.47
Naphthenes	4.347	4.196	Naphthenes	2.948	2.852
Mono-Naphthenes	4.347	4.196	Mono-Naphthenes	2.948	2.852
Di/Bicyclo-Naphthenes	0	0	Di/Bicyclo-Naphthenes	0	0
Olefins	4.856	5.213	Olefins	0.069	0.073
n-Olefins	1.851	2.038	n-Olefins	0.019	0.019
Iso-Olefins	2.562	2.749	Iso-Olefins	0.05	0.053
Naphtheno-Olefins	0.426	0.408	Naphtheno-Olefins	0	0
Di-Olefins	0.017	0.018	Di-Olefins	0	0
Oxygenates	0.09	0.083	Oxygenates	0	0
Unidentified	0.826	0.791	Unidentified	1.257	1.184

5.0 Mileage Accumulation

The vehicles were aged over four quarterly driving periods spanning the four seasons. Each vehicle was nominally driven twice per day and parked outdoors for a minimum of 8 hours between drives. Drives were performed on a 4.7 mile oval track at Chrysler's Chelsea Proving Ground in Michigan (Figure 12) and on road in Colorado.

Figure 12. Chrysler's Chelsea Proving Ground (left), CRVs driven on track (right)

A logbook was kept for each vehicle documenting every drive cycle, driver, odometer, date, fueling action, and standard maintenance performed. Vehicle fuel and oil level, belts, hoses and tires were checked before each drive. Repairs that were related to the evaporative emissions systems are discussed with the results in Section 7.0.

The logbook also contained the driver's estimate of vehicle crank time. Crank times were adequate for nearly all drives. There was only one incident where a vehicle failed to start. Vehicle 10E20 cranked but did not start on the morning of January 22, 2011 when the ambient temperature was about 8°F. The vehicle was allowed to thaw indoors and was subsequently started two days later. The starting problem was likely related to the RE20 fuel RVP which was somewhat low compared to the seasonal specification (ASTM D4814-09b), due to seasonal fuel carryover in the bulk storage tank.

Vehicle aging information is summarized in Appendix 12.4. The average miles per drive over the quarterly aging period was consistently near the 25.9 mile target for the SRC. Frequently, it was not possible to complete 180 drives in 90 days, due to vehicle repairs, inclement weather, holiday interruptions, or driver availability. The vehicles were parked outdoors for the entire aging process, and a minimum eight hour outdoor soak time was required between drives.

6.0 Test Results Organization

Over 600 individual SHED tests and 152 FTP75 exhaust emissions tests were performed for the study. The permeation rates, evaporative emissions mass, and exhaust emissions mass data reside in a master dataset, in Microsoft Excel® format. This master dataset is also included in the Appendix 12.6 of this report.

Results are presented in graphical form to make interpretation of the wealth of data easier. For the SHED tests, bar charts are used to display the results for each vehicle model. Data are presented at Age 0 (the benchmark data before aging began), and after 90, 180, 270 and 360 equivalent days of driving.

Bar charts are presented for the Permeation Test. The blue bars and red bars represent results from vehicles exposed to E0 and E20 respectively. For the Baseline Tests, the bars are grouped by Day 1 and Day 2 diurnal events, to provide additional information on the possible mechanism that may have caused evaporative emissions changes. The Baseline Test data also include ethanol, methanol and R134 refrigerant mass estimated from the Innova instrument, and therefore provides some qualitative information about the make-up of the evaporative emissions.

A significant amount of other data, including hydrocarbon concentration and temperature variation over time, were collected but not displayed here for brevity. Excerpts of the time domain data are provided in Section 7 where relevant to interpretation of the SHED results.

7.0 SHED Test Results

7.1 Vehicle 1E Results

Vehicles 1E0 and 1E20 were very closely matched at the start of the study. The permeation leak rate was about the same for both vehicles, and did not change significantly over all three modes of the two-hour permeation test run before aging began (Figure 13, upper). Evaporative emissions were also very comparable for both vehicles at the start of the study, at about 0.6g per day for the two-day Baseline SHED (Figure 14). Evaporative emissions were well under the Federal Enhanced Evaporative Emissions standard of 2.5g that apply for this model.

Vehicle 1E0 had tires replaced on two occasions during the aging period. Tire wear was likely aggravated by a toe-in alignment problem identified midway through the study. Both vehicles had the same engine repairs made within one month of each other, at the start of the 90-day track aging period: repairs included cam shaft seal, water pump, timing belt, oil pump seals and oil pan seal. These repairs were made primarily to eliminate fluid seepage past seals. The oil seepage was not a contributor to evaporative emissions because motor oil consists of heavier hydrocarbons that do not volatilize under SHED diurnal temperatures. The maintenance events are indicated on Figure 13.

Both vehicles had increasing permeation leak rates over the two-hour Permeation Test as the vehicles aged. However, the leak rates remained below 120 mg/hour suggesting that there were no gross system malfunctions detected. The permeation for Vehicle 1E20 trended higher than Vehicle 1E0 during the first mode soak of the two-hour permeation test, with the exception of the 90-day result.

Vehicle 1E0 had very consistent permeation leak rates for the two-day diurnal Permeation Test as it aged. In contrast, the permeation leak rates for the vehicle exposed to E20 fuel increased significantly as it aged (Figure 13, lower). The permeation of ethanol was very evident for the two-day diurnal Permeation Tests for Vehicle 1E20, where ethanol mass was typically measured to be about 25% of the total FID hydrocarbon mass (data in Appendix 12.6).

The evaporative emissions from the Baseline Tests were somewhat consistent for Vehicle 1E0 during periodic testing, but the vehicle exposed to E20 fuel had significantly higher evaporative emissions as it aged (Figure 14).

The vehicles were conditioned on ethanol-free TE0 ethanol-free fuel for 14 days prior to the Baseline test, but there was evidence of ethanol carryover for Vehicle 1E20. The ethanol mass, as measured with the Innova instrument, increased in proportion to the FID hydrocarbon emissions (Figure 14). The ethanol concentration reached a peak of 0.172 g/day at the end of the study. This finding indicates that the ethanol continued to permeate through various hoses and seals even after a change to ethanol-free fuel, and was a contributor to the increasing evaporative emissions from this vehicle.

Collectively, this data shows that Vehicle 1E20 had an increase in permeation and in total evaporative emissions following the 360 days of exposure to E20 fuel.

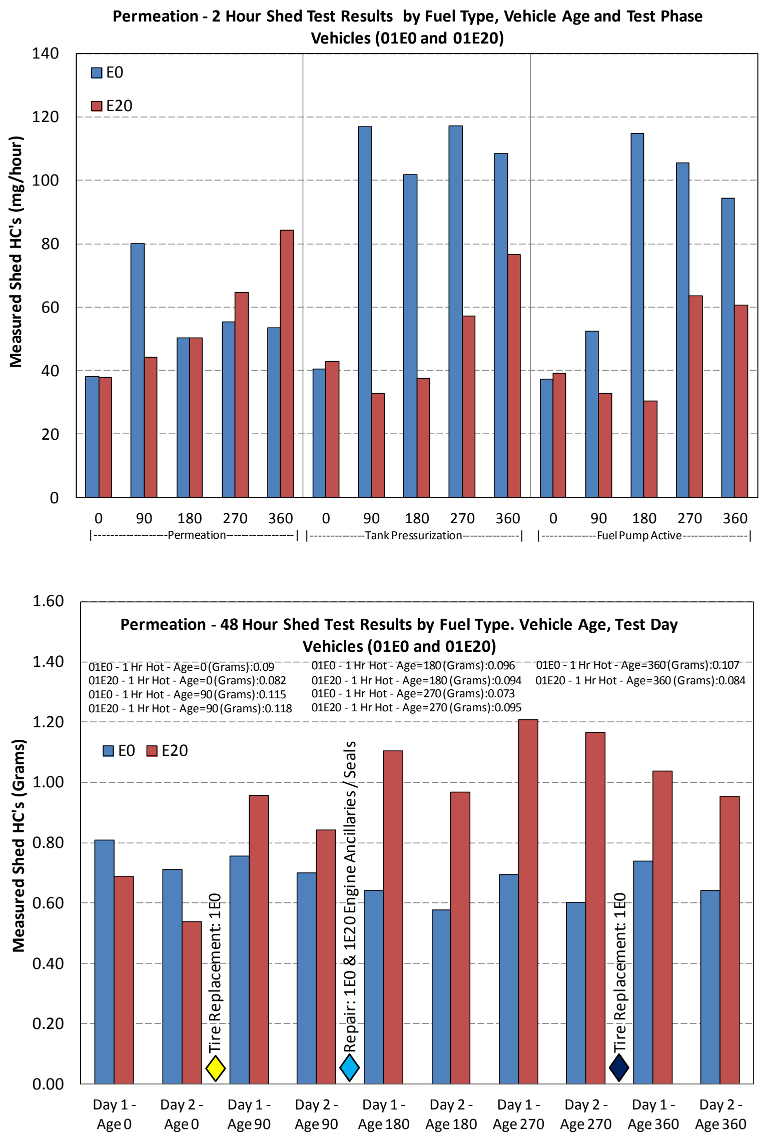


Figure 13. Vehicle 1E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

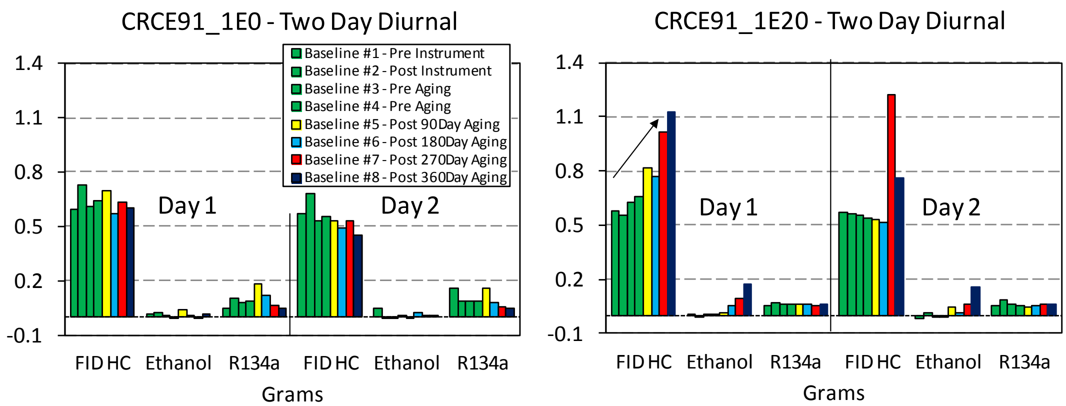


Figure 14. Vehicle 1E Baseline Evaporative Emissions Before and After 360 Days Aging

7.2 Vehicle 2E Results

The Baseline #1 and #2 tests indicate that the evaporative emissions were not significantly effected by the changes made to the vehicle for instrumentation (Figure 17). Following transport to Michigan and on-track operation to allow for adaptive learning, the pre-aging Baseline Tests #3 and #4 indicated that Vehicle 2E20 had about 50% higher evaporative emissions than Vehicle 2E0.

Also at the start of the study, Vehicle 2E0 had a lower permeation leak rate than Vehicle 2E20 while soaking during the first mode of the two-hour Permeation Test (Figure 16, top). Contrary to this, during the two-day Permeation Test, Vehicle 2E0 had higher permeation rates than Vehicle 2E20 (Figure 16, bottom). It was therefore not conclusive which vehicle had the higher permeation at the start of the study. The data suggests that the permeation may have been substantially different under the steady soak temperature of 86°F for the two-hour test, and the mechanism of permeation changed significantly during the 72°-96°-72°F temperature excursions associated with the two-day diurnal.

Both vehicles had PCV valves replaced just prior to the start of track aging. Vehicle 2E0 had front tires replaced on two occasions, and Vehicle 2E20 had front tires replaced once during track aging.

The permeation leak rates over the two-hour Permeation Test remained below 50 mg/hour, suggesting that there were no gross system malfunctions detected, with the possible exception of the Vehicle 2E20 result after 360 days of aging (Figure 16, upper). For that test result, the leak rate increased to 210 mg/hour after the fuel pump was energized (Figure 15). The leak was fuel vapor; no liquid fuel leaks were observed. The fuel tank pressure and temperature were verified to be correctly controlled during this test, and the exact cause of the fuel leak was not readily isolated. This step change in permeation was not evident during the subsequent one-hour hot soak and two-day Permeation SHED Tests (Figure 16, bottom), further suggesting that the vapor leak was induced by fuel system pressurization.

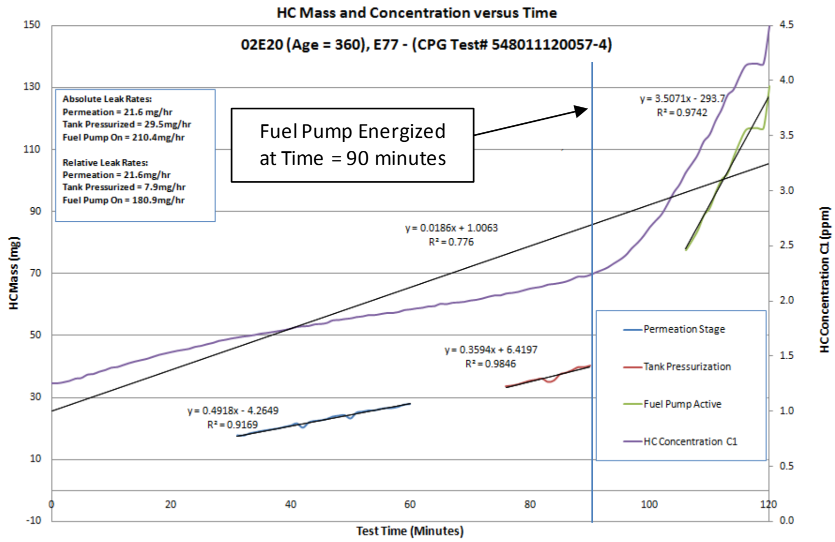


Figure 15. Vehicle 2E20 Fuel Vapor Leak, Two-Hour Permeation Test After 360 Days Aging

For Vehicle 2E0, the two-day permeation rate performed at 270 days of aging was not consistent with other tests for this vehicle. The higher permeation rate did not appear to be due to inadvertent fuel contamination prior to loading the vehicle in the SHED: the one-hour hot soak mass was not elevated, and high HC mass gain continued on Day 2, making fuel contamination an unlikely cause.

High levels of ethanol were measured for Vehicle 2E20 during the two-day Permeation Tests, averaging 0.276 g/day. The peak ethanol level was measured at 270 days of aging, correlating with the higher FID HC mass measurements observed for that SHED test.

Evaporative emissions from Vehicle 2E20 were much more variable compared to vehicle 2E0 throughout the course of the aging process (Figure 17). Ethanol emissions averaged about 0.07 g/day for two-day Baseline SHED tests performed after 90 days of fuel exposure. This finding indicated that the ethanol continued to permeate through various hoses and seals even after a change to ethanol-free fuel, and was a contributor to the evaporative emissions from this vehicle.

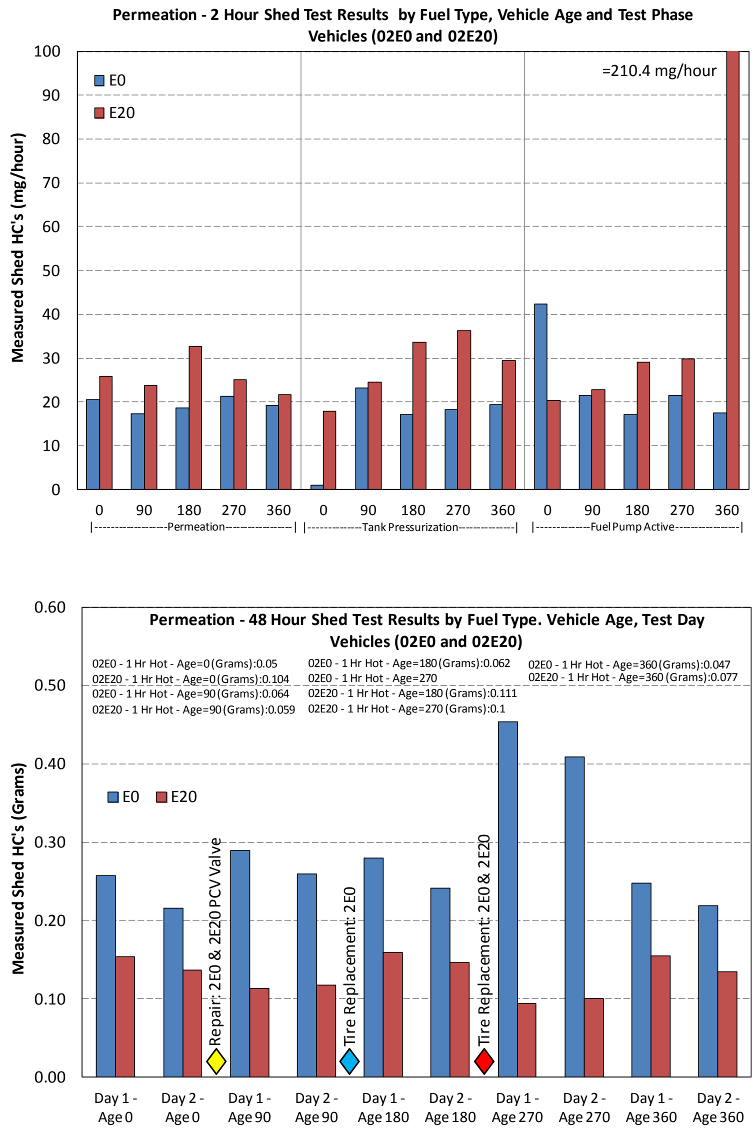


Figure 16. Vehicle 2E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

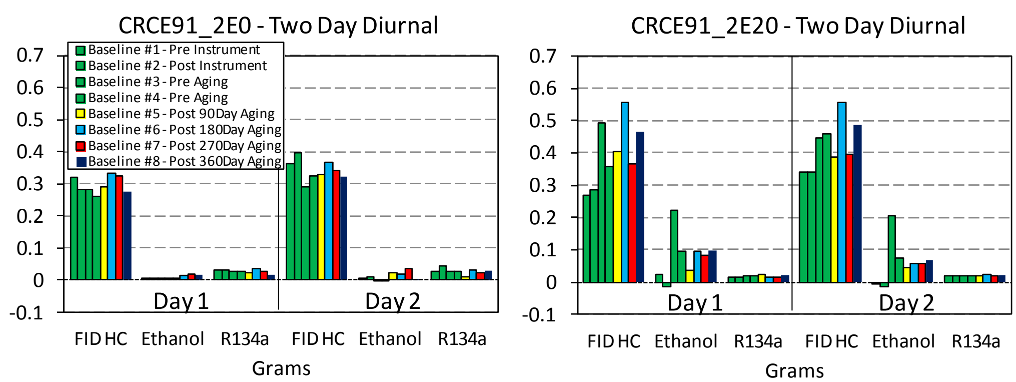


Figure 17. Vehicle 2E Baseline Evaporative Emissions Before and After 360 Days Aging

7.3 Vehicle 3E Results

Vehicle 3E20 had a very minor refrigerant leak that was detected by the Innova during the initial Baseline Tests (Figure 19, Baseline #2). This refrigerant leak was so small that it would escape detection by the car owner or dealer. A hydrocarbon sniffer was used to isolate the source of the leak: a damaged o-ring and loose cap on the air conditioner service port. The o-ring was replaced and the cap tightened securely before performing the pre-aging SHED tests at CPG.

The permeation leak rates and evaporative emissions were very comparable for both vehicles at the start of the study (Figure 18 and Figure 19, respectively). The only noteworthy maintenance was tire replacement for Vehicle 3E20 during the Q3 aging period.

The permeation leak rates were under 20 mg/hour for all two-hour Permeation Tests throughout the aging period. Because very low HC concentrations were measured over a short two-hour period, the mass emissions are somewhat scattered. This scatter made spotting trends or comparing fuel effects very difficult as the vehicles aged. The longer duration two-day Permeation Tests also did not reveal any clear differences for the vehicles exposed to the E0 and E20 fuels.

Evaporative emissions were under 0.25 g/day for both vehicles over the duration of the study. Vehicle 3E0 averaged 0.160 g/day following 360 days of fuel exposure, appearing somewhat worse than Vehicle 3E20 which emitted 0.111 g/day. Given the variability of results at the different test periods and the very low mass levels measured, there was no compelling evidence that the evaporative emissions were impacted by E20 fuel exposure.

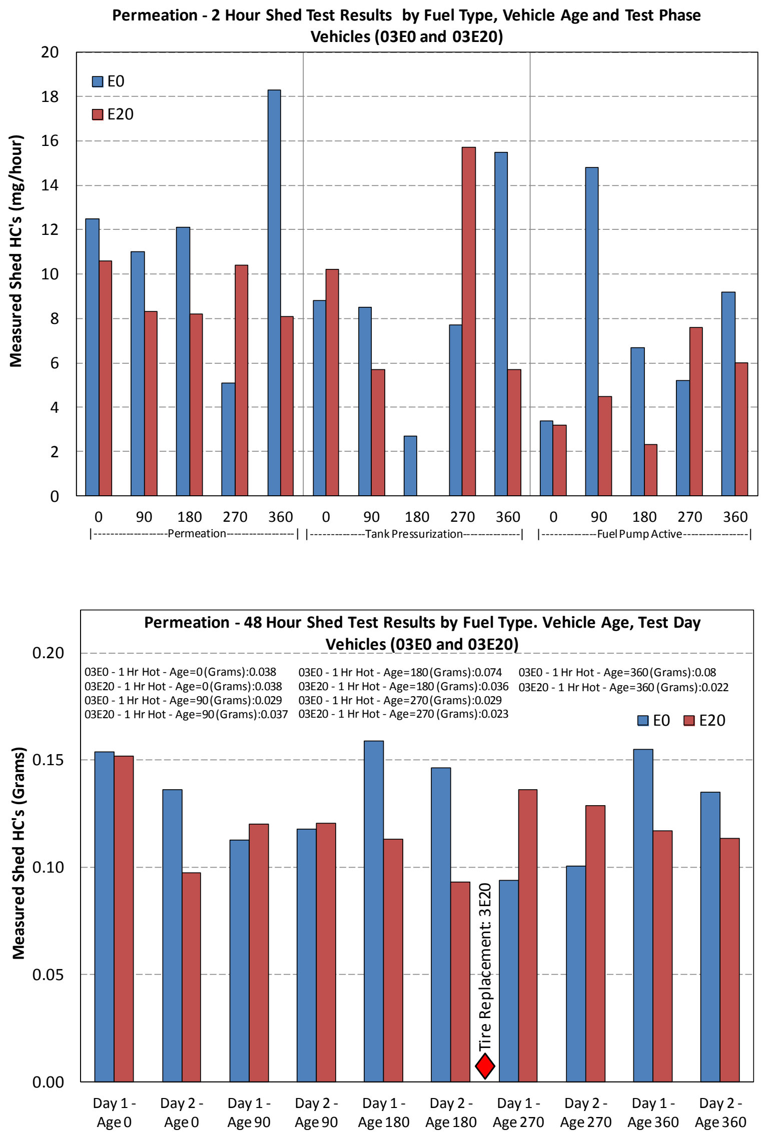


Figure 18. Vehicle 3E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

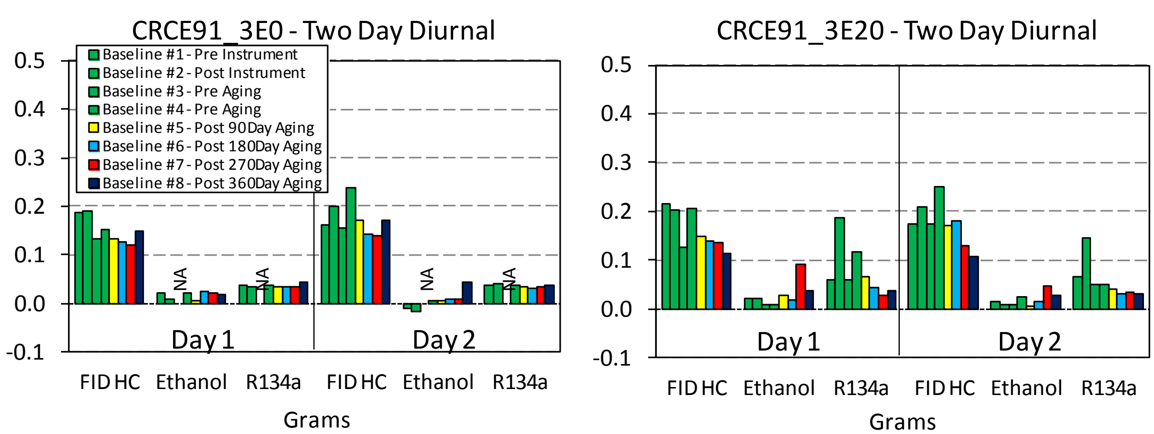


Figure 19. Vehicle 3E Baseline Evaporative Emissions Before and After 360 Days Aging

7.4 Vehicle 4E Results

Vehicles 4E0 and 4E20 had the lowest permeation and lowest evaporative emissions of any model in the study. There were no unscheduled maintenance events for these vehicles during the aging period.

The permeation leak rates were 10 mg/hour or less for all two-hour Permeation Tests throughout the aging period (Figure 20, upper). The measured hydrocarbon concentration in the SHED changed by only about 0.2 ppmC1 over the two hour duration of the test. A small negative leak rate was calculated for Vehicle 4E20 at the 90-day interval using the procedure described in Section 3.5, and should be considered to be no change in permeation. This negative leak rate resulted because the hydrocarbon concentration change was extremely small in magnitude and not monotonic over time. There was no clear change in permeation rate as the vehicles aged, based on the two-hour test procedure.

The longer time duration of the two-day Permeation Test relative to the two-hour test procedure made the former better suited to quantify mass change for these vehicles. The permeation rate decreased for both vehicles as they aged (Figure 20, lower). This finding suggests that the vehicles were not completely conditioned when the SHED testing began, despite all the conditioning steps taken (Section 3.2).

Evaporative emissions decreased over time for Vehicle 4E0 (Figure 21). For Vehicle 4E20 exposed to E20 fuel, the evaporative emissions remained constant throughout the aging period.

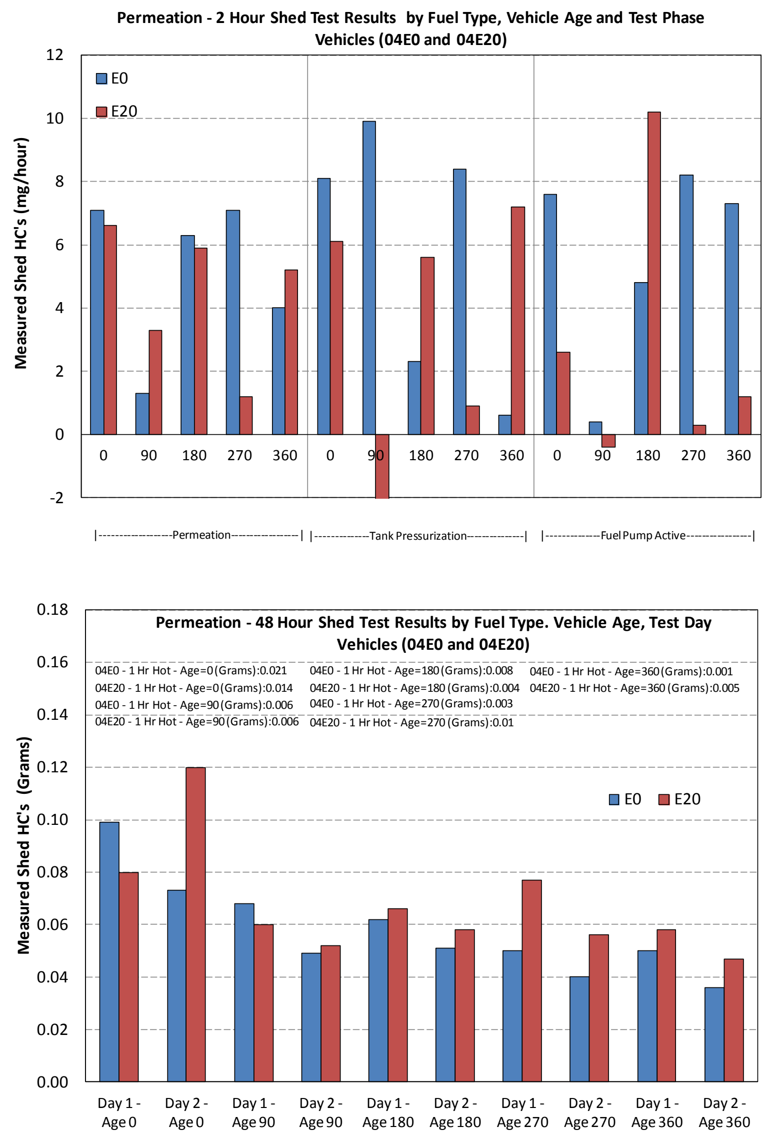


Figure 20. Vehicle 4E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

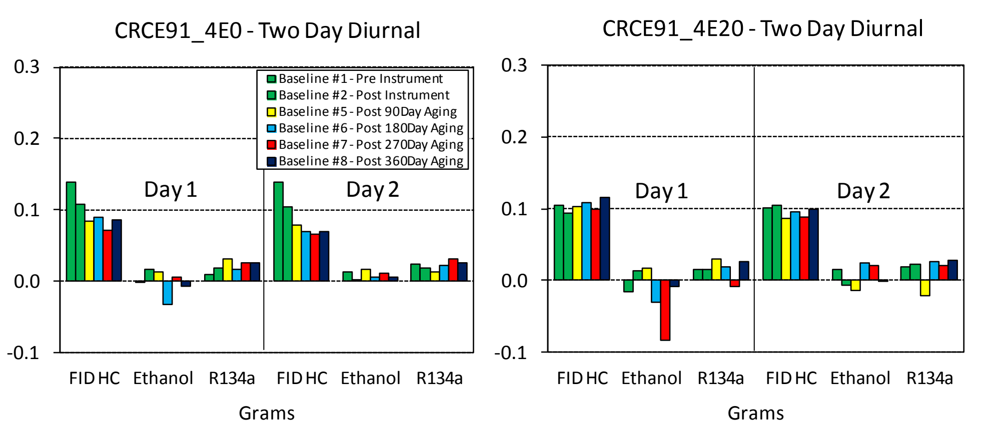


Figure 21. Vehicle 4E Baseline Evaporative Emissions Before and After 360 Days Aging

7.5 Vehicle 5E Results

The Baseline Test results produced at high altitude in Colorado were fairly repeatable (Baseline #1 & #2, Figure 23), but a step change in the evaporative emissions was observed after the 5E vehicles were transported to Michigan for testing (data not included in this report). The evaporative emissions systems were inspected, and the vehicles were driven on a track on several occasions to ensure the control system had adapted to low altitude operation and was in a state of I/M readiness. Upon retest (Baseline #3 & #4, Figure 23), the Day 2 evaporative emissions for both vehicles remained much higher than previous tests but were substantially below the Federal Tier 2 2004 LDV/LLDT standard that applied for this model. A decision was made to continue testing the pair of vehicles.

The evaporative emissions system on both vehicles malfunctioned during Q1 track aging, and driving was halted at 31 days into the period. A representative from the vehicle manufacturer participated in vehicle inspections. An OBD scan revealed diagnostic trouble code P0448 "Evaporative Emissions Control System Vent Control Valve Circuit Shorted". It was determined that the purge valves were functioning properly. Both canisters were removed and upon partial disassembly it was determined that the canisters had ingested an extraordinary amount of dirt drawn in through the canister vent port. This contamination significantly compromised the canister performance.

A decision was made to replace the canisters with new parts. The new canisters were butane-aged for ten purge-load cycles prior to installation. In addition, a new retrofit canister vent filter kit was installed on both vehicles. The vehicles were not originally equipped with canister vent filters. The manufacturer had released a retrofit kit and service bulletin to correct field issues associated with the evaporative control system. Following installation, the vehicles were conditioned for 14 days on TE0 ethanol-free fuel (by performing one SRC every other day). The Baseline Test was repeated after fuel conditioning was completed (Baseline #4b green bars, Figure 23). This was the only pre-aging benchmark test performed with the new canister for this vehicle model; prior results (indicated by white bars, Figure 23) could not be used for the statistical analysis due to the parts change. The Day #2 evaporative emissions dropped significantly following canister replacement and were comparable to levels measured in Colorado. A new Permeation Test sequence was then performed to establish the pre-aging performance of the vehicles.

The permeation was generally higher for Vehicle 5E20 for both two-hour and two-day Permeation Tests completed through 360 days of aging. The difference in permeation rates between Vehicles 5E0 and 5E20 markedly increased over time for the two-day test (Figure 22, lower).

Day 1 and Day 2 evaporative emissions also increased for Vehicle 5E20 following canister replacement (Figure 23). Evaporative emissions were found to be very high for the Day 2 measurement performed after 180 days of fuel exposure. The high Day 2 emissions were caused by vapors breaking through the canister, due to an insufficient canister purge during the FTP75 dynamometer cycle that preceded the SHED test. The purge volume for the 180-day Baseline Test was about a third of the typical volume, as measured using a dry gas meter for selected tests (Table 6). The cause for the low purge volume during the 180 day test was unknown, since no MILs or MIL resets had occurred.

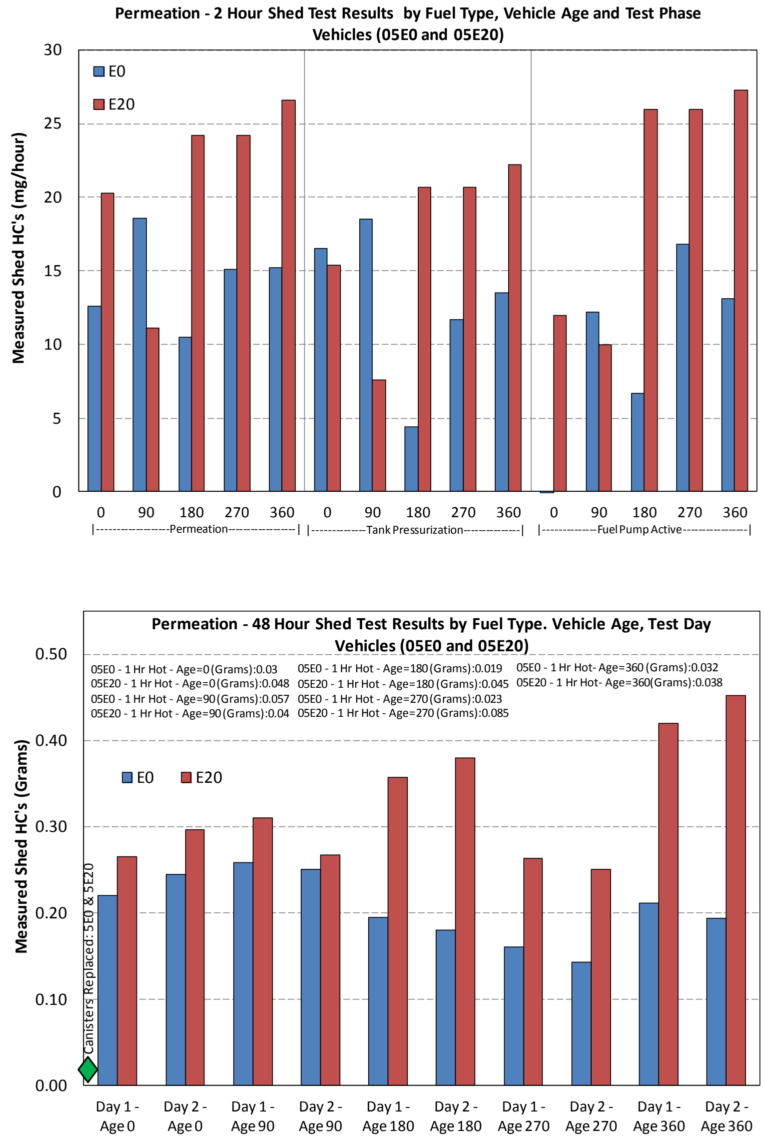


Figure 22. Vehicle 5E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

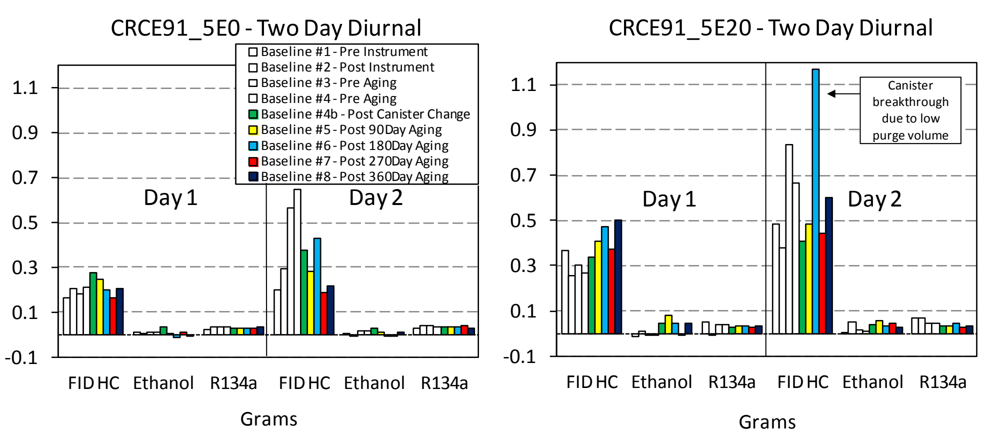


Figure 23. Vehicle 5E Baseline Evaporative Emissions Before and After 360 Days Aging

Table 6. Vehicle 5E Purge Volume for Selected FTP75 Tests, Run Prior to Baseline SHED Tests

Vehicle	Test ID	Date	Purge Volume 1st 18 Hills (cu. ft.)	Purge Volume Total (cu. ft.)	Comment
5E0	548011100175–5	4/9/2010	19.56	26.32	Age=0 Days, before original canister failure and replacement
5E20	548011100176–5	4/9/2010	19.60	25.73	Age=0 Days, before original canister failure and replacement
5E20	548011100710–4	10/5/2010	17.67	24.05	Age=0 Days, after canister replacement
5E20	548011110478–4	5/16/2011	18.52	25.20	Age=90 Days
5E20	548011111135–4	8/30/2011	5.67	8.01	Age=180 Days Low purge volume explains high Day 2 result for Baseline Test
5E20	548011120109–4	2/13/2012	21.54	29.17	Age=270 Days
5E0	548011120548-4	7/3/2012	19.09	24.94	Age=360 Days
5E20	548011120582–4	7/18/2012	18.50	25.00	Age=360 Days

7.6 Vehicle 6E Results

The fuel tank gauge for Vehicle 6E20 was not working when it was recruited into the study. To correct this problem, the tank-mounted fuel pump module (including the integrated rheostat for the fuel gauge) was replaced. The repair was made before any fuel conditioning or testing was performed.

Tires were replaced for each vehicle during track aging. Vehicle 6E20 had a transmission failure just after the 360-day permeation tests were completed. The transmission was replaced, and a two-hour permeation test was repeated to demonstrate that there was no shift in the permeation rate of the vehicle. The vehicle then continued on with the 14-day fuel conditioning on TE0, and the Baseline Test was performed.

Vehicle 6E0 started the study with significantly higher permeation and evaporative emissions than Vehicle 6E20 (Figure 24 and Figure 25, respectively).

The permeation rate for the two-hour test was variable throughout the study but remained below 100 mg/hour, indicating that there were no gross evaporative system malfunctions detected. The two-day Permeation Tests were very consistent for this vehicle model as the vehicles aged. Note that Day 1 permeation was always higher than Day 2, and the results were very repeatable for each test interval (Figure 24, bottom).

The two-day Baseline Tests yielded similar trends. Day 1 evaporative emissions were always higher than Day 2 for this vehicle model.

A step change in evaporative emissions occurred for Vehicle 6E0 between Baseline #3 and #4 tests. The cause of this step change was unknown. For all subsequent tests, the evaporative emissions were very consistent for this vehicle at each test interval.

The evaporative emissions results for Vehicle 6E20 were very repeatable at both test locations and over the entire duration of the study. Following 360 days of fuel exposure, the permeation and evaporative emissions were not impacted by the test fuels for this vehicle model.

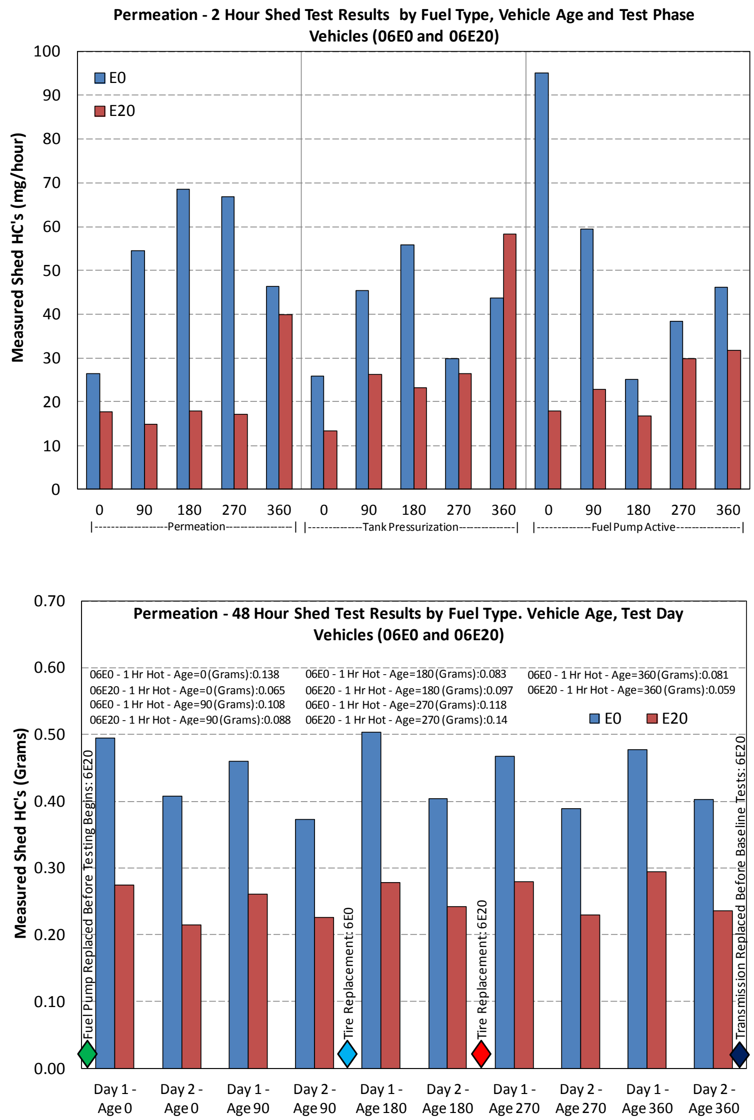


Figure 24. Vehicle 6E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

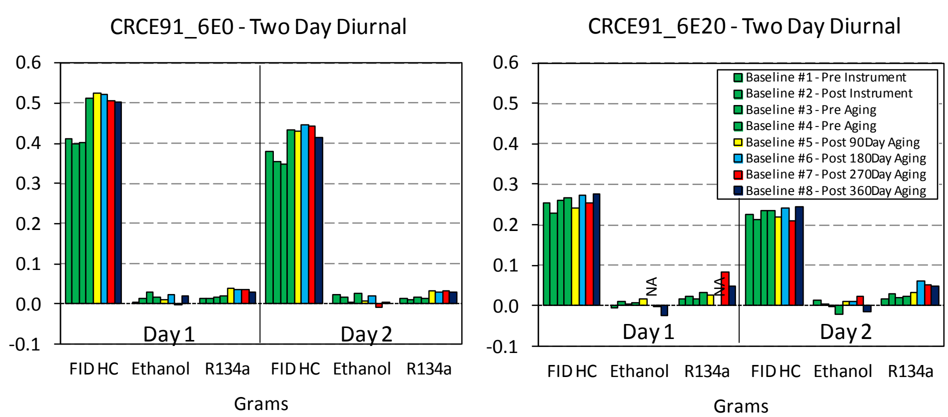


Figure 25. Vehicle 6E Baseline Evaporative Emissions Before and After 360 Days Aging

7.7 Vehicle 7E Results

Prior to track aging, engine oil seepage was found at the intake manifold/head/block gasket for Vehicle 7E20. There was a concern about possible backflow of port-injected fuel combining with oil from crankcase ventilation in the intake manifold, and the possible impact of this residue on the test results. The residue was removed and the gasket was replaced on Vehicle 7E20 prior to Baseline Test #3. Investigation confirmed that the same gasket was changed on Vehicle 7E0 at the dealership just prior to purchase.

The tires were replaced for both vehicles just prior to starting Q3 track aging.

Both vehicles had similar permeation leak rates prior to aging over all three modes of the two-hour permeation test (Figure 27, top). In contrast, Vehicle 7E20 had higher permeation rates than Vehicle 7E0 during the two-day Permeation Test (Figure 27, bottom). The data suggest that the permeation for the vehicles may have been substantially different under the steady soak temperature of 86°F for the two-hour test, and the mechanism of permeation changed significantly during the 72°-96°-72°F temperature excursions associated with the two-day diurnal. Vehicles 7E0 and 7E20 also had similar evaporative emissions levels prior to aging (Baseline Tests #3 and #4, Figure 28).

The permeation rates for the two-hour, one-hour hot soak and two-day diurnal SHED tests all generally trended upward as both vehicles were aged. Moreover, the evaporative emissions for the one-hour hot soak and two-day Baseline Tests also increased over time.

There was overwhelming evidence of evaporative emissions system deterioration when the vehicles were tested following 270 days of track aging. Both vehicles failed the evaporative emissions system pressure decay check (Section 3.3), indicating that the systems were not sealed when stationary. SHED tests confirmed gross leaks in the evaporative emissions systems; the tests were aborted at this point (Figure 26). There was no MIL or pending DTC for the vehicles. A rigorous system inspection revealed the purge valves were leaking on both cars. The purge valves were not fully seated. This was determined by applying light system pressure to the inlet and verifying air escaping past the purge valve on the outlet of the assembly.

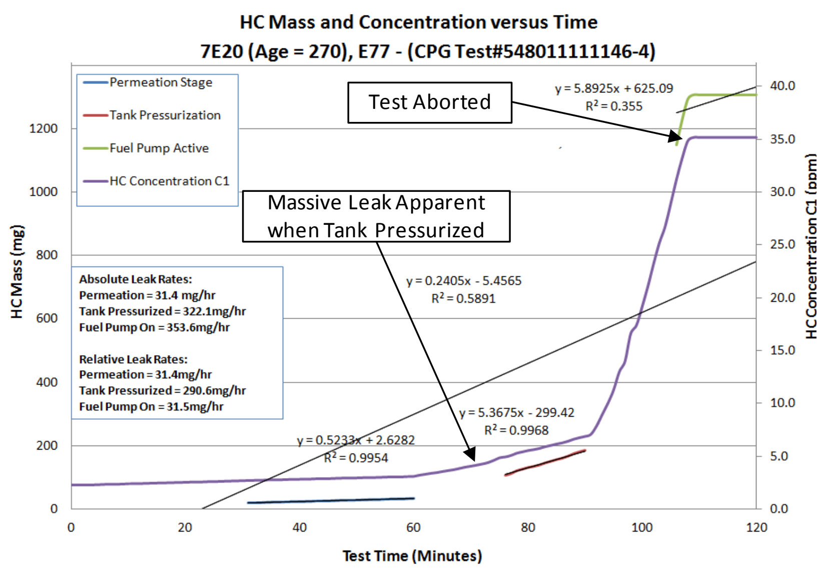


Figure 26. Continuous FID HC for Two-hour Permeation Test, Vehicle 7E20 with Purge Valve Leak

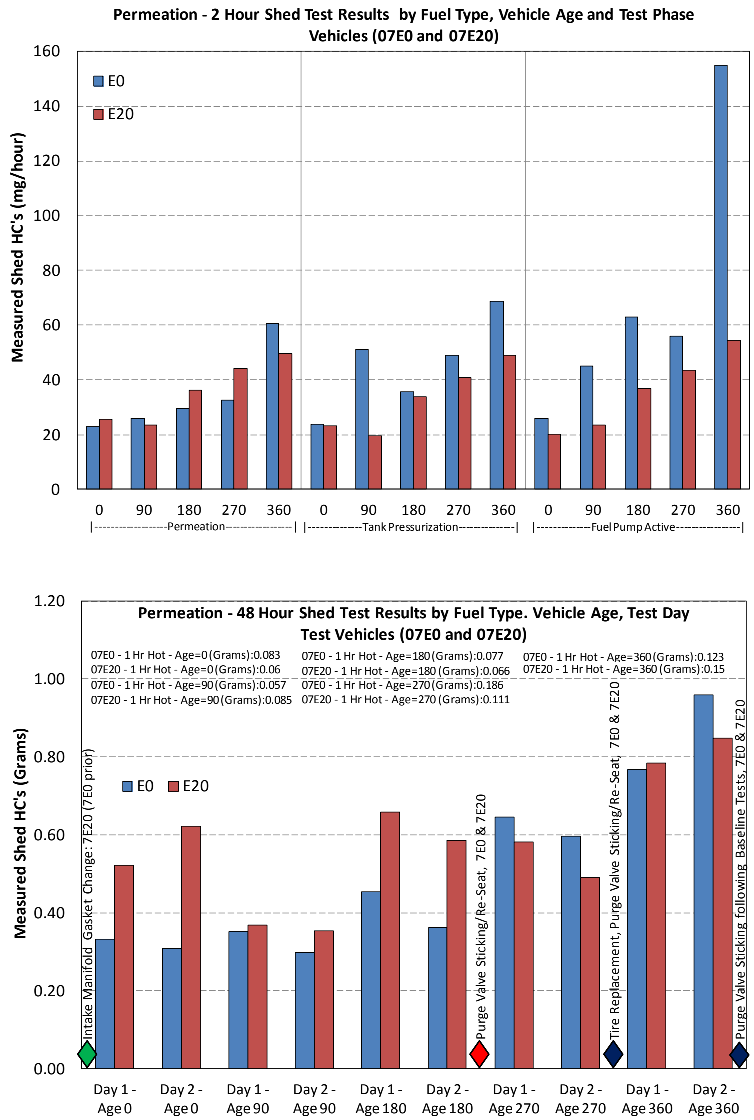


Figure 27. Vehicle 7E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

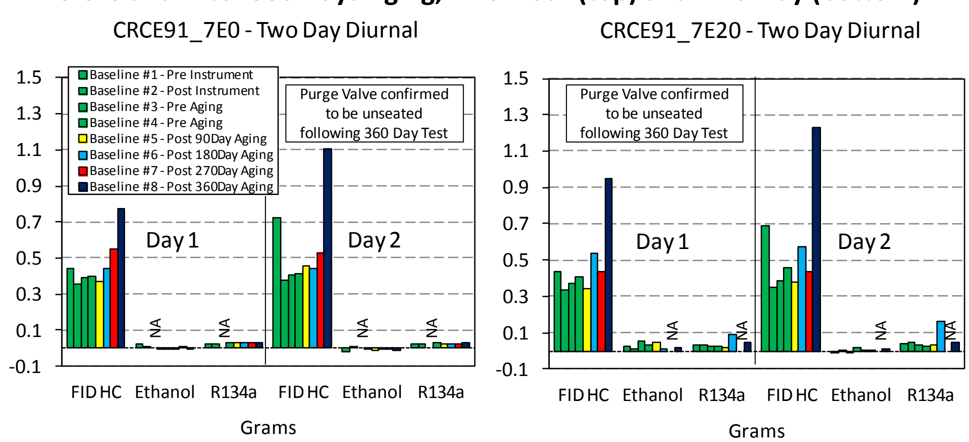


Figure 28. Vehicle 7E Baseline Evaporative Emissions Before and After 360 Days Aging

Replacing the purge valves with new parts would have defeated the objective of assessing the durability of the system for different fuels. A decision was made to re-seat the valves and continue testing. The valves were re-seated by exercising the valve using compressed air until no further leakage was detected. The 270-day Permeation Test sequence, 14-day fuel conditioning and Baseline Tests were then performed. Both vehicles passed the evaporative system pressure decay check following the Baseline Test, indicating the 270-day results were representative of a vehicle without an evaporative system malfunction.

Following completion of Q4 track aging, both vehicles again failed the evaporative system pressure decay check. There was no MIL or pending DTC for the vehicles. The valves were again re-seated prior to performing the SHED tests. Both vehicles passed the evaporative system pressure decay check before and after the Permeation Tests, indicating the 360-day permeation results were representative of a vehicle without an evaporative system malfunction. However, the purge valves from both vehicles were again confirmed to be unseated following the 360-day Baseline Tests, and the leaking purge valves accounted for the very high evaporative emissions measured for both Day 1 and Day 2 of the final Baseline Test.

Despite a functional problem with the purge valve, the highest one-hour hot soak plus diurnal emission was 1.327 grams for Vehicle 7E20, still considerably below the Federal Enhanced Evaporative Emission standard of 2.5 grams that pertains to this vehicle model.

7.8 Vehicle 8E Results

Vehicle 8E20 started the study with significantly higher permeation rates and evaporative emissions relative to Vehicle 8E0 (Figure 29 and Figure 30, respectively).

Following 90 days of aging, Vehicle 8E20 had nearly double the permeation rate during the two-day diurnal portion of the Permeation Test compared to its pre-aging result (Table 7). Since the SHED result was unexpectedly high, a more rigorous vehicle inspection was performed to identify the cause. A pressure check of the evaporative system revealed a small pressure decay which was not considered significant. A sensitive hydrocarbon sniffer instrument detected a leak at the gas cap. The sniffer was unable to detect the leak when the gas cap was replaced with a new OEM gas cap. A decision was made to continue testing with a new OEM gas cap. The Permeation Test was repeated with the new OEM gas cap installed and conclusively proved that the original OEM cap on Vehicle 8E20 had a leaking seal (Table 7).

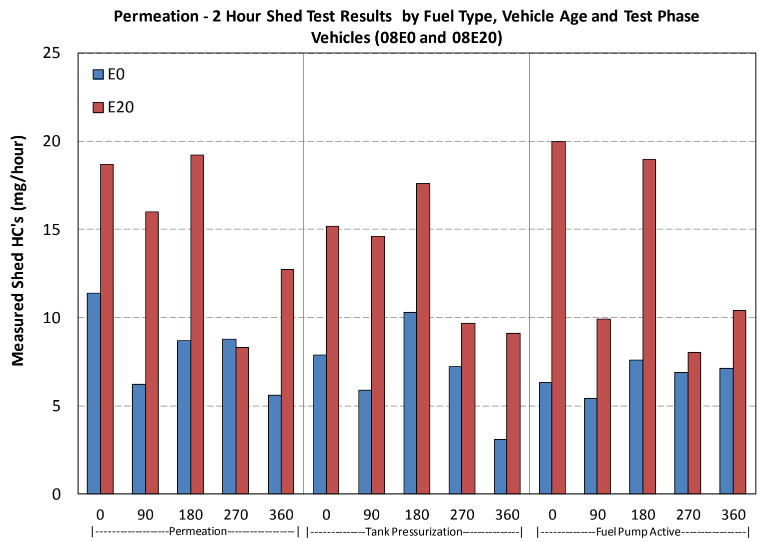
Table 7. Permeation Test Results for Vehicle 8E20, with Original and New Factory Gas Caps

Car 8E20	1 Hr Hot Soak (g)	48 hr Diurnal Day 1 (g)	48 hr Diurnal Day 2 (g)
Pre-Aging (0 Day), original OEM gas cap	0.034	0.272	0.268
90 Days Aging, original OEM gas cap	0.040	0.577	0.509
90 Days Aging, new OEM gas cap	0.038	0.243	0.223

The leaking gas cap did not cause a MIL or pending DTC on Vehicle 8E20. Even with the leaking gas cap installed, the evaporative emissions for Vehicle 8E20 were just within federal evaporative emissions standards pertaining to this vehicle.

A new OEM gas cap was also installed on Vehicle 8E0 so as to not bias the results. The original OEM gas caps from both vehicles were sent for forensic analysis. The original gas cap from Vehicle 8E20 had a looser fit and the seal could spin around the gas cap, whereas the gas cap from Vehicle 8E0 had a much tighter-fitting seal. Under high magnification, more dirt was visible on the seal from Vehicle 8E20.

The permeation leak rates were under 20 mg/hour for all two-hour Permeation Tests throughout the aging period. The SHED test results did not reveal any clear trend as the vehicles were aged on E0 and E20 fuels. The two-day permeation decreased for Vehicle 8E0 from start to finish and increased slightly for Vehicle 8E20. Contrary to that finding, the evaporative emissions increased for Vehicle 8E0 relative to its pre-aging result and decreased for Vehicle 8E20.



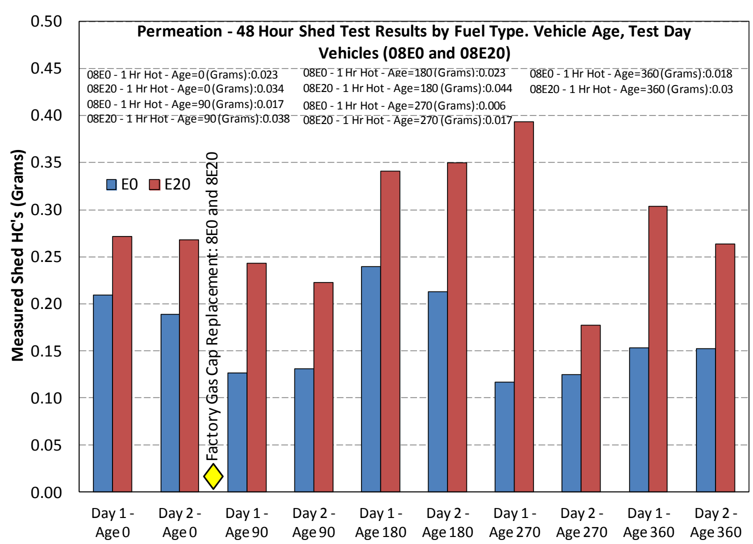


Figure 29. Vehicle 8E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

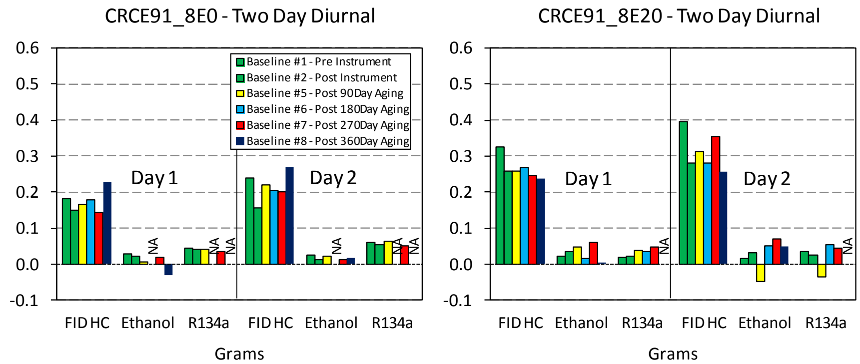


Figure 30. Vehicle 8E Baseline Evaporative Emissions Before and After 360 Days Aging

7.9 Vehicle 9E Results

Following transport to Michigan, these older model vehicles required a considerable amount of track time to adapt to lower altitude conditions and reach a state of I/M readiness before testing. The evaporative emissions for Vehicles 9E0 and 9E20 were at comparable levels prior to aging (Baseline #4, Figure 32). Vehicles 9E0 and 9E20 both had A/C system refrigerant leaks detected during SHED testing. A decision was made midway through the study to reclaim the R134a refrigerant prior to SHED testing to avoid confounding the HC FID measurements.

Vehicle 9E0 had an extremely high two-hour permeation rate following 90 days of aging. The vehicle was inspected for possible causes. A hydrocarbon leak was found at the hose segments leading to and from the fuel pressure regulator located in the engine compartment. A decision was made to replace the hose segments with new OEM parts, as some distress was evident. Upon retest, Vehicle 9E0 continued to have extremely high permeation. The modified gas cap (similar to Figure 6) was subsequently determined to be the cause of the vapor leak. The modified gas cap from Vehicle 9E20 was used on Vehicle 9E0 to complete the permeation test at 90 days reported here (Figure 31). Vehicle 9E0's original OEM gas cap was used for all one-hour and two-Day Permeation SHED Tests and Baseline Tests.

Both vehicles had tire replacements, and Vehicle 9E20 had an axle replacement during track aging.

The permeation rates were highly variable for Vehicle 9E0, particularly a large swing in permeation that occurred between the 90-, 180- and 270-day test results. In contrast, the permeation rates from Vehicle 9E20 followed a consistently increasing trend as it aged.

The evaporative emissions from both vehicles decreased relative to the benchmark measurements taken at the start of the study (Figure 32). The emissions rates were very similar for both vehicles.

Ethanol mass emissions were significant for Vehicle 9E20 Baseline Test results. As observed for other older vehicle models in the study, ethanol continued to permeate through various hoses and seals even after 14-day conditioning on ethanol-free fuel.

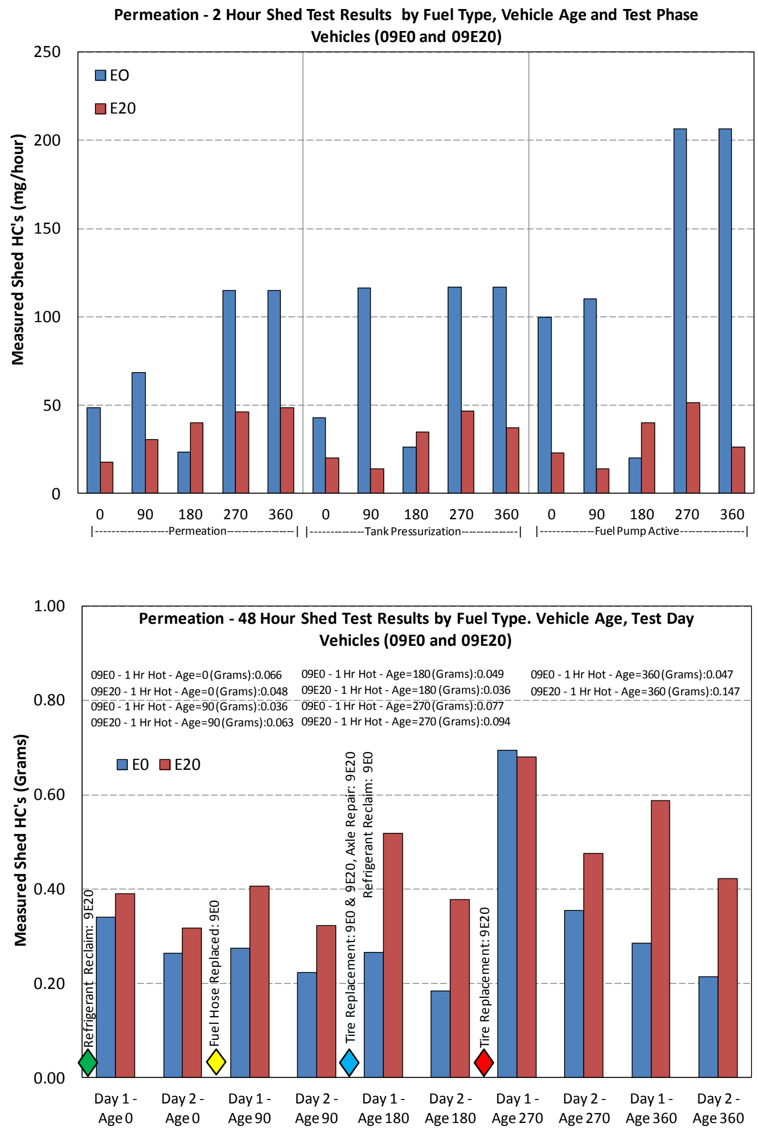


Figure 31. Vehicle 9E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

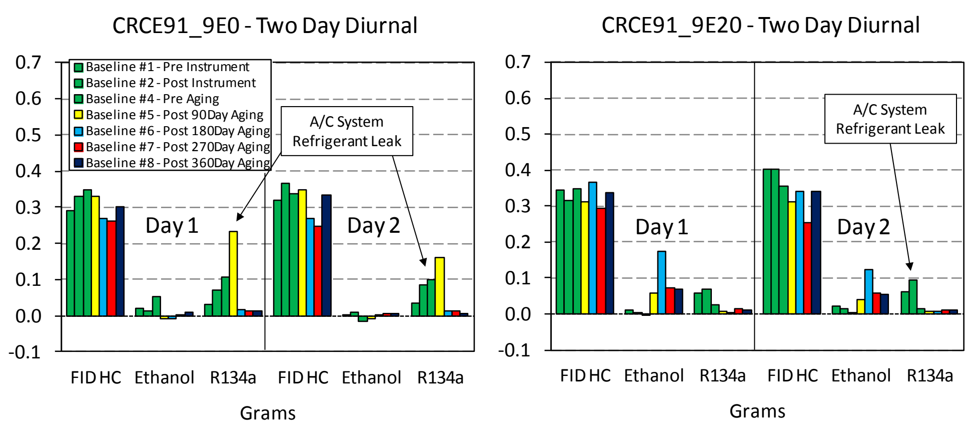


Figure 32. Vehicle 9E Baseline Evaporative Emissions Before and After 360 Days Aging

7.10 Vehicle 10E Results

Vehicles 10E0 and 10E20 were quite closely matched at the start of the study, having comparable two-day diurnal emissions for the two-Day Permeation Test (Figure 33, lower) and for the Baseline Test (Figure 34). Vehicle 10E0 had tires replaced during the Q4 aging period.

The permeation leak rates were under 20 mg/hour for all two-hour Permeation Tests throughout the aging period. Day 1 permeation was always higher than Day 2 for both vehicles. The diurnal permeation rate increased slightly more for Vehicle 10E20 than for Vehicle 10E0 over the 360 day aging period.

The evaporative emissions remained somewhat comparable for both vehicles throughout the aging period. The highest one-hour hot soak plus diurnal emission was 0.268 grams for Vehicle 10E20, significantly under the Federal Tier 2 2004 LDV/LLDT standard of 1.2 g for this vehicle model. Vehicle 10E0 had some ethanol carry-over that was measured in all the pre-aging tests (Baselines 1-4, Figure 34).

A correlation between the ethanol emissions and FID HC emissions is very apparent for this particular vehicle. The drop in ethanol emissions to low levels following 90 days of aging coincided with a step change reduction in the FID HC emissions.

The refrigerant levels measured during the Baseline Tests appear to be a significant fraction of the total hydrocarbon mass. However, the mass levels of about 0.06 g/day were comparable to other vehicles. Since the refrigerant mass was comparable for both vehicles and the mass was not increasing over time, there was no evidence of a system malfunction, and therefore no motivation to reclaim the refrigerant prior to SHED testing.

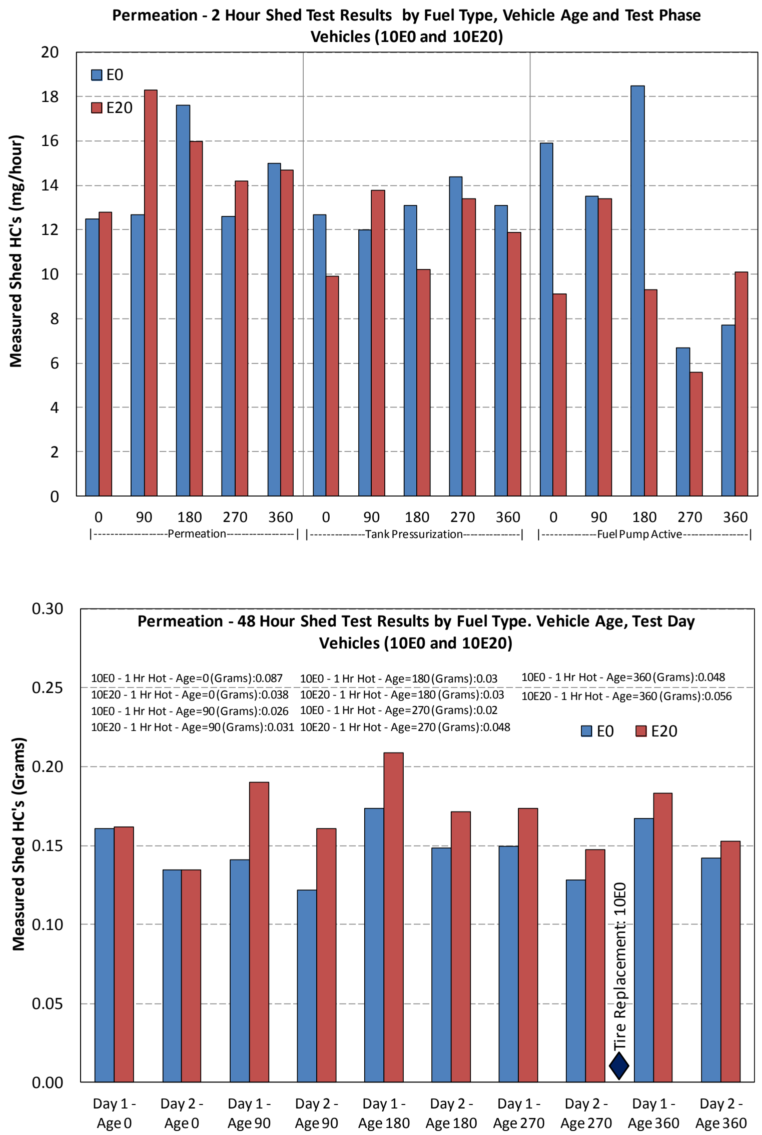


Figure 33. Vehicle 10E Permeation Leak Rates
Before and After 360 Days Aging, Two-Hour (top) and Two-Day (bottom)

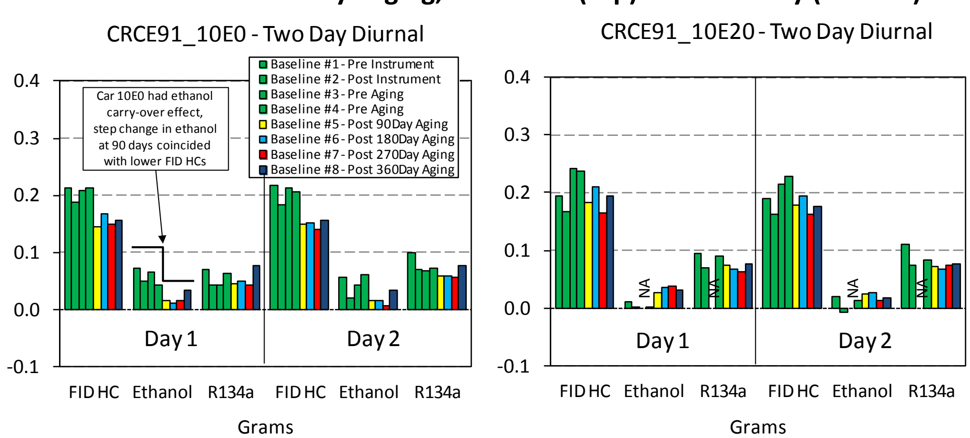


Figure 34. Vehicle 10E Baseline Evaporative Emissions Before and After 360 Days Aging

7.11 Comparison of High Altitude and Low Altitude SHED Results

All twenty vehicles were conditioned and initially tested in SHEDs in Colorado. Two Baseline Tests were performed: one test before (Baseline #1) and one test after the vehicle modifications were made (Baseline #2). The intent of performing the two Baseline Tests was to demonstrate that the vehicle modifications had no impact on their evaporative emissions.

Following Baseline Testing, 16 vehicles were shipped to Michigan, and four vehicles remained in Colorado (Vehicle IDs # 4E0, 4E20, 8E0 and 8E20). The fleet was split in order to collect data at low and high altitudes, since the evaporative emissions systems must be designed to meet EPA standards from 0 to 5500 feet elevation above sea level.

Upon arrival in Michigan, the 16 vehicles were driven on the track to adapt the control system to low altitude operation. Then two Baseline Tests (Baseline #3 and #4) were performed to establish an evaporative emissions benchmark and to allow a direct comparison of the SHED results between the high altitude and low altitude emissions laboratories.

Because of barometric pressure differences, the EPA certification fuel standard 40CFR86.113-04 specifies 9.0psi nominal RVP for elevations below 4000 feet, and 7.8psi nominal RVP above 4000 feet. CPG tests were performed using TE0 fuel, and SGS-ETC tests were performed using TE0_Alt fuel, described in Section 4 and Appendix 12.3.

The comparison of evaporative emission results was reasonable between the labs (Figure 35, Baseline #2 vs. Baseline #4). Diurnal evaporative emissions measured at the high altitude and low altitude labs correlated to within 10%, with a strong R^2 correlation coefficient of 0.84 for Day 1. The R^2 correlation coefficient was weaker on Day 2 of the diurnal test.

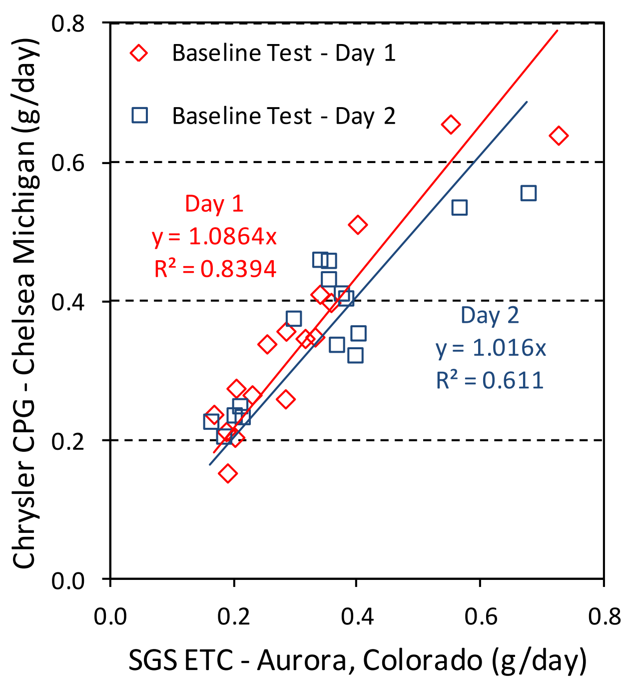


Figure 35. Comparison of Baseline SHED Results at Colorado and Michigan Labs

8.0 Statistical Analysis of SHED Results

The overall goal of the study and the focus of this analysis is to determine if gasoline containing 20% by volume ethanol (E20) has a long term effect on light-duty vehicle evaporative emissions. Per the test plan in Section 3.3, ten pairs of vehicles were purchased, carefully matched with respect to approximately similar dates of production and accumulated odometer mileage. All of the vehicles were tested on ethanol-free gasoline before the study began to provide a benchmark point for changes in evaporative emissions rates over time. One vehicle in each pair was randomly assigned to be operated on E0 ethanol-free gasoline, and the other on E20. The vehicles were driven twice a day for 90 days while being operated on the E0 or E20 fuel and tested for evaporative emissions. This process was repeated for 360 days of aging and yielded five data points in time for each vehicle (0, 90, 180, 270 and 360 days of aging). All of the data from each measurement in the study (including exhaust emissions test data from the FTP75 tests) appear in Appendix 12.6 of this report.

At the end of each mileage accumulation interval, the vehicles completed a Permeation Test sequence, fuel change, 14 day fuel conditioning, and then a Baseline Test sequence. The Baseline Test was designed to directly compare the change in evaporative emissions for both vehicles in each pair. The Baseline Test results were more relevant to assess the effect of the aging fuel on evaporative emissions deterioration because:

- Both vehicles in the pair were SHED tested using the same certification gasoline.
- The vehicles were tested in their natural state, whereas Permeation Tests used a non-permeable hose to run vented vapors to a slave canister outside of the SHED.
- The effect of fuel exposure on total evaporative emissions, and not just the permeation component, was of most interest for those involved in emissions certification.

For these reasons, the Baseline Test data were used in the statistical analysis to determine if exposure to E20 fuel increased evaporative emission rates.

The data from the one-hour hot soak tests and the two-day diurnal tests were used to calculate two different metrics for the evaluation. Because the goal of the study was to determine if the use of E20 fuel would increase evaporative emissions, the data from both the one-hour hot soak and the diurnal testing can be used to represent the evaporative emissions from the vehicles, albeit in differing operational modes. One-hour hot soak testing is useful for identifying larger scale leaks in vehicles immediately following operation of the car (such as a gross evaporative system or fuel system leaks, or contamination from a fuel spill). The hot soak mode of testing that occurs following vehicle operation represents a real-world behavior of interest for determining evaporative emissions. But owing to its short duration, the test may not be a good indicator for quantifying the change in emissions for comparative purposes. In contrast, the diurnal test is a preferred test method for accurately quantifying total evaporative emissions rates in part due to its longer duration, but lacks the hot soak component. Since both the hot soak and diurnal evaporative emissions rates are of interest, two metrics were used for statistical analysis:

- The average of the Day 1 and Day 2 results from the two-day diurnal Baseline Test, expressed in mg/day.
- A composite result comprised of the one-hour hot soak mass plus the greater of Day 1 or Day 2 mass from the Baseline Test, expressed in mg.

The analysis approach attempted to categorize the data into subgroups, and considered pooling the data for all vehicles having the same evaporative emissions standard as shown in Table 8. Whereas the objective was to gain insight on "like technology" groups of vehicles, it was found that each vehicle model had a unique response characteristic during the aging processes. It was therefore concluded that the pooling of data for a fleet analysis or subgroup analysis was not appropriate, and each vehicle model should be analyzed individually.

Table 8. Certification Evaporative Emissions Standards for Vehicles in the Study

Certification Evaporative Standards (1 Hr + Max Diurnal Day, g)			
	Std, g	Vehicles	n
Federal Tier 2 2009	0.65	4, 8	2
Federal Tier 2 2004	1.2	3, 5, 10	3
Enhanced Evap 100%	2.5	1, 2, 6, 7, 9	5

The goal was to compare the data from the vehicle aged on E0 with the same vehicle model aged on E20 fuel, to determine if operation on the E20 fuel caused an increase in evaporative emissions over time. The analysis focused on the difference in the emissions between each pair of vehicles as a function of time. Two benchmark tests were generally performed before aging began, and single tests were performed after 90, 180, 270 and 360 days of aging.

The data analysis was performed using the following methods:

1. For each vehicle at each time interval, the data were normalized to the benchmark tests performed at the start of the study (0 days):
   - Normalized emission rate at start is set zero = emission rate at start - emission rate at start
   - Normalized emission rate at X days = emission rate at X days - emission rate at start

2. The normalized ten pairs of data were then processed to calculate the difference in emissions rate between the E20 and E0 vehicles at each of five time intervals: 0, 90, 180, 270 and 360 days of aging. A positive value indicates Vehicle E20 had higher evaporative emissions than Vehicle E0, a negative value indicates the Vehicle E20 had lower emissions than Vehicle E0:
   - Emissions difference at X days = E20 – E0 vehicle normalized emission rates at X days

3. Linear regression was used to determine the slope for each pair of vehicles representing at each point in time the rate of emissions increase in mg of FID HC per day. The basic regression model was simply:
   - Emissions difference at X days = days * slope (mg FID HC emissions per day)

All 20 vehicles had two Baseline Tests performed at SGS-ETC prior to the start of road aging. The first test was performed prior to any vehicle modification. The second test was performed after modifications were made to the vehicle for the Permeation Tests (Section 3.5). After this initial testing, eight pairs of vehicles (1E, 2E, 3E, 5E, 6E, 7E, 9E, and 10E) were loaded in enclosed vehicle carriers and transported to CPG. An enclosed vehicle carrier was used to prevent hydrocarbons from potentially adhering to the vehicles during transport (such as from the diesel exhaust of the carrier tractor). In addition to this precaution, to ensure that there were no changes in the emissions caused by the transport from Denver Colorado to Chelsea Michigan, two additional evaporative emissions tests were run on each of the 16 vehicles upon arrival at CPG. Therefore, vehicle models 4E and 8E had two sets of evaporative emissions tests performed prior to aging and the other eight pairs received a total of four evaporative emissions tests prior to aging.

Analysis of the test data for vehicle pairs 4E and 8E indicated that there were no significant differences between the pre- and post-instrumentation measurements, so both were used as 0-day benchmark data in the analysis. For the remaining vehicle models transported to Michigan, only the last two Baseline Tests performed at CPG were used for the 0-day benchmark data, to eliminate any lab-to-lab differences in the calculation procedure. Vehicles 5E0 and 5E20 had one Baseline Test available for 0-day benchmark data, performed following the canister change and reconditioning (Section 7.5).

8.1 Baseline Test Data Results, Plots and Data Summaries

Baseline test results for all vehicles participating in the study are summarized in Section 8.1.1. Two evaporative emissions metrics are presented. This data provides an overall perspective on how vehicle emissions changed over the aging period and due to E20 fuel exposure.

Detailed results for individual vehicles and linear regression are presented graphically in Section 8.1.2. Individual test results are tabulated in Appendix 12.6.

8.1.1 Test Data Summaries

The average diurnal evaporative emission (={Day 1 + Day 2}/2) and linear regression results for all vehicles are presented in Table 9. The top table includes the average of the benchmark data taken prior to aging (0 Days), and total evaporative emissions for single tests performed after 90, 180, 270 and 360 days of aging. The middle table provides a normalization of the data to the 0 Day benchmark data and includes a linear regression result. The slope is mg/day per day of aging. The slope multiplied by 360 days equates to the change in evaporative emissions at the end of the study in mg/day, based on the linear regression result. This metric represents an average diurnal emissions change due to fuel exposure and aging, and is plotted for each vehicle on Figure 36 (blue and red bars).

The bottom table shows the difference in evaporative emissions between the vehicle aged on E20 and the vehicle aged on E0 fuel, at each time interval. This data set also includes the calculated slopes and R^2 correlation coefficients for a linear regression through the data points for the resulting difference in emissions for the vehicle pair. The slope multiplied by 360 days equates to the difference in evaporative emissions between Vehicle E20 and Vehicle E0 at the end of the study in mg/day and is also shown on Figure 36 (green bars).

The data is also summarized in the same format using another metric, the one-hour hot soak mass plus maximum daily emission mass (Table 10 and Figure 37). The maximum daily emission mass is the highest of the Day 1 and Day 2 emissions measurements for the two-day diurnal test. This metric is a composite mass result that includes two different modes of emissions: evaporative emissions immediately following vehicle operation and diurnal emissions. This metric is used by regulatory agencies and can be compared to the EPA standard for evaporative emissions certification.

Table 9. Summary of Baseline Test Results by Vehicle Model, Day 1 & Day 2 Average

Baseline Test, Day 1 and Day 2 Average by Vehicle (mg/day)

	Elapsed Test Days	1E0	1E20	2E0	2E20	3E0	3E20	4E0	4E20	5E0	5E20	6E0	6E20	7E0	7E20	8E0	8E20	9E0	9E20	10E0	10E20
Time = 0 Average	0	583.3	594.4	288.6	438.9	169.3	188.8	122.5	101.3	325.6	372.1	422.7	248.5	402.1	406.5	182.3	315.3	366.1	379.9	210.7	230.6
Time = 90	90	611.3	671.2	309.3	396.4	152.7	160.3	81.0	94.5	263.4	447.8	477.5	231.6	415.3	361.9	194.0	285.0	338.3	311.6	146.6	180.5
Time = 180	180	529.4	640.3	349.4	557.1	134.2	159.7	80.0	101.5	313.9	821.5	484.4	256.0	443.4	554.1	191.0	273.5	267.8	353.8	159.5	203.0
Time = 270	270	583.8	1120.2	333.1	381.0	130.6	132.6	68.5	93.5	176.9	407.6	473.0	231.1	539.0	438.3	172.5	299.0	254.1	274.7	144.7	163.6
Time = 360	360	525.9	941.7	300.2	476.0	160.3	111.0	78.0	107.5	211.6	552.3	458.2	261.3	940.6	1089.2	248.5	247.0	317.5	339.8	155.9	184.5

Baseline Test, Day 1 and Day 2 Average Normalized to Time=0 Result (mg/day)

	Elapsed Test Days	1E0	1E20	2E0	2E20	3E0	3E20	4E0	4E20	5E0	5E20	6E0	6E20	7E0*	7E20*	8E0	8E20	9E0	9E20	10E0	10E20
Time = 0 Average	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time = 90	90	28.0	76.8	20.7	-42.4	-16.6	-28.5	-41.5	-6.8	-62.2	75.6	54.8	-16.9	13.2	-44.6	11.8	-30.3	-27.8	-68.3	-64.1	-50.2
Time = 180	180	-53.9	45.8	60.8	118.3	-35.1	-29.1	-42.5	0.3	-11.7	449.4	61.7	7.5	41.3	147.6	8.8	-41.8	-98.3	-26.1	-51.2	-27.6
Time = 270	270	0.5	525.8	44.5	-57.8	-38.7	-56.2	-54.0	-7.8	-148.7	35.5	50.3	-17.4	136.9	31.8	-9.8	-16.3	-112.1	-105.2	-66.0	-67.0
Time = 360	360	-57.4	347.2	11.6	37.2	-9.1	-77.8	-44.5	6.3	-114.0	180.1	35.4	12.7	538.5	682.7	66.3	-68.3	-48.6	-40.1	-54.7	-46.1
	Slope	-0.114	1.161	0.119	0.063	-0.089	-0.210	-0.173	-0.002	-0.366	0.667	0.174	-0.001	0.402	0.275	0.098	-0.161	-0.280	-0.221	-0.216	-0.182
	R-squared	0.361	0.632	0.090	0.017	0.146	0.952	0.584	0.100	0.601	0.078	0.182	0.082	0.840	0.204	0.351	0.560	0.370	0.210	0.422	0.078
360 Day Change by Vehicle		-41.0	417.9	43.0	22.6	-31.9	-75.5	-62.2	-0.6	-131.7	240.2	62.7	-0.4	144.7	98.9	35.3	-58.1	-100.7	-79.5	-77.8	-65.4

Baseline Test, Day 1 and Day 2 Average, Emissions Difference by Vehicle Model (mg/day)

	Elapsed Test Days	1E	2E	3E	4E	5E	6E	7E*	8E	9E	10E
Standard		**2.5g**	**2.5g**	**1.2g**	**0.65g**	**1.2g**	**2.5g**	**2.5g**	**0.65g**	**2.5g**	**1.2g**
Time = 0 Average	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time = 90	90	48.8	-63.1	-11.9	34.8	137.8	-71.7	-57.8	-42.0	-40.5	13.9
Time = 180	180	99.7	57.5	6.0	42.8	461.2	-54.1	106.3	-50.5	72.2	23.5
Time = 270	270	525.3	-102.3	-17.5	46.3	184.2	-67.6	-105.1	-6.5	6.9	-1.1
Time = 360	360	404.6	25.6	-68.7	50.8	294.2	-22.7	144.2	-134.5	8.5	8.7
	Slope	1.275	-0.057	-0.121	0.171	1.033	-0.175	-0.127	-0.259	0.059	0.034
	R-squared	0.754	0.001	0.582	0.769	0.336	0.045	0.129	0.472	0.064	0.001
360 Day Difference: Vehicle E20-Vehicle E0		459.0	-20.4	-43.6	61.6	371.9	-63.1	-45.9	-93.4	21.1	12.3

* Vehicle Model 7E, Time = 360 data not used to determine slopes or R-squared

Figure 36. Summary of Baseline Test Results by Vehicle Model, Day 1 & Day 2 Average

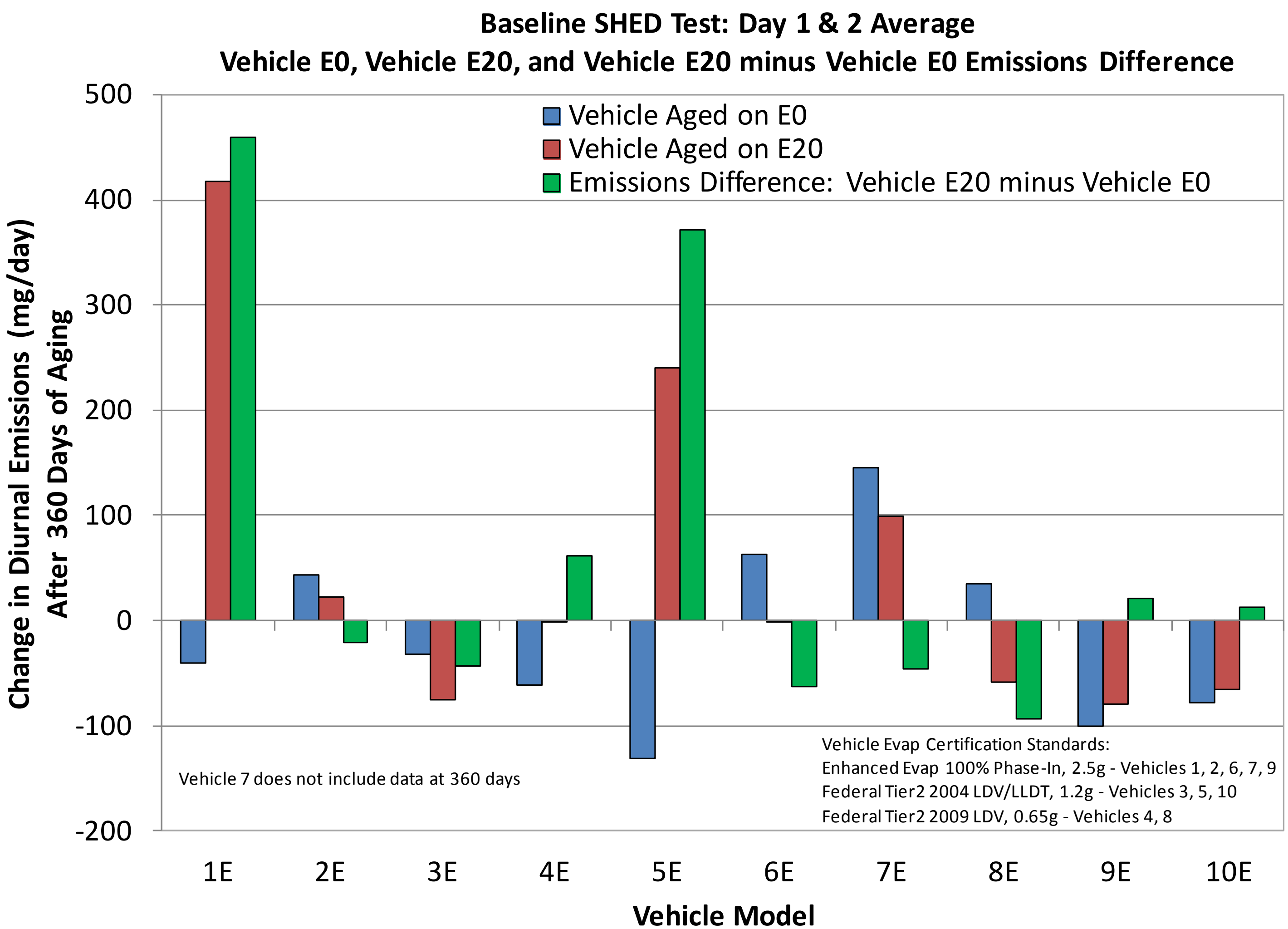


Table 10. Summary of Baseline Test Results by Vehicle Model, One-Hour Hot Soak + Max Daily Emission

Baseline Test, One-Hour Hot Soak + Maximum Daily Emission by Vehicle (mg)

	Elapsed Test Days	1E0	1E20	2E0	2E20	3E0	3E20	4E0	4E20	5E0	5E20	6E0	6E20	7E0	7E20	8E0	8E20	9E0	9E20	10E0	10E20
Time = 0 Average	0	706.7	719.3	348.4	529.1	245.4	241.2	133.0	114.0	401.4	427.7	534.2	327.8	450.2	487.9	216.0	359.5	404.8	449.9	235.0	262.1
Time = 90	90	748.2	993.3	366.6	579.7	193.5	189.8	91.0	111.0	329.4	527.6	678.1	283.3	493.2	403.6	226.0	322.0	378.9	347.0	166.9	223.2
Time = 180	180	621.5	887.7	396.6	583.7	173.8	200.9	90.0	109.0	440.0	1197.2	589.6	317.1	484.7	629.8	211.0	289.0	298.7	407.7	189.5	235.3
Time = 270	270	681.9	1285.0	386.6	421.3	165.8	161.7	72.0	99.0	207.4	477.8	570.7	282.3	597.8	505.2	203.0	357.0	284.8	334.8	167.5	181.1
Time = 360	360	657.4	1209.1	355.8	530.6	222.9	132.0	87.0	115.0	224.6	675.1	545.5	315.8	1184.6	1327.0	282.0	263.0	363.2	397.0	181.0	226.3

Baseline Test, One-Hour Hot Soak + Maximum Daily Emission Normalized to Time=0 Result (mg)

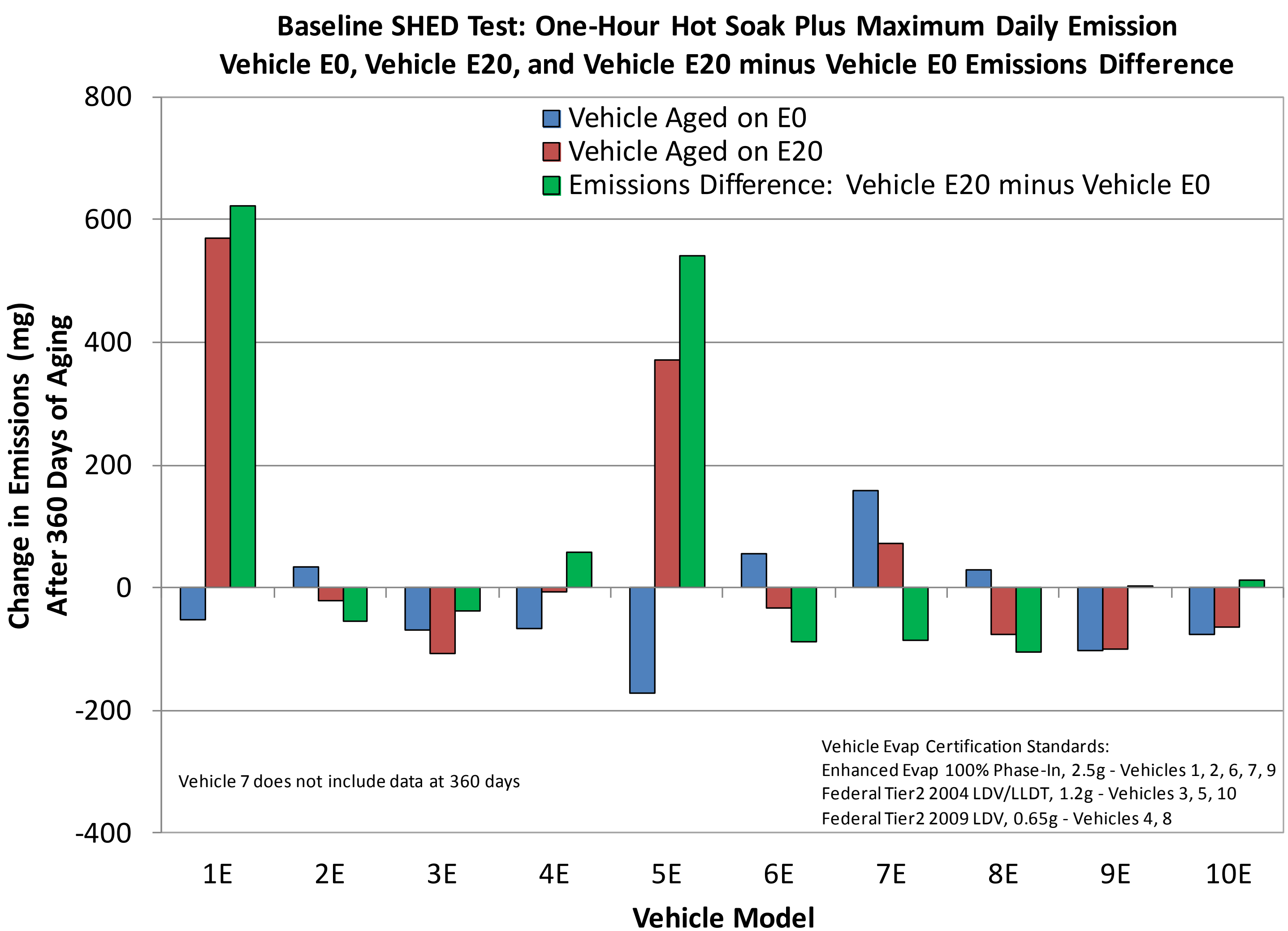
	Elapsed Test Days	1E0	1E20	2E0	2E20	3E0	3E20	4E0	4E20	5E0	5E20	6E0	6E20	7E0*	7E20*	8E0	8E20	9E0	9E20	10E0	10E20
Time = 0 Average	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time = 90	90	41.4	274.0	18.1	50.6	-52.0	-51.4	-42.0	-3.0	-72.1	99.9	143.9	-44.5	43.0	-84.3	10.0	-37.5	-25.9	-103.0	-68.2	-39.0
Time = 180	180	-85.2	168.3	48.2	54.6	-71.6	-40.3	-43.0	-5.0	38.5	769.5	55.4	-10.7	34.5	141.9	-5.0	-70.5	-106.0	-42.3	-45.5	-26.8
Time = 270	270	-24.8	565.7	38.2	-107.8	-79.7	-79.5	-61.0	-15.0	-194.1	50.1	36.5	-45.5	147.6	17.3	-13.0	-2.5	-120.0	-115.1	-67.6	-81.0
Time = 360	360	-49.3	489.8	7.4	1.4	-22.5	-109.2	-46.0	1.0	-176.8	247.4	11.3	-12.0	734.5	839.2	66.0	-96.5	-41.6	-53.0	-54.1	-35.8
	Slope	-0.148	1.580	0.096	-0.059	-0.194	-0.299	-0.183	-0.020	-0.476	1.029	0.152	-0.093	0.440	0.200	0.083	-0.212	-0.283	-0.276	-0.214	-0.177
	R-squared	0.294	0.753	0.073	0.141	0.118	0.896	0.593	0.061	0.527	0.050	0.055	0.035	0.776	0.148	0.299	0.350	0.291	0.158	0.369	0.050
360 Day Change by Vehicle		-53.4	568.9	34.5	-21.1	-69.9	-107.6	-66.0	-7.2	-171.3	370.5	54.6	-33.4	158.5	71.9	30.0	-76.3	-101.9	-99.3	-77.1	-63.8

Baseline Test, One-Hour Hot Soak + Maximum Daily Emission, Difference by Vehicle Model (mg)

	Elapsed Test Days	1E	2E	3E	4E	5E	6E	7E*	8E	9E	10E
Standard		2.5g	2.5g	1.2g	0.65g	1.2g	2.5g	2.5g	0.65g	2.5g	1.2g
Time = 0 Average	0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Time = 90	90	232.5	32.5	0.6	39.0	172.0	-188.5	-127.3	-47.5	-77.1	29.2
Time = 180	180	253.5	6.4	31.3	38.0	731.0	-66.2	107.4	-65.5	63.8	18.7
Time = 270	270	590.5	-146.0	0.2	46.0	244.2	-82.0	-130.3	10.5	4.8	-13.4
Time = 360	360	539.1	-5.9	-86.6	47.0	424.2	-23.4	104.7	-162.5	-11.4	18.3
	Slope	1.729	-0.154	-0.105	0.163	1.505	-0.245	-0.241	-0.295	0.007	0.037
	R-squared	0.876	0.182	0.382	0.676	0.274	0.017	0.077	0.375	0.035	0.003
360 Day Difference: Vehicle E20-Vehicle E0		622.3	-55.5	-37.7	58.8	541.8	-88.0	-86.7	-106.3	2.6	13.3

* Vehicle Model 7E, Time = 360 data not used to determine slopes or R-squared

Figure 37. Summary of Baseline Test Results by Vehicle Model, One-Hour Hot Soak + Max Daily Emission



It is noted that both Vehicle 7E0 and Vehicle 7E20 experienced purge valve sticking prior to and during the 360 day tests (Section 7.7). Because the unseated purge valves caused dramatically higher evaporative emission for both vehicles and was not representative of normal operation, the 360 day results for Vehicle 7E0 and 7E20 were both excluded from the linear regression models presented here.

Regarding the summary results for all vehicles (Figure 36 and 37), positive values indicate an increase in evaporative emissions over the 360 day aging period, and negative values indicate an evaporative emissions decrease. The green bars represent the difference in evaporative emissions between the vehicle aged on E20 fuel and the matched vehicle aged on E0 fuel. A summary of the total emissions difference for each of the vehicle models following 360 days of aging is also shown in Table 11, using both metrics.

Table 11. Summary of Total Emissions Change over 360 Days of Aging

Baseline Test, Emissions Difference by Vehicle Model (mg /day) After 360 Days Aging, Vehicle E20-Vehicle E0										
Metric / Vehicle	**1E**	**2E**	**3E**	**4E**	**5E**	**6E**	**7E***	**8E**	**9E**	**10E**
Day 1 & 2 Average (mg/day)	459.0	-20.4	-43.6	61.6	371.9	-63.1	-45.9	-93.4	21.1	12.3
One Hour Hot Soak + Maximum Day (mg)	622.3	-55.5	-37.7	58.8	533.9	-88.0	-86.7	-106.3	2.6	13.3

* Vehicle Model 7E, Time = 360 data not used

Vehicle models 1E and 5E showed a pronounced increase in evaporative emissions following E20 fuel exposure, compared to control vehicles operated on E0 fuel. The evaporative emission rates of Vehicles 1E20 and 5E20 were 459 and 372 mg/day higher, respectively, than the E0-fueled control vehicles following 360 days of aging.

The One-Hour Hot Soak + Maximum Day metric was considerably higher for Vehicle models 1E and 5E because of the maximum daily emission was much higher than the average daily emission near the end of the study. The evaporative emission for Vehicles 1E20 and 5E20 were 622 and 534 mg/day higher, respectively, than the E0-fueled control vehicles following 360 days of aging. Model 1E was certified to the Federal Enhanced Evaporative Emissions Standard, and model 5E was certified to the Federal Tier2 2004 LDV/LLDT Standard.

Evaporative emissions from vehicle models 3E, 9E and 10E decreased over the 360 day aging period, for both fuels tested. The cause for this decrease cannot be determined with certainty because of the many factors and mechanisms associated with the vehicle technology and SHED testing. Since the recruited vehicles had prior real-world exposure, the evaporative emissions decrease may be related to street fuel carry-over effects, "off-gassing" effects of car surface treatments, the repetitious two-a-day driving schedule, or other unknown mechanisms.

The conclusions reached regarding evaporative emissions changes and vehicle-to-vehicle differences over time were essentially the same for both of the metrics used for analysis.

8.1.2 Individual Vehicle Pair Results

For each vehicle pair, four plots and a brief description of the results are presented:

- Two-Day Diurnal Results – Day 1, Day 2 and the Day1 and Day 2 average emission rates for both the E0 and E20 vehicle
- Two-Day Diurnal Results, Average Difference – The average emissions for each vehicle at each point in time were subtracted (Vehicle E20 – Vehicle E0), plotted and fit with a line representing the change over time in emissions of the E20 vehicle over the E0 vehicle
- Two-Day Diurnal and One-Hour Hot Soak Results, Average Difference – Maximum of Day 1 or Day 2 of the diurnal test plus the one-hour hot soak results for both the E0 and E20 vehicle
- Two-Day Diurnal and One-Hour Hot Soak Results, Average Difference - The emissions for each vehicle at each point in time were subtracted (Vehicle E20 – Vehicle E0), plotted and fit with a line representing the change over time in emissions of the E20 vehicle over the E0 vehicle

8.1.2.1 Vehicles 1E0 and 1E20

For this vehicle pair using both metrics, evaporative emissions from Vehicle 1E20 increased over time and those from the Vehicle 1E0 decreased over time (Figures 38 to 41). The R^2 coefficient for the difference plots were 0.754 and 0.876, which indicates that the data were highly consistent with showing an impact of E20 fuel on the vehicle's evaporative emissions rate over time. The permeation test data also show that the permeation rate of HC evaporative emissions increased over time for the Vehicle 1E20 in all modes of testing (permeation, tank pressurized and with the fuel pump on). As show in Table 11, the diurnal emissions were 459 mg/day higher for Vehicle 1E20 compared to Vehicle 1E0 after 360 days of aging.

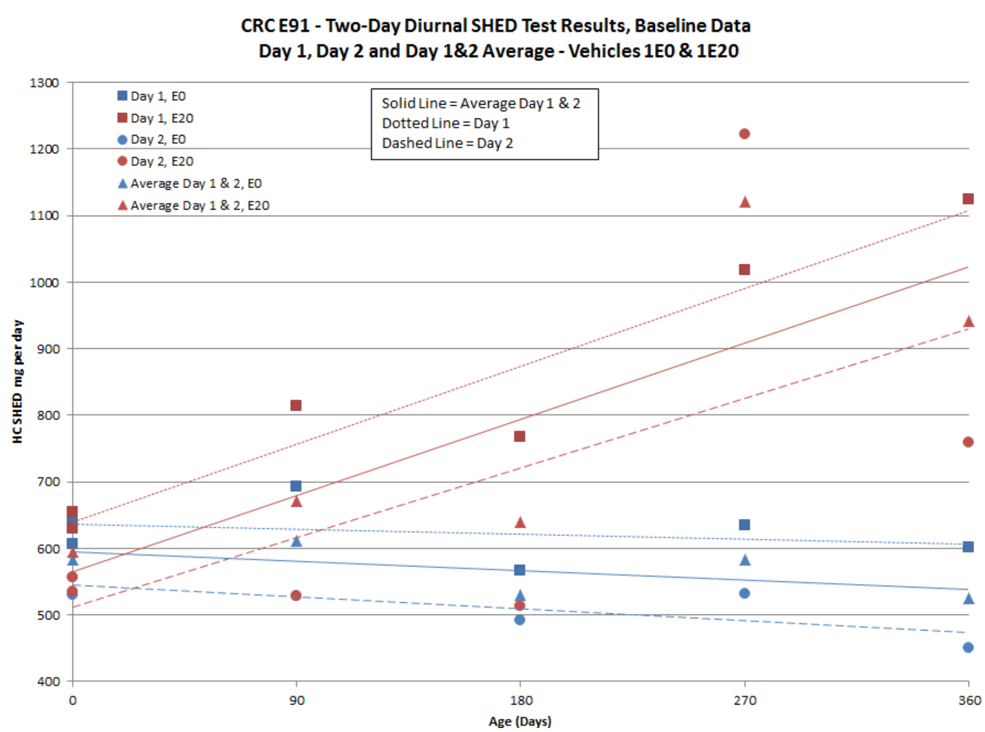


Figure 38. Linear Regression, Vehicles 1E0 & 1E20

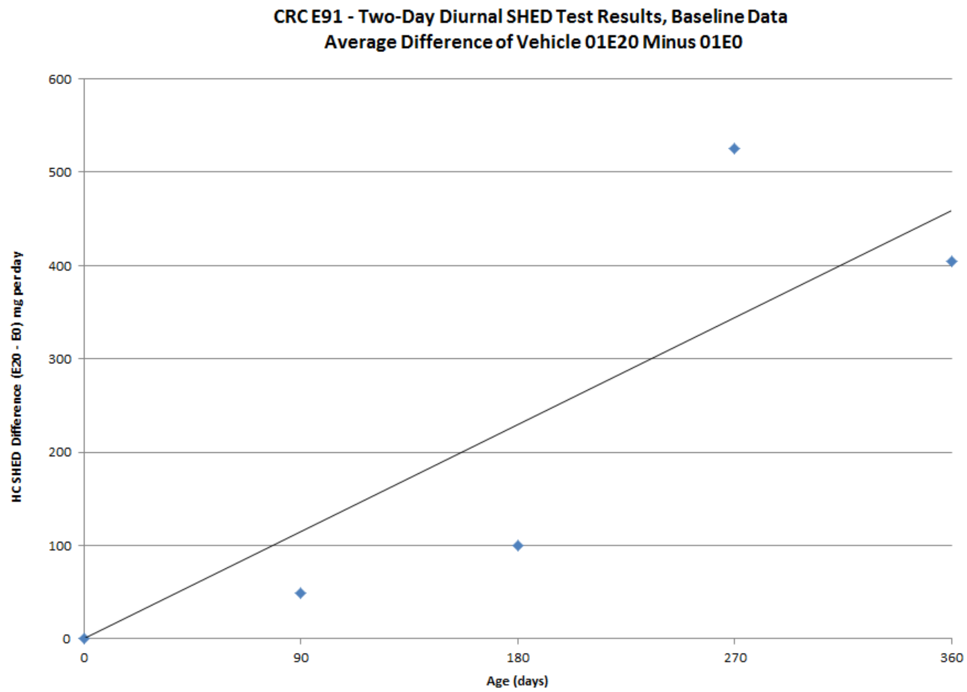


Figure 39. Linear Regression, Vehicles 1E0 & 1E20

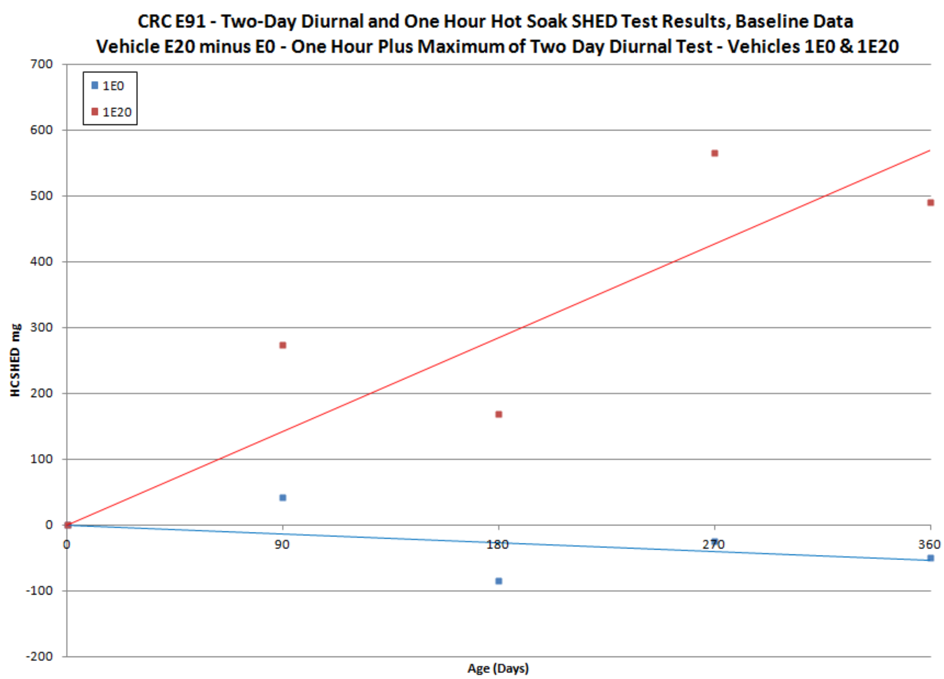


Figure 40. Linear Regression, Vehicles 1E0 & 1E20

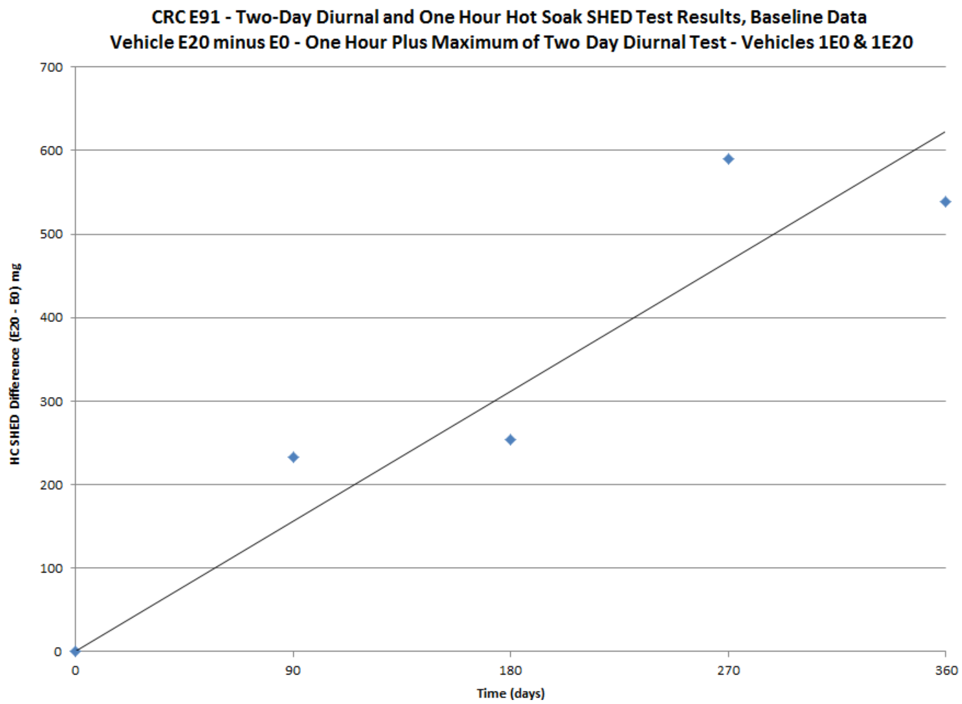


Figure 41. Linear Regression, Vehicles 1E0 & 1E20

8.1.2.2 Vehicles 2E0 and 2E20

The average of Day 1 and Day 2 diurnal emissions from both members of this vehicle pair increased over time (Figure 42). The difference plot (Figure 43) shows Vehicle 2E20 vehicle having very slightly higher emissions (20.4 mg/day over the 360 days of aging) than the Vehicle 2E0. However, Figure 42 shows the data were quite variable; the vehicles alternated having higher emissions between time periods. Using the data from the one-hour hot soak plus the maximum day of the diurnal test, the difference plot (Figure 44) indicates that the Vehicle 2E0 had higher emissions than Vehicle 2E20 vehicle (55.5 mg over the 360 days of aging). There was one measurement on Vehicle 2E20 at 270 days which influenced the entire result, as seen in Figures 44 and 45. If this result were excluded, the difference between the two vehicles would have been very small.

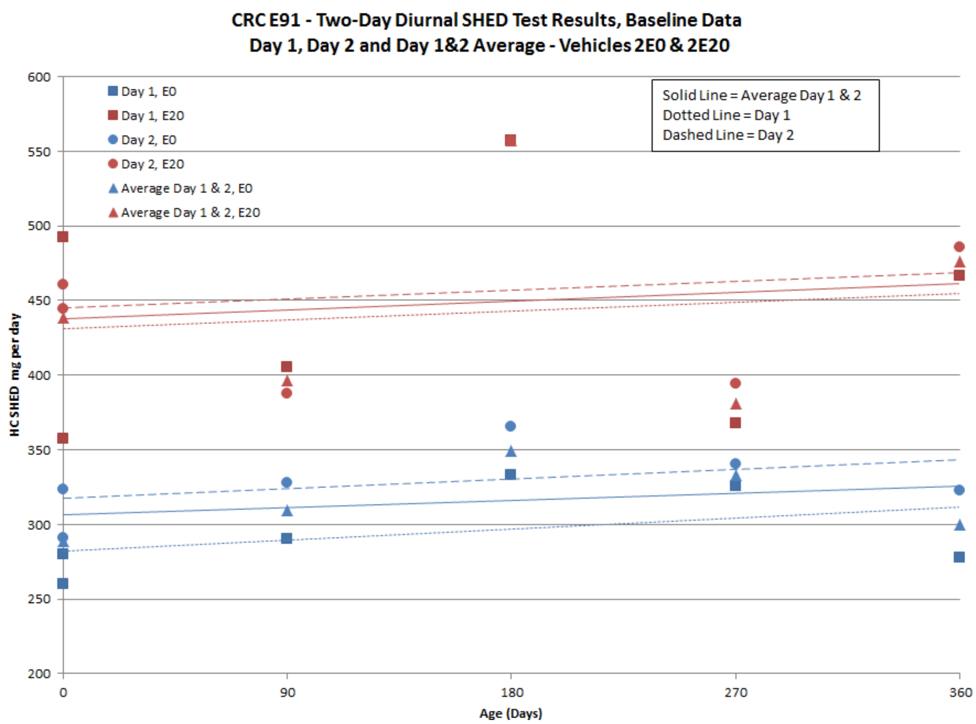


Figure 42. Linear Regression, Vehicles 2E0 & 2E20

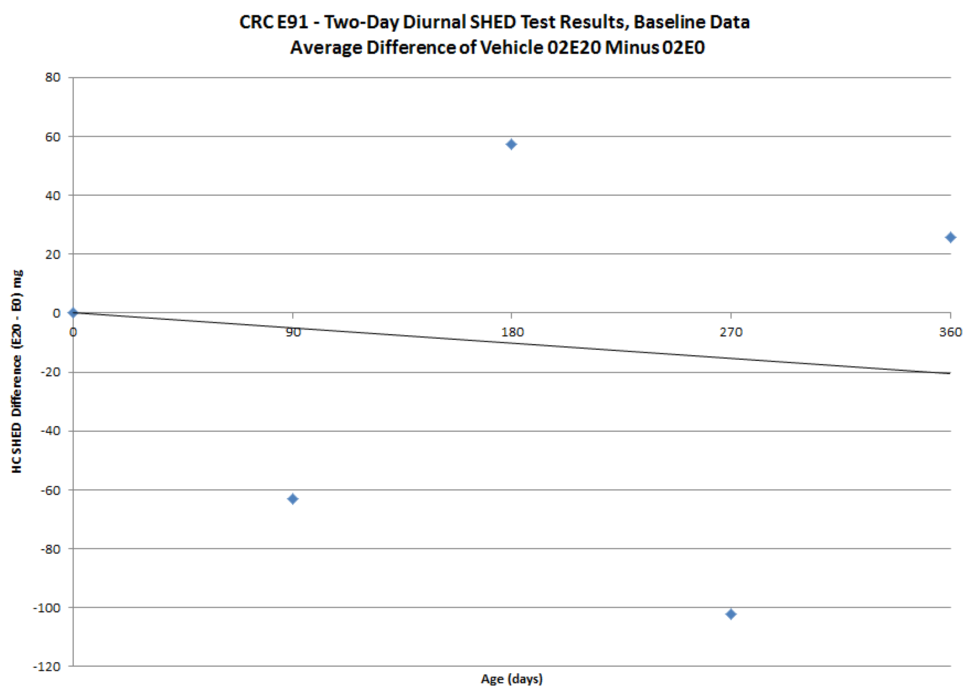


Figure 43. Linear Regression, Vehicles 2E0 & 2E20

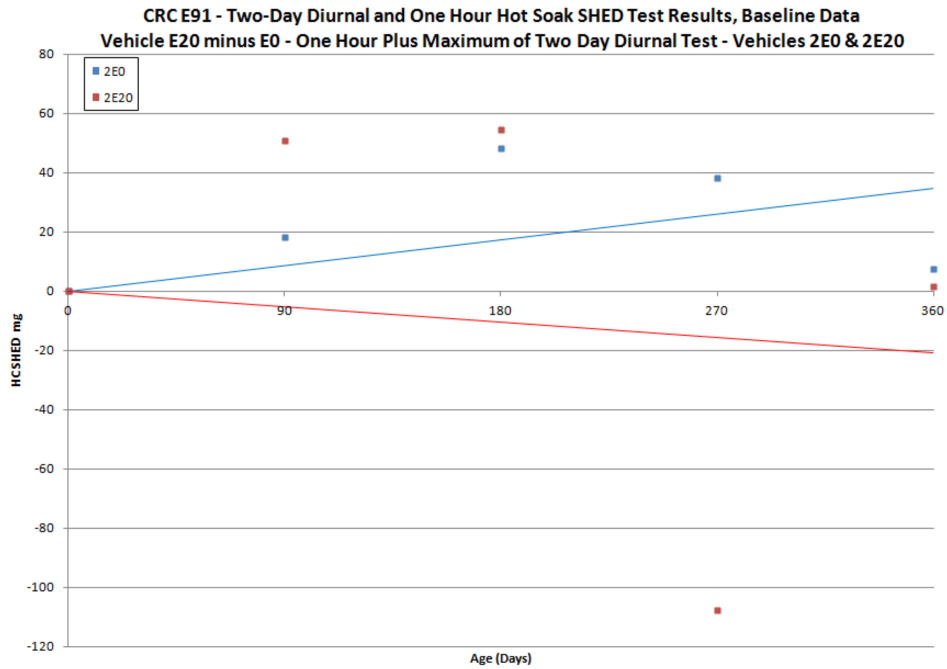


Figure 44. Linear Regression, Vehicles 2E0 & 2E20

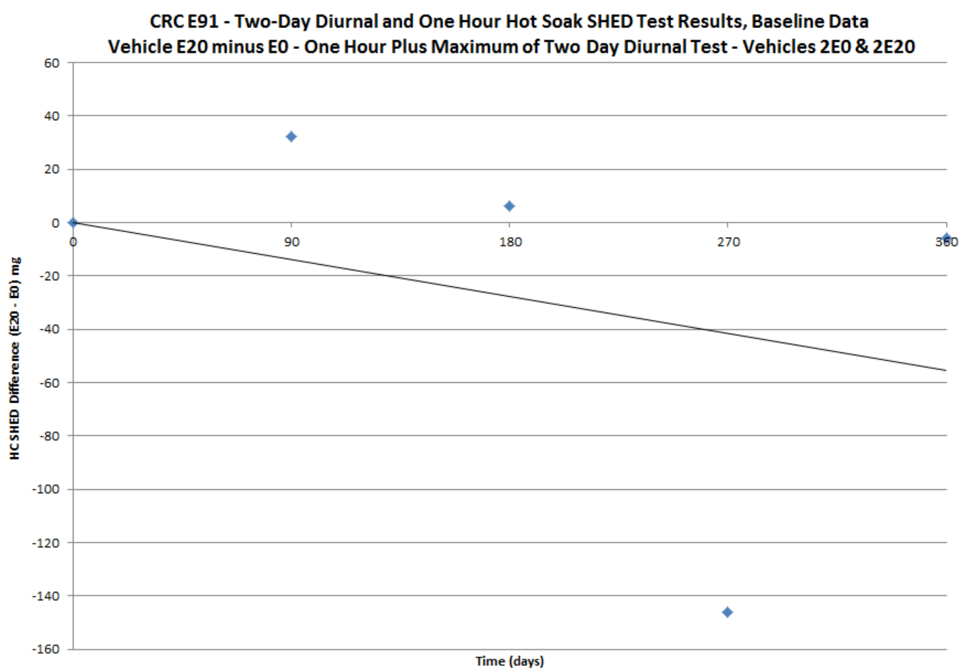


Figure 45. Linear Regression, Vehicles 2E0 & 2E20

8.1.2.3 Vehicles 3E0 and 3E20

Emissions from both members of the Vehicle 3E pair decreased over time. However, the emissions from Vehicle 3E20 vehicle decreased faster based on both metrics. Emissions from the Vehicle 3E0 were 44 mg/day higher than the Vehicle E20 vehicle.

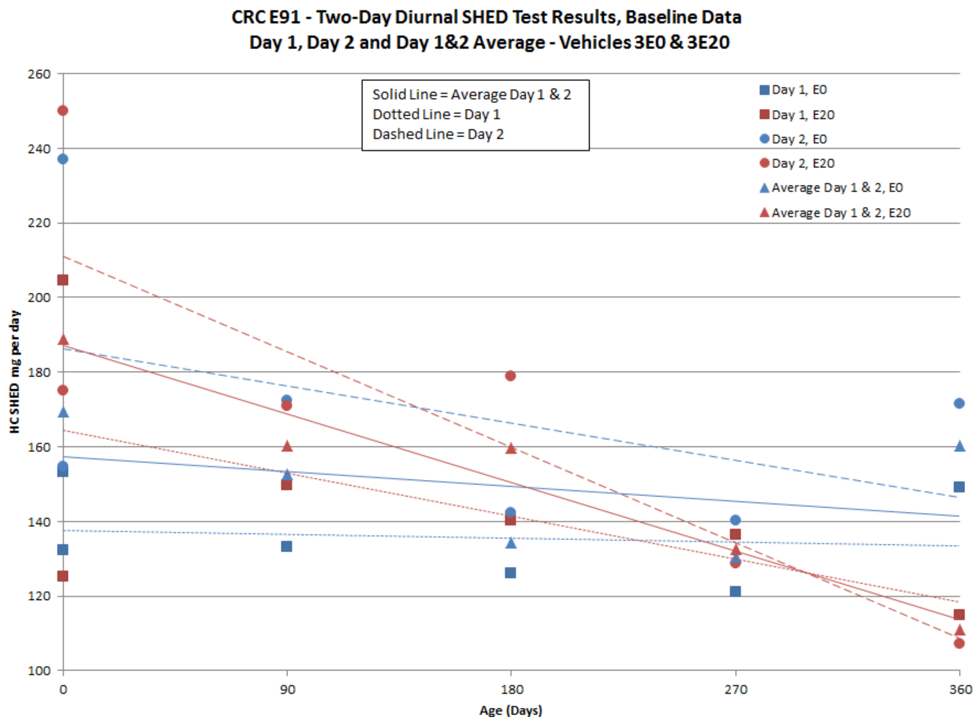


Figure 46. Linear Regression, Vehicles 3E0 & 3E20

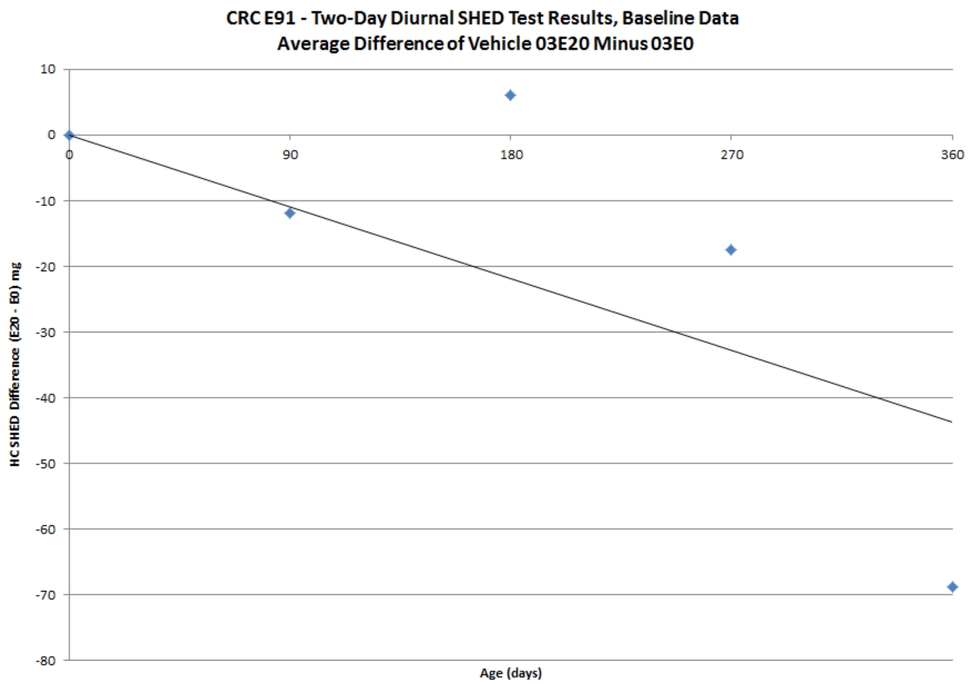


Figure 47. Linear Regression, Vehicles 3E0 & 3E20

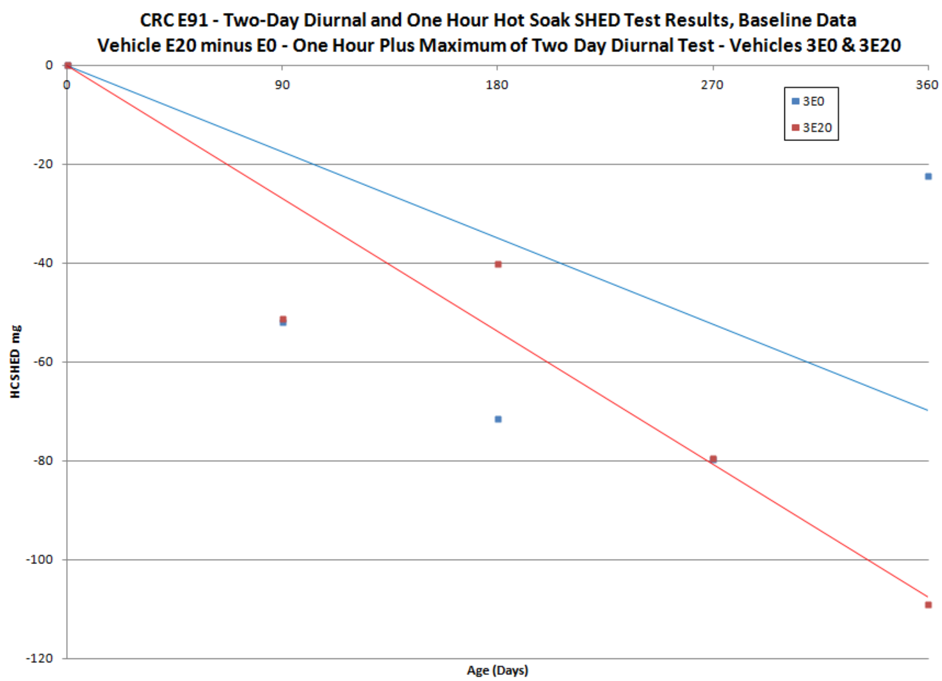


Figure 48. Linear Regression, Vehicles 3E0 & 3E20

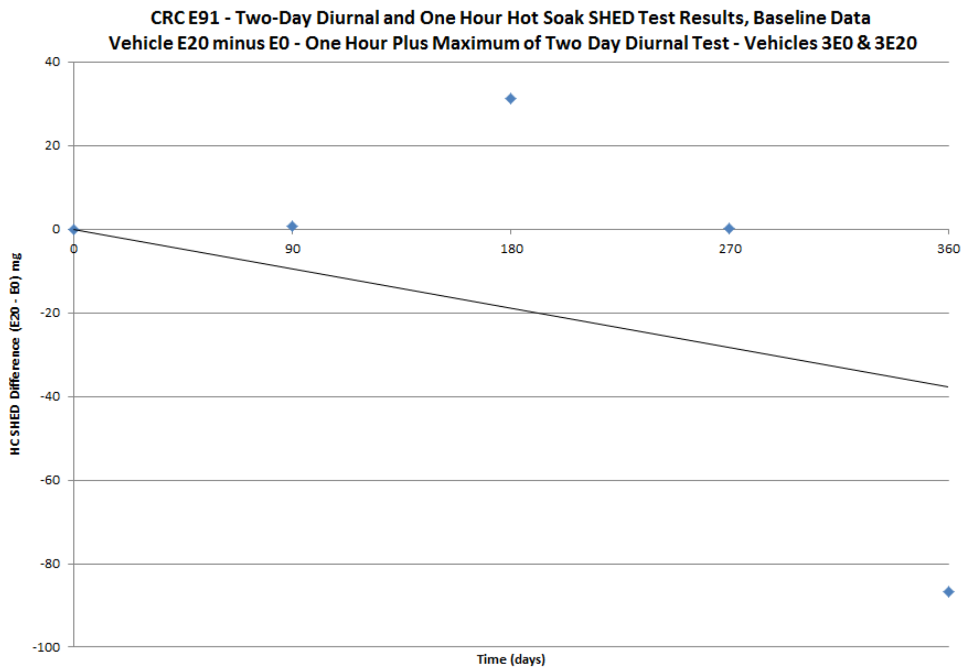


Figure 49. Linear Regression, Vehicles 3E0 & 3E20

8.1.2.4 Vehicles 4E0 and 4E20

For this pair, considering both metrics, the vehicle aged on E0 fuel had decreasing emissions over the 360 days of the study, while the vehicle aged on E20 fuel remained mostly unchanged. The average evaporative emission rate of Vehicle 4E20 was 62 mg higher than Vehicle 4E0 over the 360 day study period. Figure 51 shows that the difference plots over time for the vehicles are more curvilinear than linear; but the R^2 coefficient was 0.769 when fitting a line to the data.

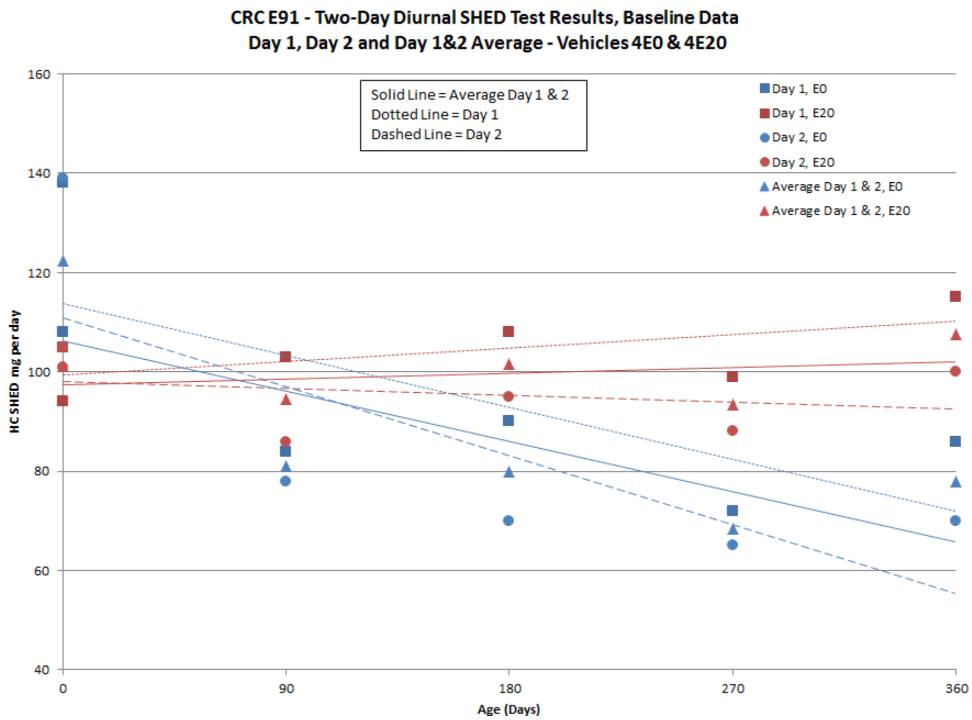


Figure 50. Linear Regression, Vehicles 4E0 & 4E20

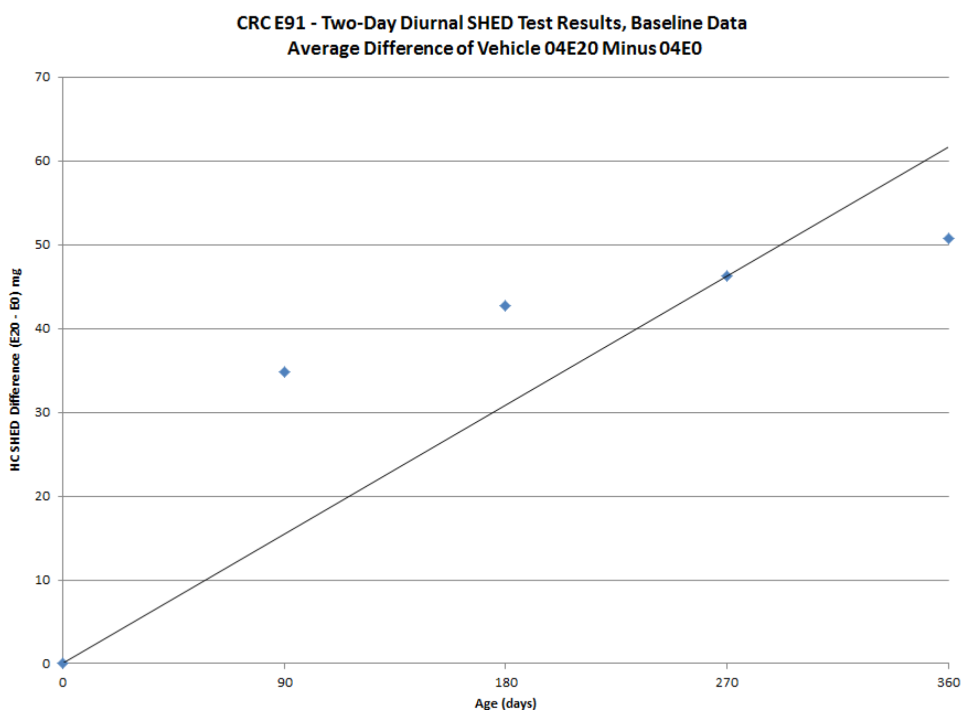


Figure 51. Linear Regression, Vehicles 4E0 & 4E20

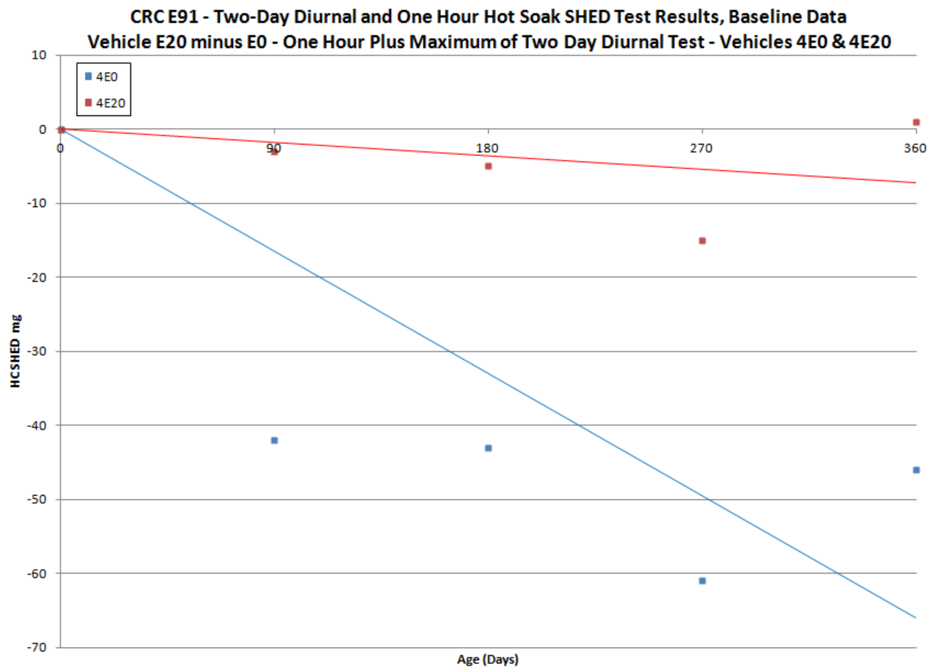


Figure 52. Linear Regression, Vehicles 4E0 & 4E20

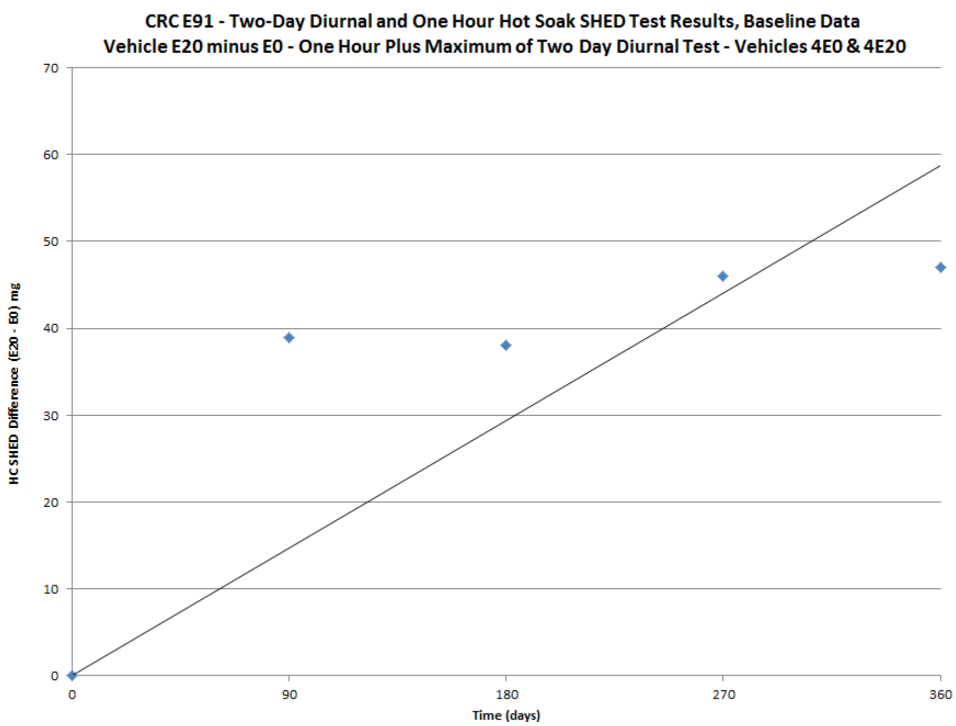


Figure 53. Linear Regression, Vehicles 4E0 & 4E20

8.1.2.5 Vehicles 5E0 and 5E20

The emissions from Vehicle 5E20 increased while those for the Vehicle 5E0 vehicle decreased for tests performed following the canister change in both vehicles. In addition, the elevated emissions for the Vehicle 5E20 vehicle at 180 days may appear to be an outlier and were caused by a low canister purge volume preceding the SHED test (see Figure 54). However, even if these data were excluded, it is clear that emissions from the Vehicle 5E20 vehicle were increasing while those from the control vehicle were decreasing using both metrics.

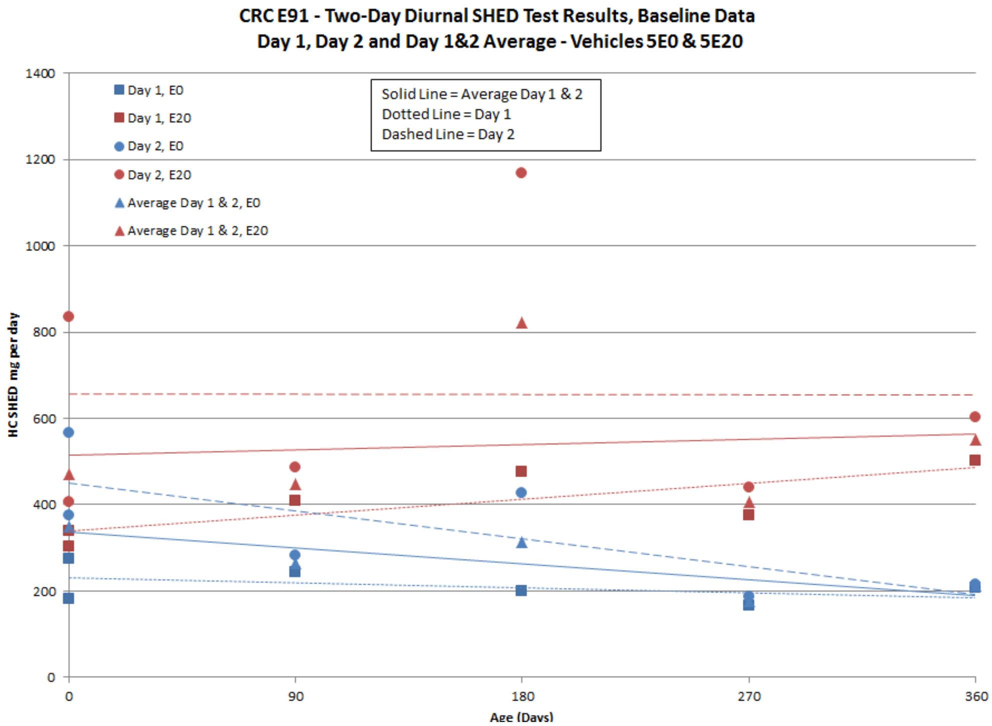


Figure 54. Linear Regression, Vehicles 5E0 & 5E20

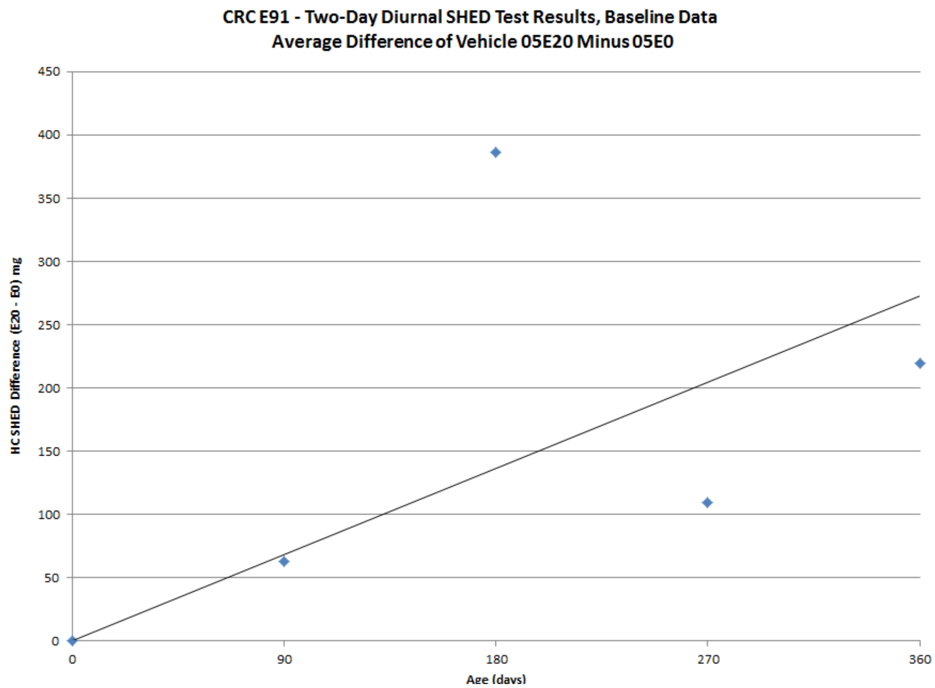


Figure 55. Linear Regression, Vehicles 5E0 & 5E20

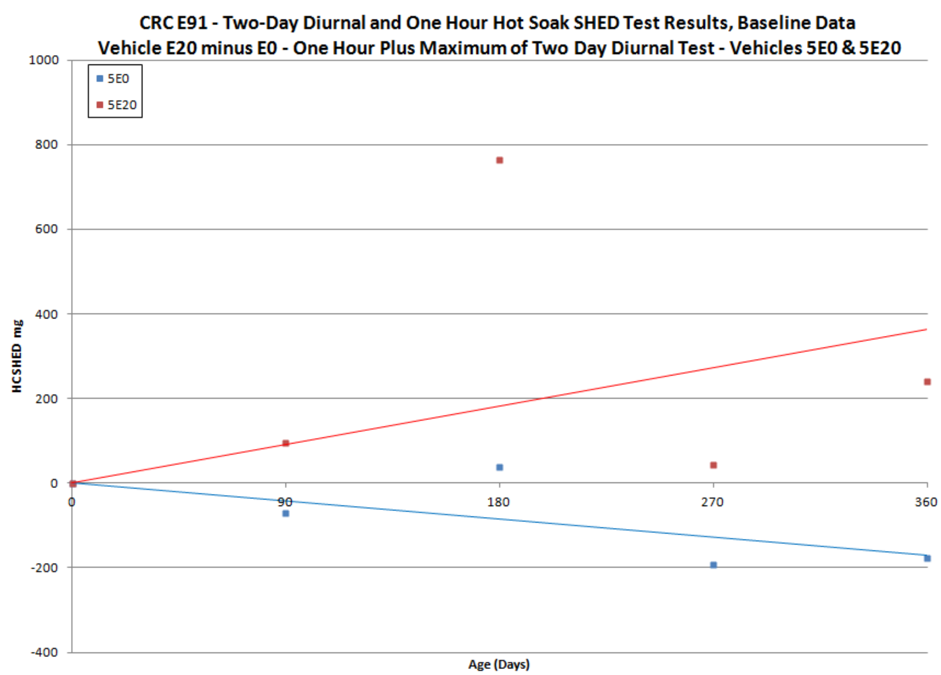


Figure 56. Linear Regression, Vehicles 5E0 & 5E20

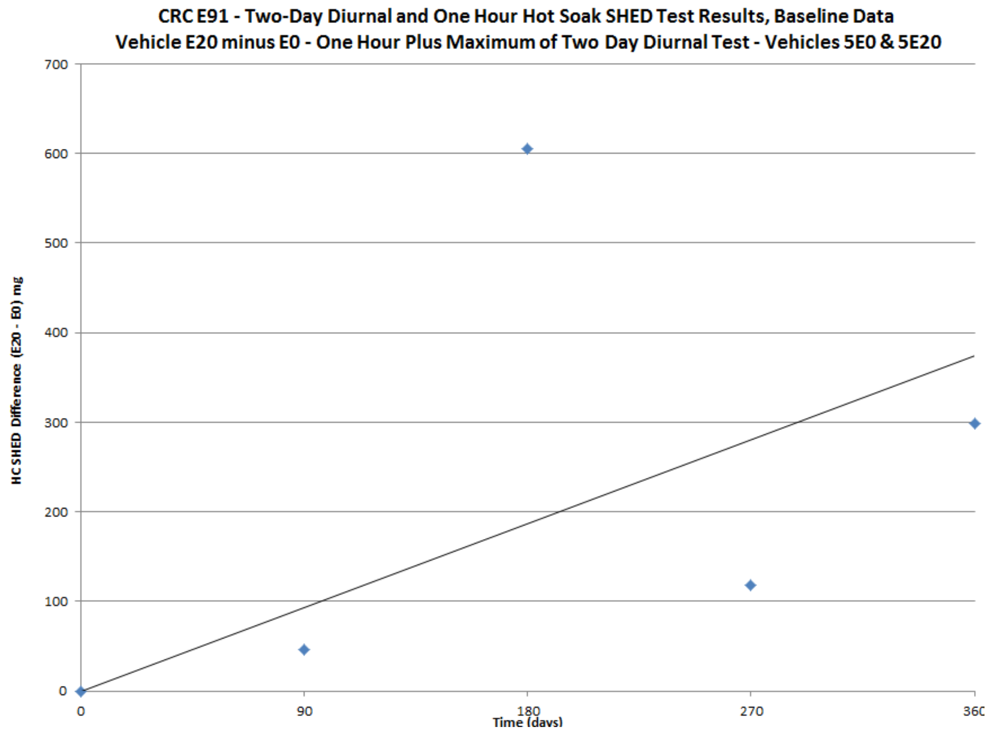


Figure 57. Linear Regression, Vehicles 5E0 & 5E20

8.1.2.6 Vehicles 6E0 and 6E20

For this vehicle pair, Vehicle 6E0 had slightly increased emissions over time using both metrics, while Vehicle 6E20 vehicle showed slightly decreasing emissions over time. Vehicle 6E0 had an evaporative emissions rate 63 mg/day higher than Vehicle 6E20 after 360 days of aging, and this is considered to be a very small difference.

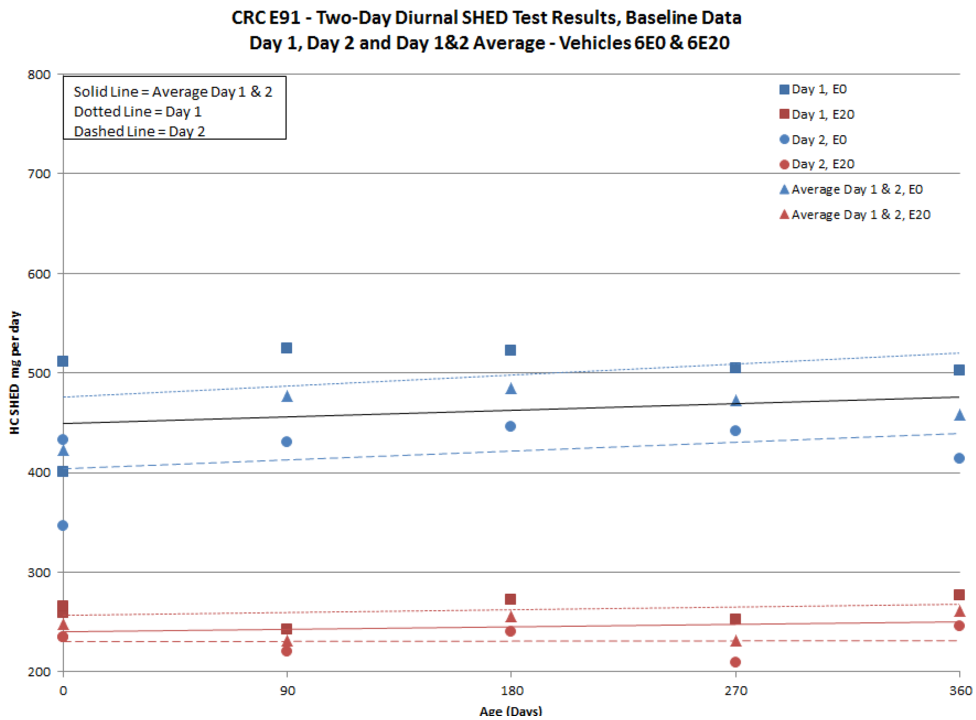


Figure 58. Linear Regression, Vehicles 6E0 & 6E20

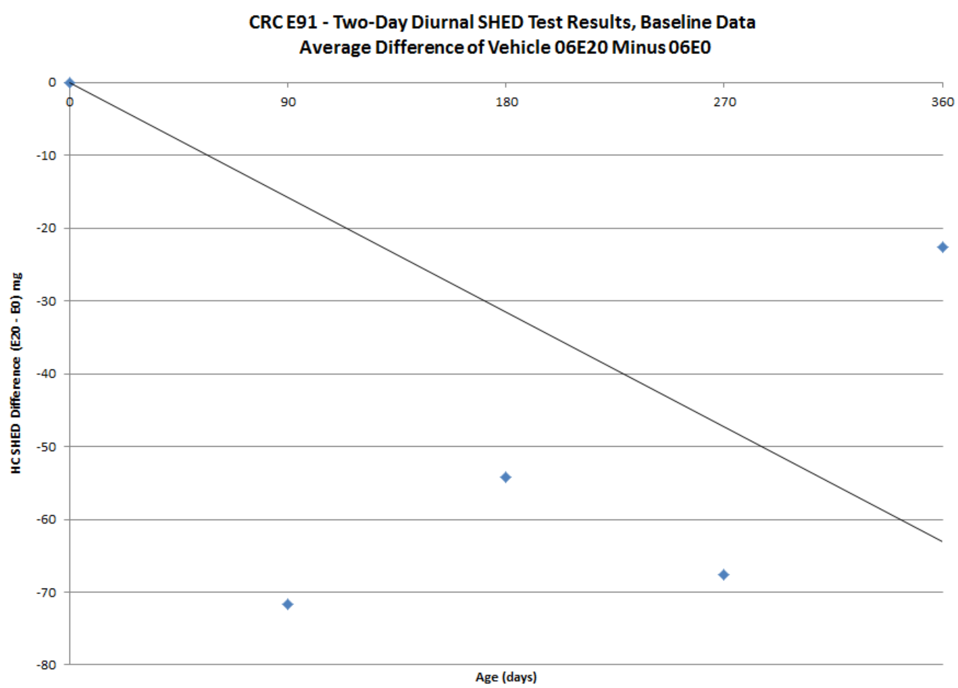


Figure 59. Linear Regression, Vehicles 6E0 & 6E20

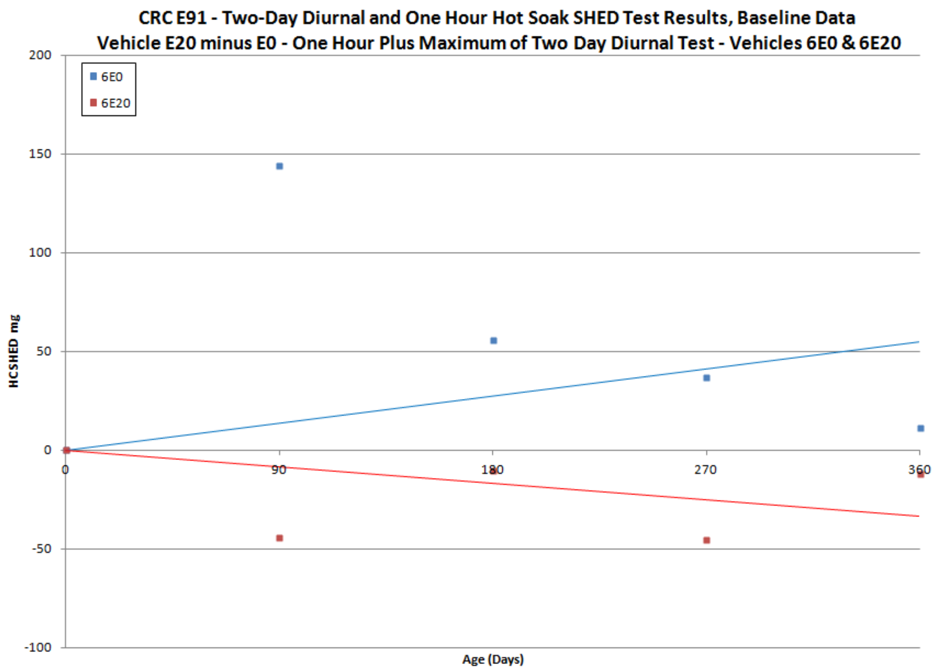


Figure 60. Linear Regression, Vehicles 6E0 & 6E20

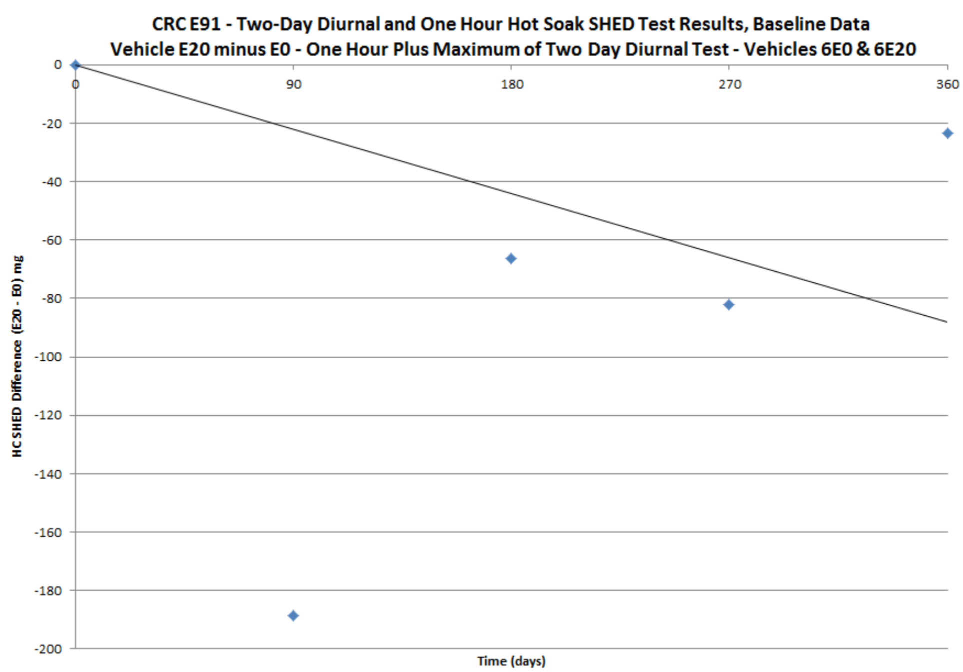


Figure 61. Linear Regression, Vehicles 6E0 & 6E20

8.1.2.7 Vehicles 7E0 and 7E20

Both Vehicle 7E0 and Vehicle 7E20 demonstrated problems with unseated purge valves. Because this operational problem was found for both vehicles and because the purge valves could be reseated when exercised (as if they were simply dirty or valve was sticking), it was decided that the purge valve sticking was not caused by exposure of fuels used in the study. Testing continued but required confirmation that purge valves were seated before each evaporative emissions test (Section 7.7). Unfortunately, during the 360-day Baseline Test, both vehicles had high diurnal evaporative emissions attributed once again to the unseated purge valves. For this reason, the data at 360 days were not used in the statistical analysis. The results from testing to 270 days were extrapolated to 360 days to aid in comparison to other vehicles.

Both Vehicle 7E0 and Vehicle 7E20 vehicles showed significant increases in emissions over the first 270 days of aging. Using both metrics, the rate of change in emissions for Vehicle 7E0 were higher than that for Vehicle 7E20 over the aging period.

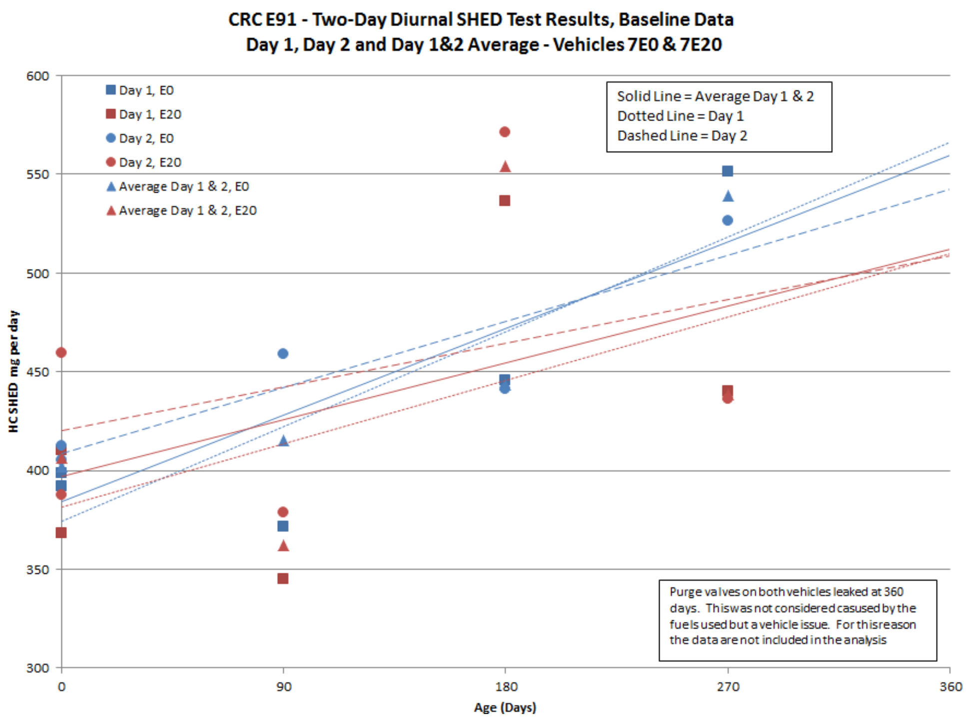


Figure 62. Linear Regression, Vehicles 7E0 & 7E20

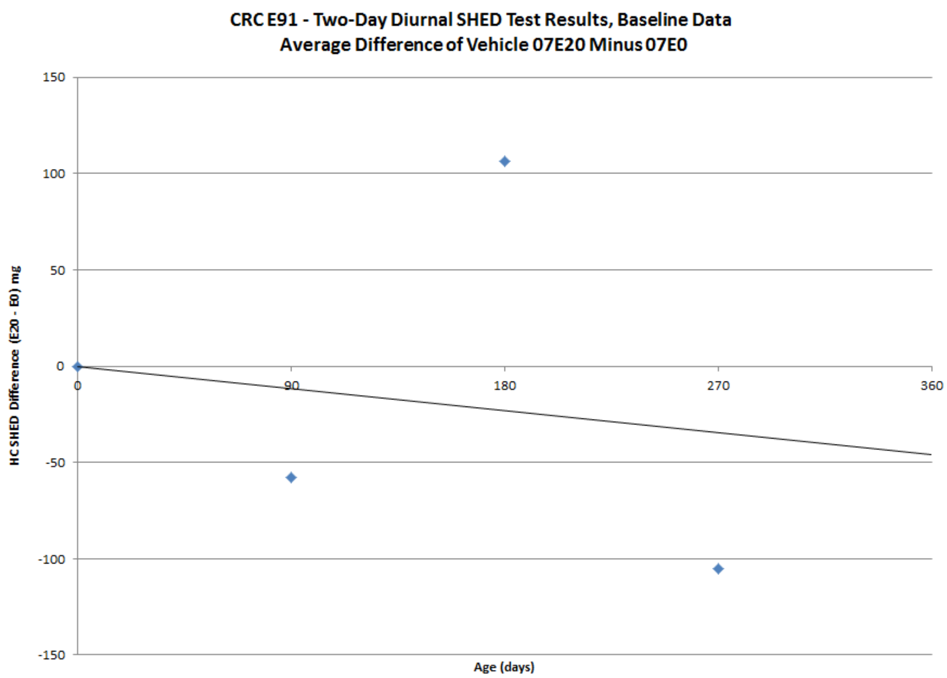


Figure 63. Linear Regression, Vehicles 7E0 & 7E20

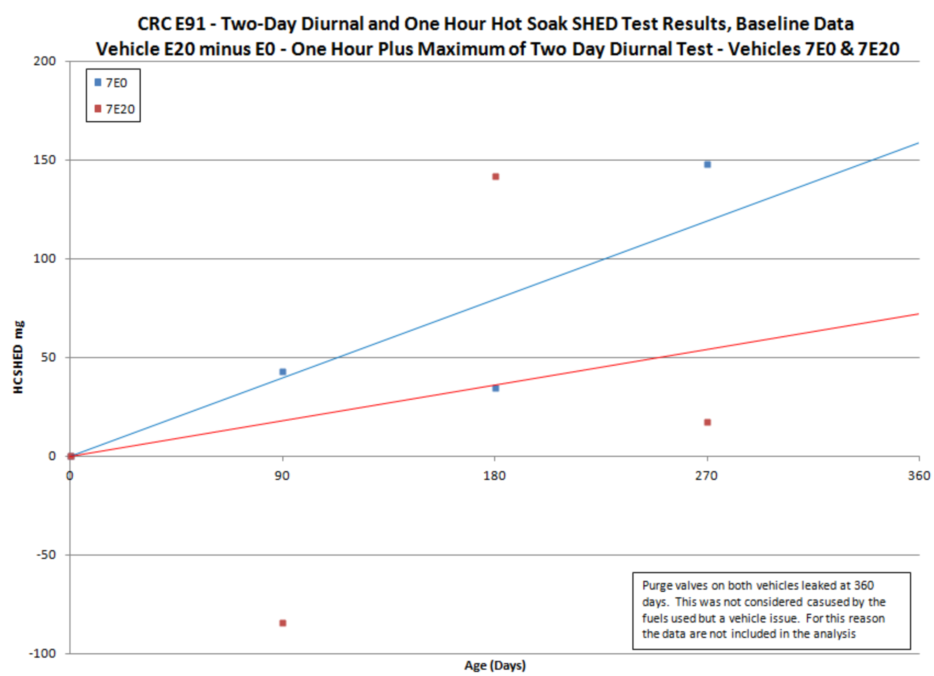


Figure 64. Linear Regression, Vehicles 7E0 & 7E20

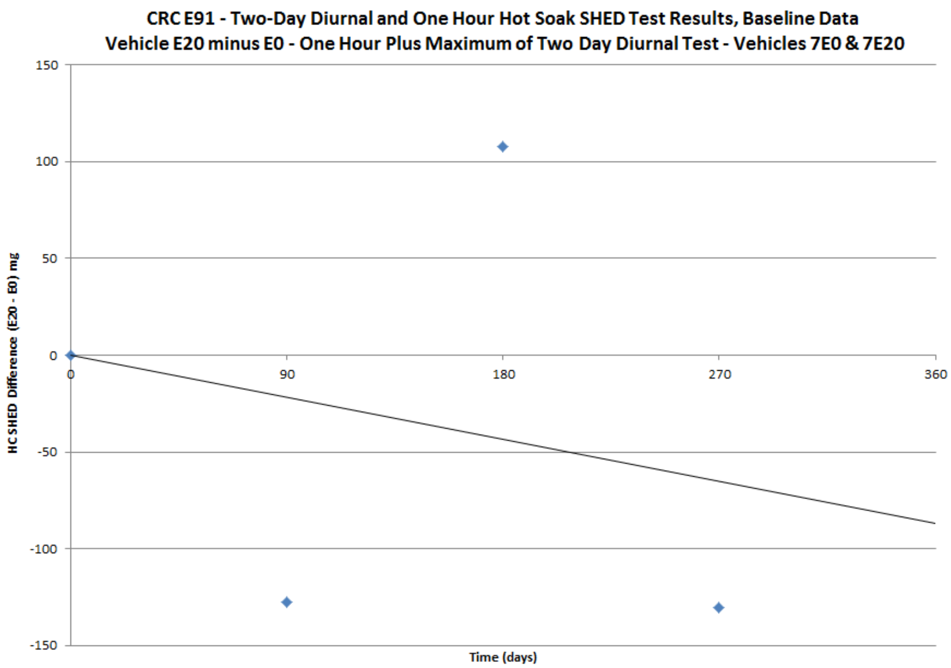


Figure 65. Linear Regression, Vehicles 7E0 & 7E20

8.1.2.8 Vehicles 8E0 and 8E20

Evaporative emissions decreased over time for Vehicle 8E20 vehicle and increased over time for Vehicle 8E0 vehicle, using both metrics. The evaporative emissions were 93mg/day lower for Vehicle 8E20 compared to Vehicle 8E0 after 360 days of aging. The average of Day 1 and Day 2 diurnal test results were more variable than the other data for both vehicles, but did not appear to influence the overall trends.

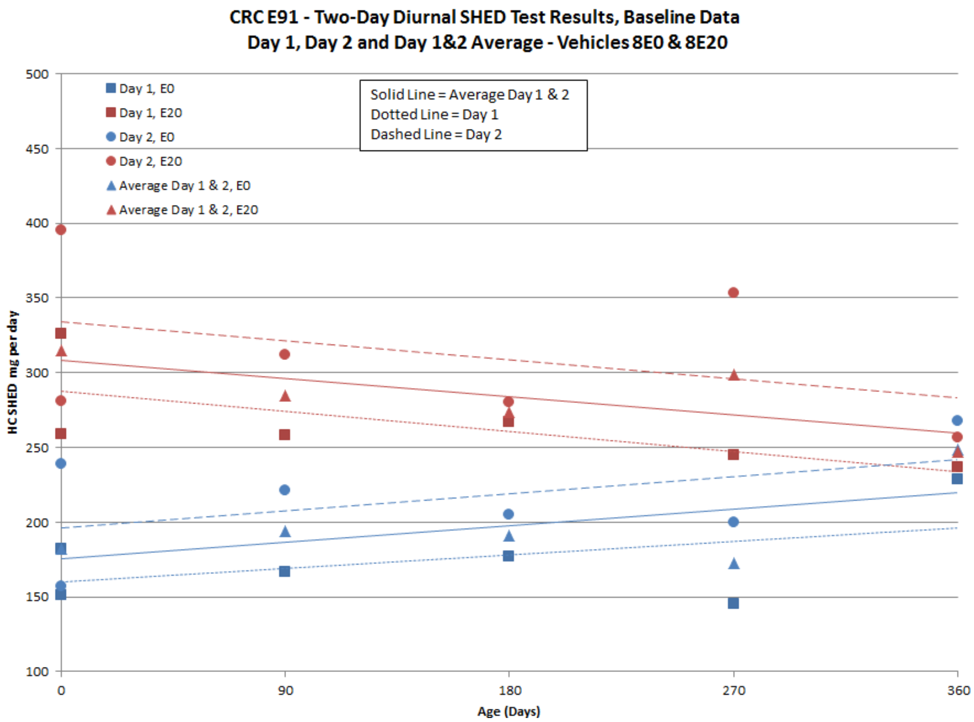


Figure 66. Linear Regression, Vehicles 8E0 & 8E20

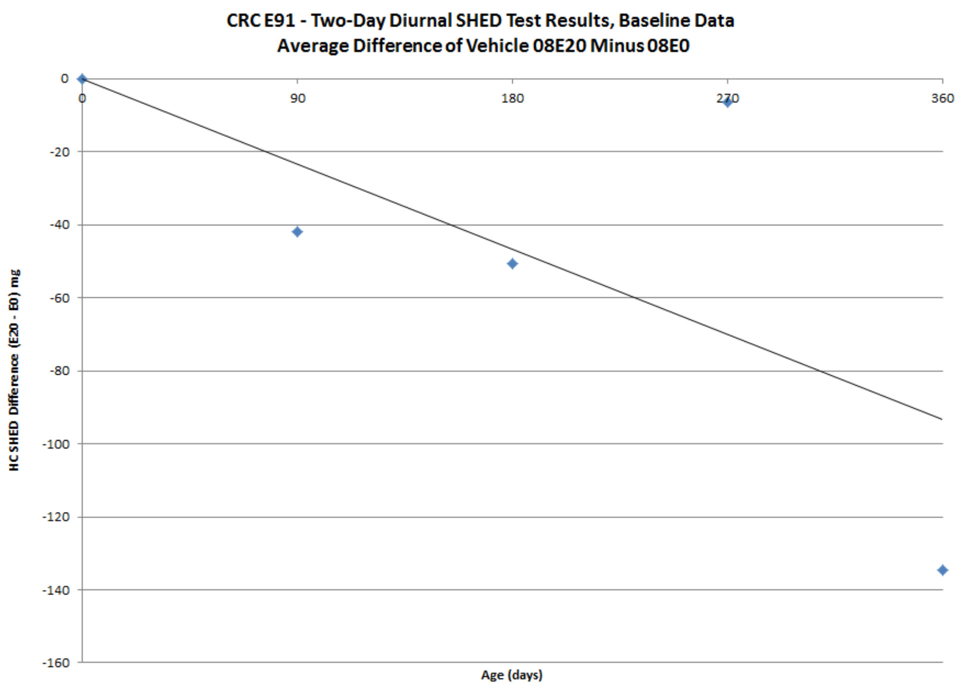


Figure 67. Linear Regression, Vehicles 8E0 & 8E20

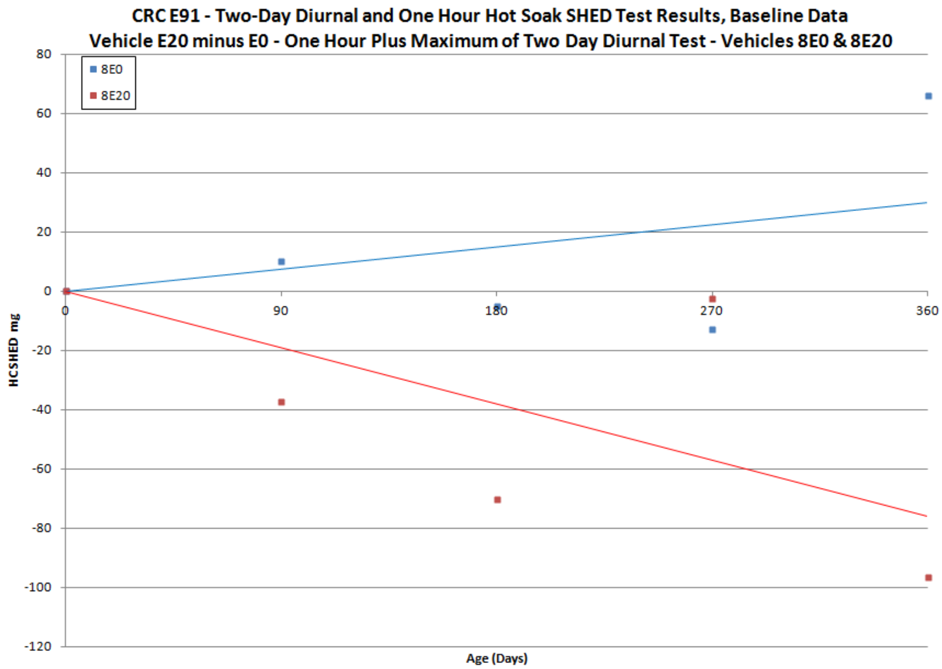


Figure 68. Linear Regression, Vehicles 8E0 & 8E20

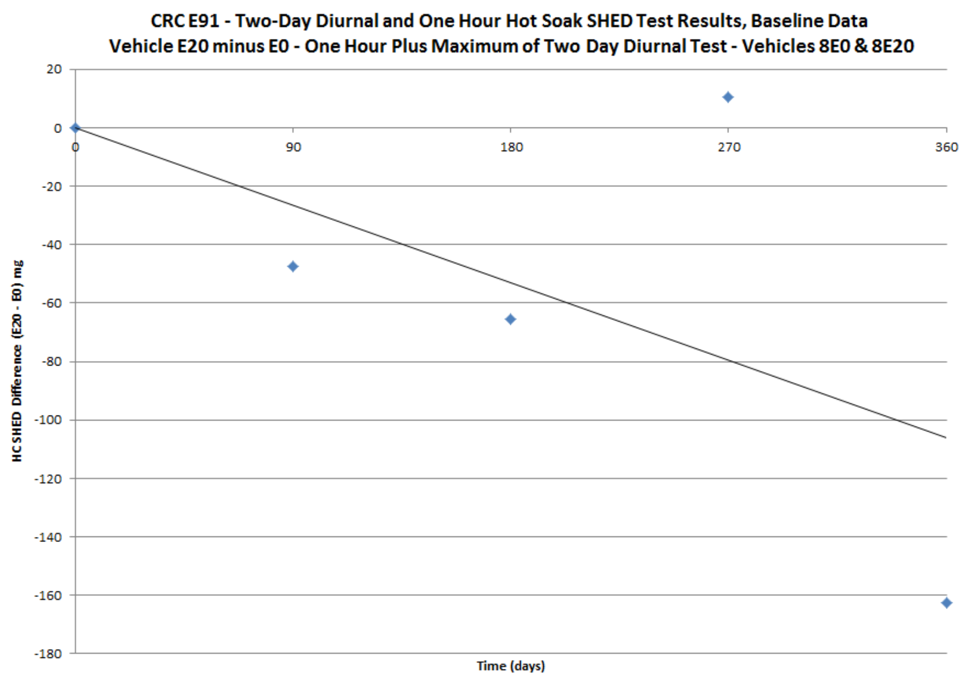


Figure 69. Linear Regression, Vehicles 8E0 & 8E20

8.1.2.9 Vehicles 9E0 and 9E20

The evaporative emission rates for both vehicles decreased significantly over the 360 days of aging using both metrics. Using the average of Day 1 and Day 2 on the diurnal test metric, the Vehicle 9E20 decreased slightly slower than Vehicle 9E0, but the vehicles had identical evaporative emission rates using the other metric. As can be seen in the plots (Figures 70 and 72), the vehicles switched position as to which had the higher emissions at 90 and 180 days, and then had fairly similar emissions at 270 and 360 days. The difference in evaporative emission rate for Vehicle 9E20 was only 21 mg/day higher over the 360 days of aging in the study.

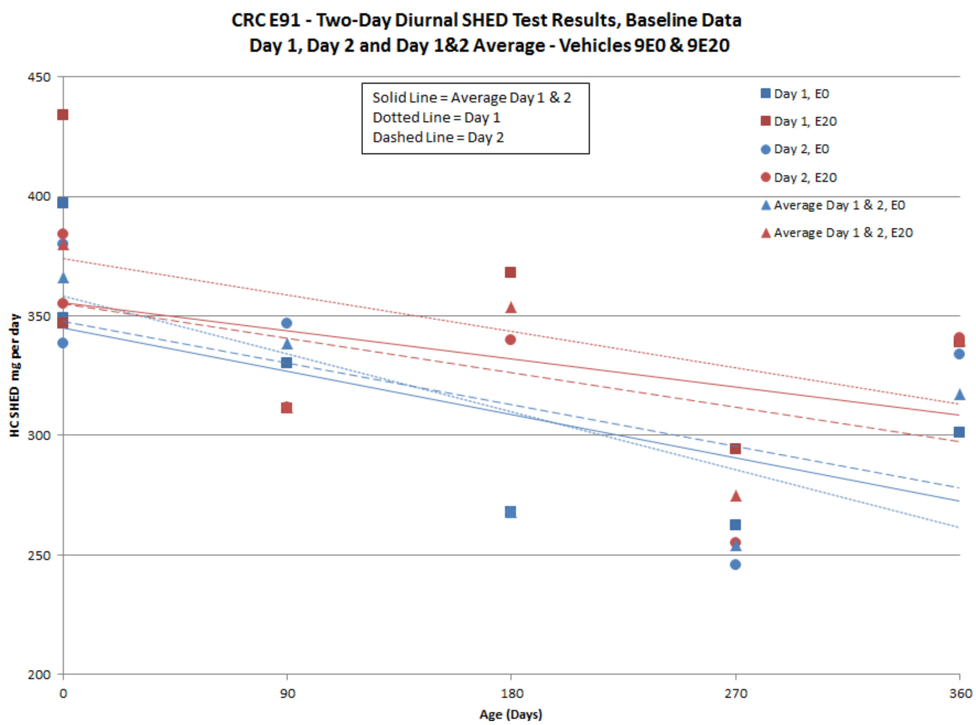


Figure 70. Linear Regression, Vehicles 9E0 & 9E20

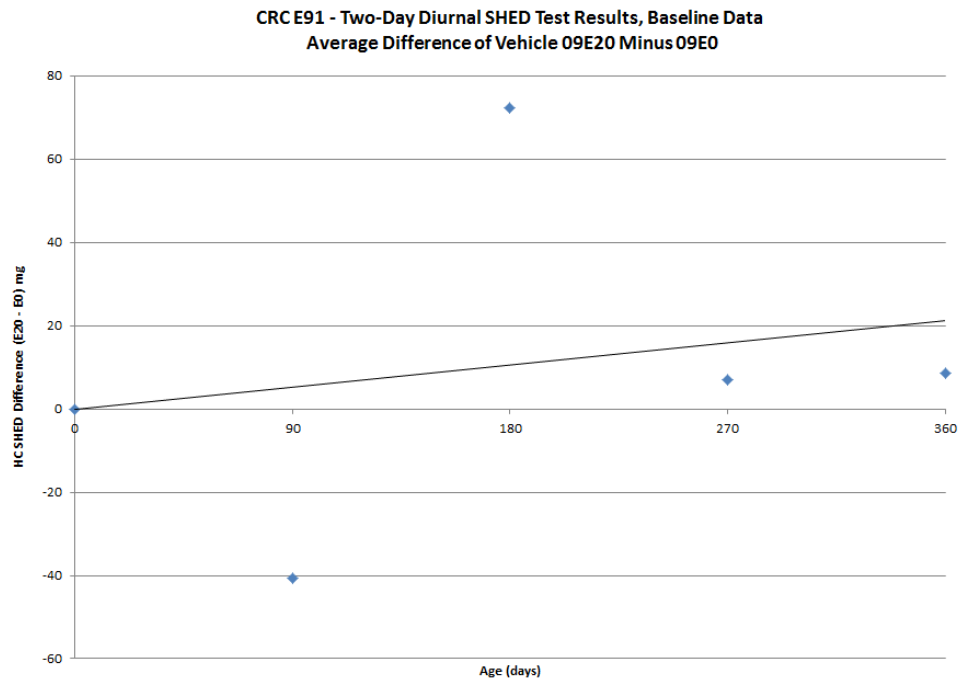


Figure 71. Linear Regression, Vehicles 9E0 & 9E20

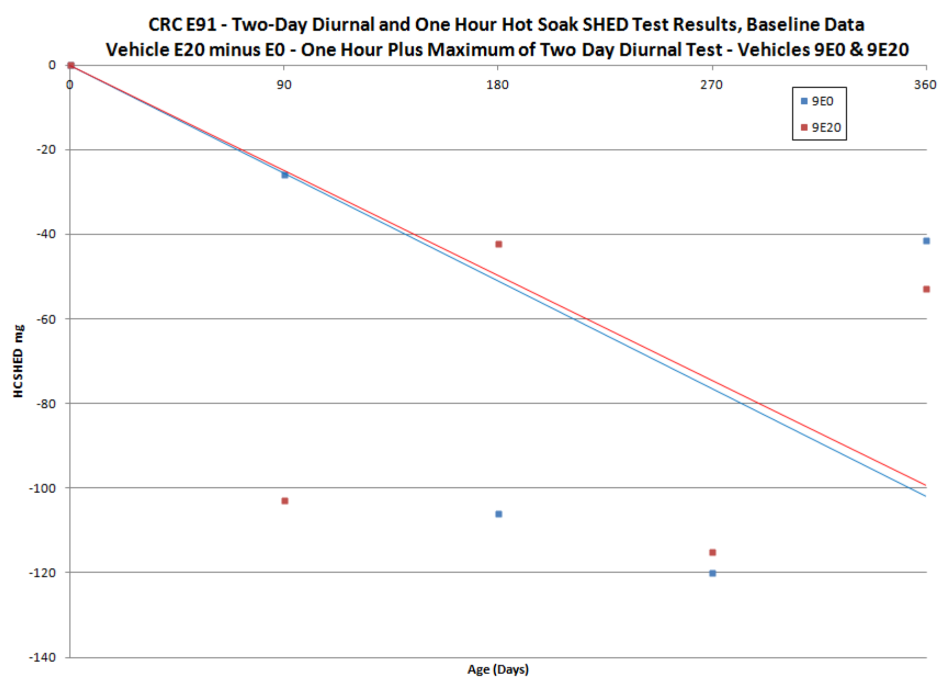


Figure 72. Linear Regression, Vehicles 9E0 & 9E20

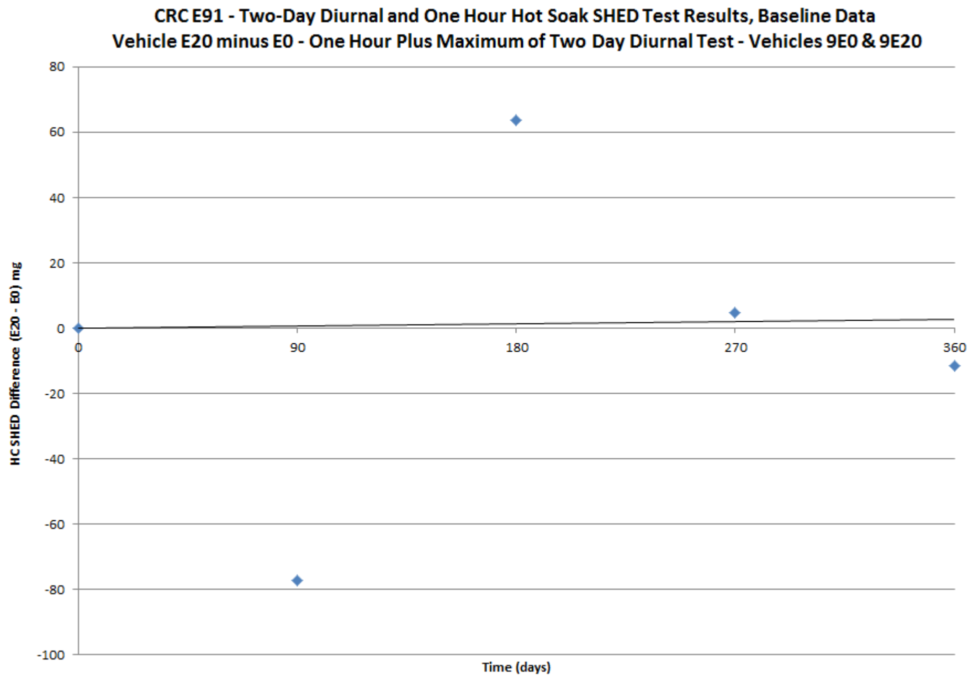


Figure 73. Linear Regression, Vehicles 9E0 & 9E20

8.1.2.10 Vehicles 10E0 and 10E20

The trends for this vehicle pair were nearly identical to the results for Vehicle 9E. Both vehicles showed a decrease in emissions as they aged. Vehicle 10E20 had only a slightly higher evaporative emission rate compared to Vehicle 10E0. The difference in evaporative emission rate for Vehicle 9E20 was only 12 mg/day higher over the 360 days of aging in the study.

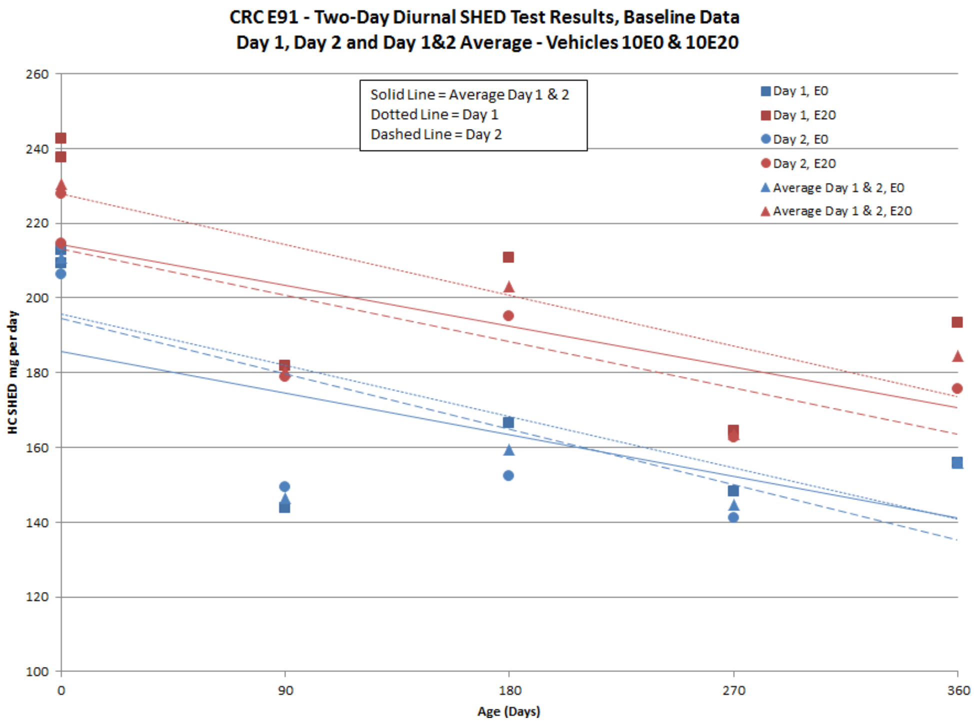


Figure 74. Linear Regression, Vehicles 10E0 & 10E20

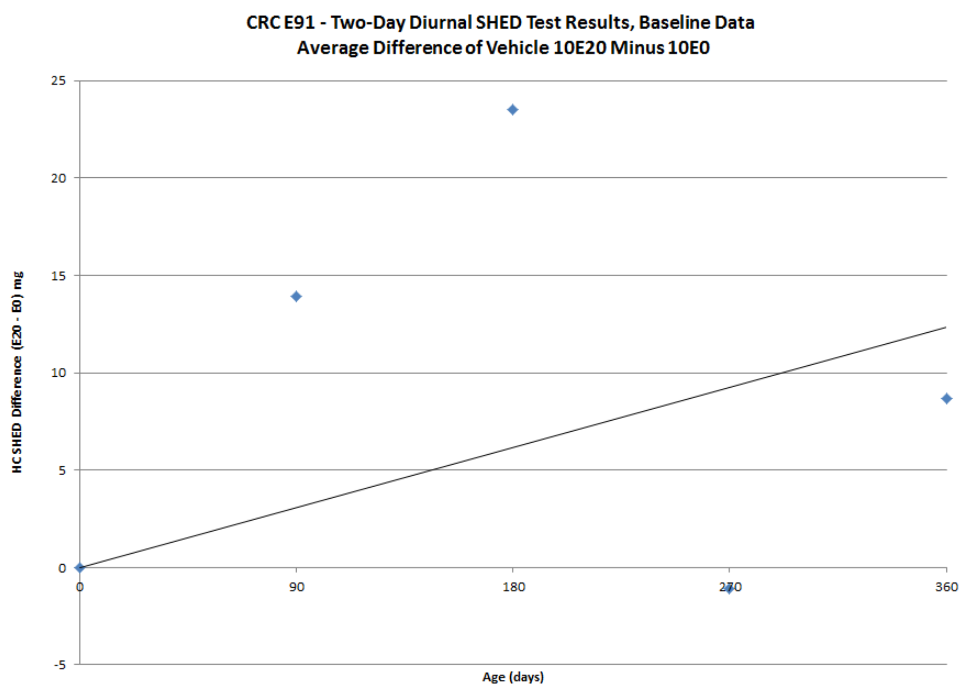


Figure 75. Linear Regression, Vehicles 10E0 & 10E20

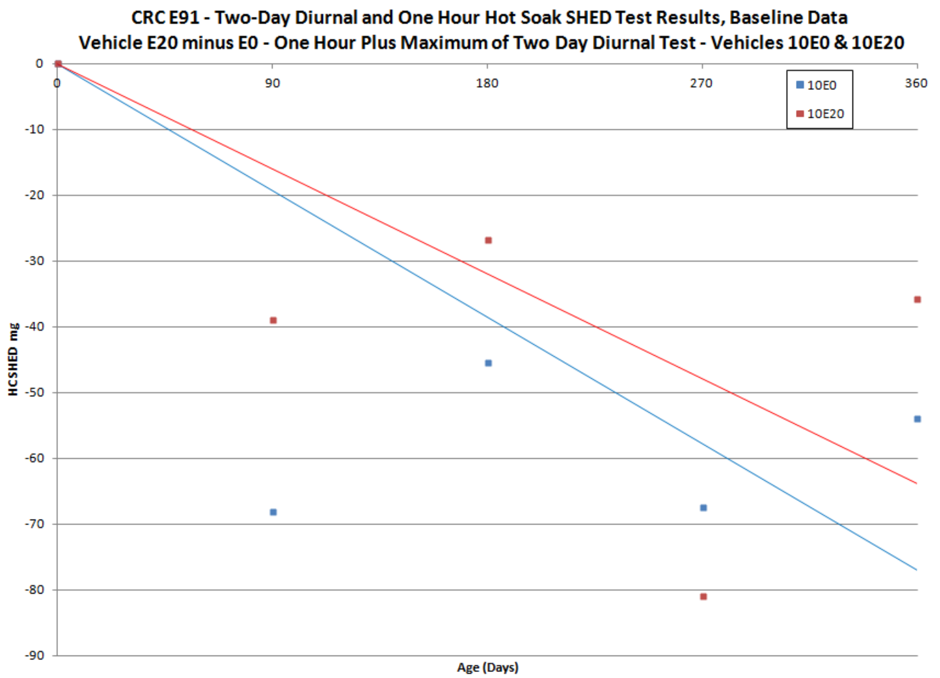


Figure 76. Linear Regression, Vehicles 10E0 & 10E20

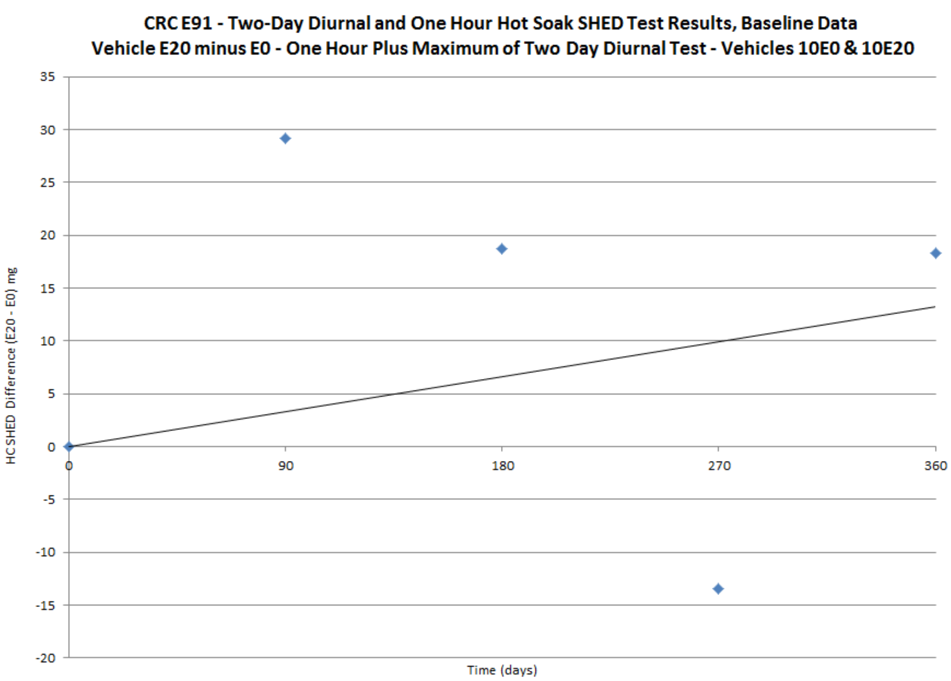


Figure 77. Linear Regression, Vehicles 10E0 & 10E20

8.2 Caveats on Findings from the Study

The following factors warrant consideration when interpreting the results from this study:

- The study results are limited to ten pairs of vehicle models which were not selected to be representative of the nation's vehicle fleet.
- All testing was performed under limited test conditions (temperature, altitude, etc.) and for a limited duration of aging which, taken together, represent only a portion of the spectrum of real world conditions to which a vehicle may be exposed.
- Aging of materials is time dependent. Although accelerated mileage accumulation was performed in the study, this may not be equivalent to a longer duration exposure of the materials to the fuels.
- It is important to note that with the exception of one pair of vehicles purchased new, all of the other test vehicles were exposed to in-use market fuels of unknown ethanol content prior to recruitment for the study. There may have been an adjustment period at the beginning of the study while the vehicles' materials adjusted to a new fuel (less ethanol in the fuel for the vehicles operated on E0 and more ethanol in the fuel for those vehicles operated on E20). This fuel carry-over effect could be a confounding factor for the Baseline Test results taken prior to vehicle aging (0 Day benchmark data).
- The vehicles had a fuel change to E0 and were operated every other day for 14 days at each aging period before the Baseline tests were run. A previous study has shown that fuel carry-over can occur when changing fuel types, and that permeation emissions generally reached stabilized levels after about one to two weeks following a fuel change [6]. However, another CRC study by the same author [7] indicates that it may take longer than two weeks to remove all ethanol from the vehicles' fuel systems. This fuel carry-over effect is a possible confounding factor for the E20-fueled vehicles in the study.
- All Baseline Test results used ethanol-free fuel. If the vehicles were SHED tested with E20 fuel in the fuel system (as would be the case if E20 fuel were sold in the marketplace), the evaporative emission rates may have been different.
- The R^2 correlation coefficients for the linear regression of the data are quite poor for many vehicle models (Tables 9 and 10). There were relatively few data points available for the regression. Moreover, linear change in vehicle evaporative emissions was not necessarily expected as they aged. The linear regression was performed as a means to quantify the average response of each vehicle over the aging period.

9.0 Exhaust Emissions Results

Vehicle exhaust emissions were measured for each FTP75 drive cycle performed as part of the Baseline Test sequence. Emissions were measured by collecting bag samples for each phase from the constant volume sampling system. Emissions laboratory equipment was compliant with EPA 40CFR Part 86 subpart B standards.

The study was not designed to investigate the effects of the fuels on exhaust emissions. Based on previous testing, the 18,650 miles accumulated for this study was not sufficient to determine how the E20 fuel impacted catalyst performance or exhaust emissions relative to the E0-fueled vehicles [5]. Nevertheless, the exhaust emissions results presented in Figures 78 and 79 were used as a quality check to confirm that the vehicles were functioning normally during the FTP75 dynamometer tests which preceded the Baseline SHED tests.

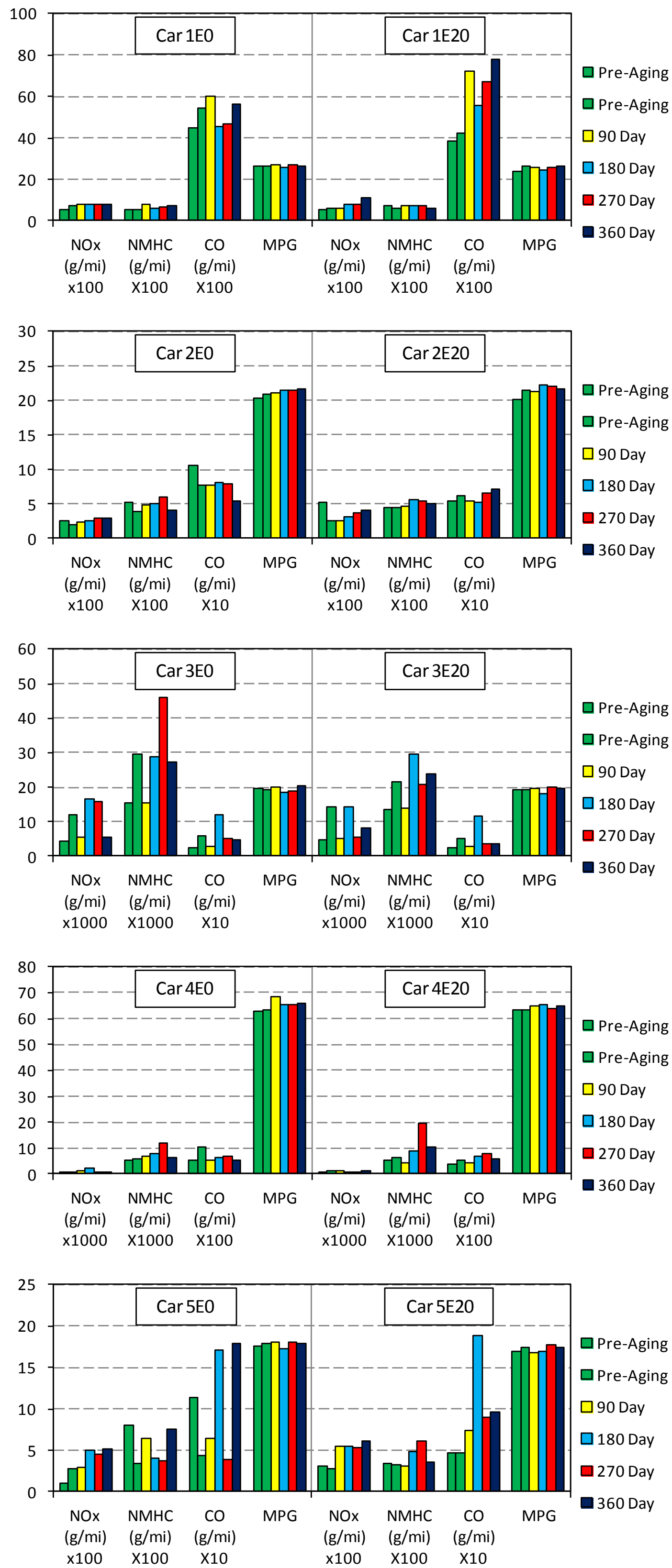


Figure 78. FTP75 Weighted Exhaust Emission Results after 360 Days Aging, Vehicles 1E to 5E

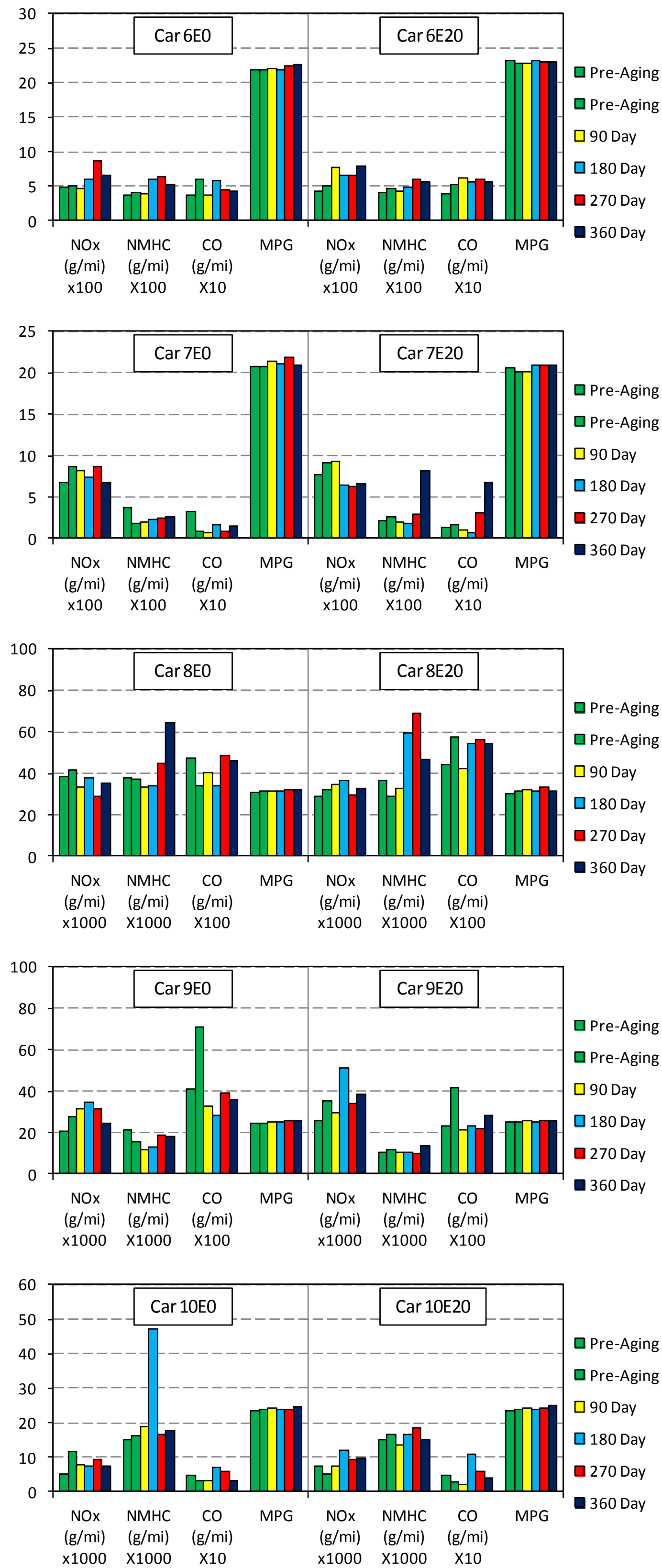


Figure 79. FTP75 Weighted Exhaust Emission Results after 360 Days Aging, Vehicles 6E to 10E

10.0 Interpretation of Results and Conclusions

- Each vehicle model in the study had unique permeation and evaporative emissions characteristics that were revealed by SHED testing. Vehicle models certified to the same federal evaporative emissions standard responded much differently to the fuel exposure and also trended differently over time.

- Vehicle models 1E and 5E showed a pronounced increase in evaporative emissions following E20 fuel exposure, compared to control vehicles operated on E0 fuel. The evaporative emission rates of Vehicles 1E20 and 5E20 were 459 and 372 mg/day higher, respectively, than the E0-fueled control vehicles following 360 days of aging. The same vehicles also had increased permeation rates following exposure to E20 fuel. Model 1E was certified to the Federal Enhanced Evaporative Emissions Standard, and model 5E was certified to the Federal Tier2 2004 LDV/LLDT Standard.

- Evaporative emissions from vehicle models 3E, 9E and 10E decreased over the 360 day aging period, for both fuels tested. The cause for this decrease cannot be determined with certainty because of the many factors and mechanisms associated with the vehicle technology and SHED testing. Since the recruited vehicles had prior real-world exposure, the evaporative emissions decrease may be related to street fuel carry-over effects, “off-gassing” effects of car surface treatments, the repetitious two-a-day driving schedule, or other unknown mechanisms.

- There is evidence that ethanol may not be readily removed from some fuel systems and evaporative emissions systems, even after more than 14 days of conditioning on ethanol-free fuel. Ethanol mass estimates for vehicles 8E0 and 10E0 averaged 22 and 55 mg/day respectively for pre-aging Baseline Tests, despite the vehicles being conditioned on ethanol-free fuel. The ethanol mass for these vehicles was reduced by 37% and 71% respectively following an additional 90 days of operation on ethanol-free fuel.

- SHED testing revealed some durability issues with evaporative emission system components. These durability issues were not related to the fuels or presence of ethanol in the fuels.
    - The canisters from both Vehicles 5E0 and 5E20 were found to be contaminated with fine dirt. Contamination occurred prior to recruitment and was due to the lack of an effective vent filter. The MIL was set and a DTC identified by an OBD scan.
    - The purge valves from both Vehicles 7E0 and 7E20 did not fully seat over the course of the aging period. There was no MIL or pending DTC detecting this problem.
    - A leaking gas cap seal on Vehicle 8E20 was detected using a sensitive hydrocarbon sniffer. The leak was sufficient to impact SHED testing. There was no MIL or pending DTC detecting this problem.

- Evaporative emissions from all of the vehicles in the study were below the federal certification standards (Figure 80). Vehicle 5E20 was very near the standard for one test, due to a low canister purge volume encountered for that test.

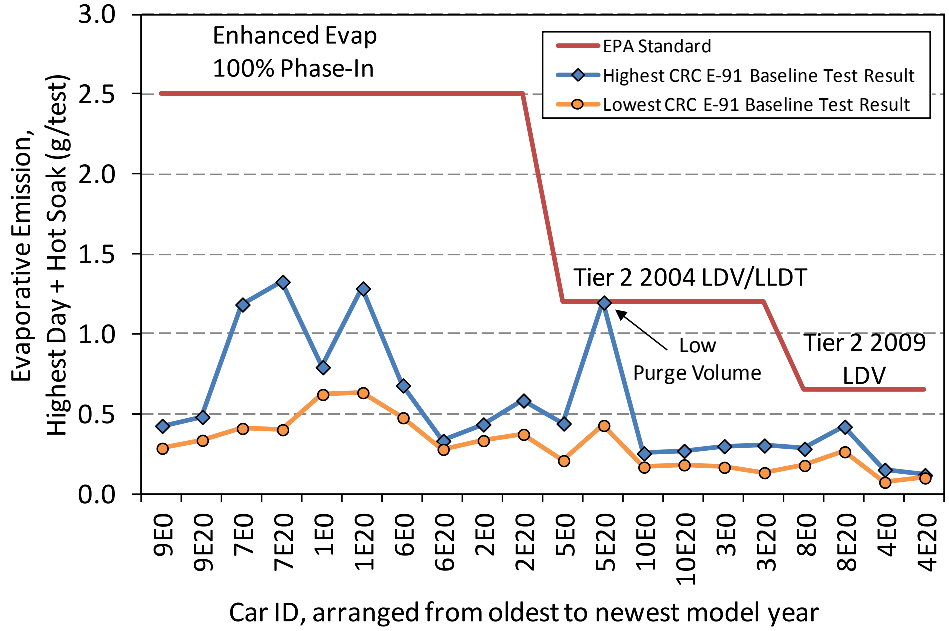


Figure 80. Summary of Baseline SHED Test Results after 360 Days Aging Compared to Federal Standards

- Information was gathered to identify the source of evaporative emissions, including permeation, fuel vapor leaks, fuel pressure driven leaks, refrigerant leaks, tire contribution, and windshield sealant contribution. Tires, tested in isolation, off-gassed at a rate of 5 to 78 mg/day. Tires are therefore an important consideration for testing future low emitting vehicles, because off-gassing could be a large percentage of the total evaporative emission measurement. R134a refrigerant was also found to be a significant contributor to SHED emissions, especially for vehicles needing to meet more stringent certification standards. R134a refrigerant emission estimates ranged from 17 to 92 mg/day for the vehicle fleet.

- Sixteen of the vehicles were tested in laboratories located at 5440 feet and at 930 feet elevation above sea level to quantify the impact of altitude on evaporative emissions. Diurnal evaporative emissions measured at the high altitude and low altitude labs correlated to within 10%.

- The two-hour Permeation Test was useful for diagnosing possible problems with the evaporative emissions systems. For the newer normally functioning vehicle models in the study, the hydrocarbon concentration change over this short duration test was too small to accurately quantify changes in permeation rates, leading to scatter in the data. Hydrocarbon change was as low as 0.2 ppmC1 over the two-hour, three-mode Permeation Test.

- The Baseline Test dataset was considered most relevant for comparing the E0 and E20 fuel effects via statistical analysis, because
  - The vehicle evaporative emissions system was not influenced by the vent hose and slave canister.
  - The effect of E20 fuel exposure on total vehicle evaporative emissions is of high interest for stakeholders involved in emissions certification and compliance.

11.0 References

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12.0 Appendices

12.1 Tire Off-Gassing Contribution to SHED Emissions

Newer vehicle tires can have significant off-gassing and may potentially skew hydrocarbon SHED measurement. In order to minimize tire off-gassing effects, no new tires were used in the study. Replacement tires were verified to be at least 300 days old based on the date code. At the start of the study, the vehicle wheels were removed and tested by themselves in the SHED over a 24-hour diurnal period. The emissions ranged from 5 to 78 mg/day (Table 12.1). The average emission of 24mg/day was approximately 12% or less of the total daily emissions from the baseline tests. The tire off-gassing contribution was quantified at the start of the study, so tires could be retested if the car had SHED testing anomalies thought to be caused by tire changes. Eleven vehicles had tire replacements during on-road aging. Tire life was considerably shorter than anticipated, and likely reduced by the frequent turns associated with aging around the oval track at CPG.

Table 12.1. Tire Off-Gassing for 24 Hour Diurnal, Prior to Road Aging

Model Year	Make	Model	Front / Rear Tire Make and Model	LF Date Code	RF Date Code	LR Date Code	RR Date Code	24hr Diurnal Shed Result, g	Tires Replaced during Aging?
2004	Chrysler	PT Cruiser	GDYR ASSURANCE	3108	3108	3606	5106	0.017	Yes
2004	Chrysler	PT Cruiser	GDYR VIVA2/DOUGLAS XTRA-TRAC	3707	0407	1607	2307	0.006	Yes
2003	Buick	LeSabre	MICHLN HARMONY	5105	0606	5105	1406	0.005	Yes
2003	Buick	LeSabre	BIG O T/R EURO TOUR	3507	3507	3507	3507	0.011	Yes
2009	Toyota	Corolla	FUSION HRI/GDYR EAGLE RSA	3209	3209	2308	2308	0.027	No
2009	Toyota	Corolla	GDYR EAGLE RSA	4209	3509	1408	1408	0.054	No
2002	VW	Jetta	PIRELLI P3000	2806	2806	2806	2806	0.005	Yes
2002	VW	Jetta	FIRESTONE FR710	0609	1109	1109	0609	0.031	Yes
2007	Honda	CRV	BRGSTN DUALER HT	3409	3309	3609	3409	0.078	Yes
2007	Honda	CRV	DNLP SIGNATURE CS	1409	1409	1509	1409	0.007	No
2007	Nissan	Pathfinder	GDYR WRNGLR RTS	1409	1409	1409	1409	0.035	No
2007	Nissan	Pathfinder	GENRL GRABBER AT2	0108	0108	0108	0108	0.030	No
2010	Toyota	Prius	YOKAHAMA AVID S33	4209	4209	4209	4209	N/A	No
2010	Toyota	Prius	GDYR ASSURANCE	3909	3909	3809	3909	N/A	No
2008	Ford	Taurus	FALKEN ZIEX	2009	2009	2009	2009	0.024	No
2008	Ford	Taurus	CONTI TOURING CNTCT	2008	2008	2008	2008	0.025	Yes
2004	Pontiac	Grand Am	FUSION URI/GDYR EAGLE GT	3606	3606	5004	1306	0.011	Yes
2004	Pontiac	Grand Am	FUSION HRI	1009	1009	4408	0409	0.031	Yes
2004	Dodge	Neon	GDYR EAGLE LS	4506	4506	4506	4506	0.011	Yes
2004	Dodge	Neon	BFG TOURING TA	0809	0709	0609	0709	0.019	No

12.2 Windshield Adhesive Off-Gassing Contribution to SHED Emissions

Vehicles 1E20, 9E20, and 10E0 had windshields cracked during the on-road aging and required replacement per CPG work rules. There was some concern that the windshield adhesive could impact the SHED results. A 24-hour diurnal SHED test was performed to quantify the adhesive contribution to SHED testing.

Dow Betaseal 400HV rapid cure adhesive was used for the windshield replacements and for SHED testing. One tube of adhesive was applied to an inert panel and tested after 7 days and after 50 days of cure time. Emissions were 55 mg/day after 7 day cure and 8 mg/day after 50 day cure. By linear interpolation, emissions were 30 mg/day after 30 day cure. This contribution was approximately 15% or less of the total daily emissions from the baseline tests, and is expected to be considerably less for actual vehicles as the surface exposure is far less. Based on the results, a minimum of 30 days of cure time was enforced to minimize any impact of the windshield adhesive on SHED test results.

12.3 Properties for Certification Gasoline and Ethanol

Fuel Properties for Certification Gasoline "TE0"

TEST	METHOD	UNITS	Specifications			RESULTS
			MIN	TARGET	MAX	
Distillation -IBP	ASTM D86	°F	75		95	87
5%		°F				110
10%		°F	120		135	124
20%		°F				145
30%		°F				169
40%		°F				200
50%		°F	200		230	223
60%		°F				234
70%		°F				246
80%		°F				267
90%		°F	305		325	317
95%		°F				334
Distillation - EP		°F			415	388
Recovery		Vol %		Report		97.1
Residue		Vol %		Report		1.0
Loss		Vol %		Report		1.9
Gravity	ASTM D4052	°API	58.7		61.2	58.9
Density	ASTM D4052	kg/l	0.734		0.744	0.743
Reid Vapor Pressure	ASTM D5191	psi	8.7		9.2	8.9
Carbon	ASTM D3343	wt fraction		Report		0.8645
Carbon	ASTM E191	wt fraction		Report		0.8606
Hydrogen	ASTM E191	wt fraction		Report		0.1351
Hydrogen/Carbon ratio	ASTM E191	mole/mole		Report		1.870
Stoichiometric Air/Fuel Ratio				Report		14.612
Oxygen	ASTM D4815	wt %			0.05	<0.01
Sulfur	ASTM D5453	wt %	0.0025		0.0035	0.0029
Lead	ASTM D3237	g/gal			0.01	<0.01
Phosphorous	ASTM D3231	g/gal			0.005	<0.0001
Silicon	ASTM 5184	mg/kg			4	<1
Composition, aromatics	ASTM D1319	vol%			35	28
Composition, olefins	ASTM D1319	vol%			10	1
Composition, saturates	ASTM D1319	vol%		Report		72
Particulate matter	ASTM D5452	mg/l			1	1
Oxidation Stability	ASTM D525	minutes	240			1000+
Copper Corrosion	ASTM D130				1	1a
Gum content, washed	ASTM D381	mg/100ml			5	<0.5
Fuel Economy Numerator/C Density	ASTM E191		2401		2441	2420
C Factor	ASTM E191			Report		1.0007
Research Octane Number	ASTM D2699		96.0			97.2
Motor Octane Number	ASTM D2700			Report		88.5
Sensitivity			7.5			8.3
Net Heating Value, btu/lb	ASTM D3338	btu/lb		Report		18494
Net Heating Value, btu/lb	ASTM D240	btu/lb		Report		18329
Color	Visual			Report		Undyed

Fuel Properties for "TE0_Alt" High Altitude Certification Gasoline

TEST	METHOD	SPECIFICATION	RESULT
Specific Gravity. 60/60	ASTM D-4052	Report	0.7397
API Gravity	ASTM D-1250	Report	59.8
Sulfur, ppm	ASTM D-5453	15-40	18.2
Oxygenates, vol%	Chromatography	None	0
Oxygen Content, wt%	Calculation	None	0
Benzene Content, vol%	Chromatography	Report	0.44
Carbon, wt%	ASTM D-5291	Report	85.968
Hydrogen, wt%	ASTM D-5291	Report	14.032
Net Heat of Combustion, BTU/lb	ASTM D-240	Report	18585
Corrosion 3 hrs @ 50^0 C	ASTM D-130	1 Max	1A
Existent Guns (washed), mg/100ml	ASTM D-381	5 Max	0.0
Phosphorous. g/gal	ICP/OES	0.005 Max	<0.001
Lead. g/gal	ICP/OES	0.050 Max	<0.0009
Oxidation Stability, min	ASTM D-525	240 Min	1434
Distillation ^{0}F	ASTM D-86		
IBP		75-105	92
5%			110
10%		120-135	124
20%			143
30%			167
40%			195
50%		200-230	217
60%			229
70%			243
80%			258
90%		300-325	303
95%			341
EP		415 Max	386
Loss (ml)			1.4
Residue (ml)			1.1
Hydrocarbon Type, Vol%	ASTM D-1319		
Aromatics		35 Max	28.1
Olefins		10 Max	2.1
Saturates		Report	69.8
Research Octane No.	ASTM D-2699	93 Min	94.7
Motor Octane No.	ASTM D-2700	Report	87.0
Antiknock Index	Calculated	Report	90.8
Sensitivity	Calculated	7.5 Min	7.7
Reid Vapor Pressure, psi	ASTM D-5191	7.6-8.0	7.9

Fuel Properties for "TE20" Base Blendstock

TEST	METHOD	SPECIFICATION	RESULT
Specific Gravity. 60/60	ASTM D-4052	Report	0.7382
API Gravity	ASTM D-1250	Report	60.2
Sulfur, ppm	ASTM D-5453	15-80	42.4
Oxygenates, vol%	ASTM D-4815	None	0
Oxygen Content, wt%	Calculation	Report	0
Benzene, vol%	Chromatography	Report	0.53
Hydrogen, wt%	ASTM D-5291	Report	13.613
Carbon, wt%	ASTM D-5291	Report	86.387
Net Heat of Combustion, BTU/lb	ASTM D-240	Report	18590
Corrosion 3 hrs @ 50° C	ASTM D-130	1 Max	1B
Existent Guns (washed), mg/100ml	ASTM D-381	5 Max	3.0
Phosphorous. g/gal	ICP/OES	0.005 Max	<0.001
Lead. g/gal	ICP/OES	0.050 Max	<0.0009
Distillation °F	ASTM D-86		
IBP		75-105	95.5
5%			118.4
10%		120-135	128.5
20%			144.1
30%			164.1
40%			190.0
50%		200-230	212.0
60%			224.8
70%			235.8
80%			252.7
90%		300-325	301.8
95%			350.1
EP		415 Max	405.0
Loss (ml)			0.9
Residue (ml)			1.0
Hydrogen Type, vol%	ASTM D-1319		
Aromatics		35 Max	27.2
Olefins		10 Max	4.5
Saturates		Report	68.3
Research Octane No.	ASTM D-2699	93 Min	94.3
Motor Octane No.	ASTM D-2700	Report	85.9
Antiknock Index	Calculation	Report	90.1
Sensitivity		7.5 Min	8.4
Reid Vapor Pressure, psi	ASTM D-5191	7.8-8.1	8.08
Oxidation Stability	ASTM D-525	240 Min	>240

Properties for Fuel Grade Ethanol Used for Blending "TE20" Emissions Fuel and "RE20" Road Aging Fuel at SGS-ETC

Batch Analysis				
Parameter	**Units**	**Results**	**Specifications**	**ASTM Test Method**
Visual Appearance		Clear and Bright	Clear and Bright	ASTM D4806
Specific Gravity		0.792	0.787 - 0.795	ASTM D4052
Apparent Proof		200.3	200 - 203	ASTM D 891
Karl Fisher Moisture	vol%	0.973	<1.0 max	ASTM E 1064
Acidity	mass %	0.004	0.007 max	ASTM D 1613
pHe		7.31	6.5 min 9.0 max	ASTM D 6423
GC Composition Results				
Ethanol	vol%	96.84	92.1 min	ASTM D 5501
Methanol	vol%	0.02	0.5 max	ASTM D 5501
Denaturant	vol%	2	2%	Calculated
Total Sulfate	mass ppm	<1.0	4 max	ASTM D7319
Inorganic Chloride	mg/l	<1.0	10 max	ASTM D7319
Copper	mg/kg	<0.02	0.1 max	ASTM D1688M
Solvent washed gum	mg/100 ml	<1.0	5.0 max	ASTM D 381
Benzene	vol%	0.01	0.06 max	ASTM D 5580
Olefins	vol%	0.29	0.50 max	ASTM D 6550
Aromatics	vol%	0.14	1.7 max	ASTM D 5580
Sulfur	mass ppm	3.00	10 max	ASTM D 5453
Denaturant Properties				
Benzene	vol%	0.48	1.1 max	ASTM D5580
Olefins	vol%	6.00	10 max	ASTM D6550
Aromatics	vol%	6.90	35 max	ASTM D5580

Properties for Fuel Grade Ethanol Used for Blending "RE20" Road Aging Fuel at CPG - Batch 1

Batch Analysis				
Parameter	**Units**	**Results**	**Specifications**	**ASTM Test Method**
Visual Appearance		Clear and Bright	Clear and Bright	ASTM D4806
Apparent Proof		200	200 min	ASTM D 801
Karl Fisher Moisture	vol%	0.9	1.0 max	ASTM D 208
Acidity	mass %	0.005	0.007 max	ASTM D 1613
pHe		7.9	6.5 min 9.0 max	ASTM D6423
GC Composition Results				
Ethanol	vol%	96.8	92.1 min	ASTM D 5601
Methanol	vol%	0.1	0.5 max	ASTM D 5601
Denaturant	vol%	2	1.96 min 5.0 max	ASTM D 5601
Total Sulfate	mass ppm	0.20	4 max	EPA 300.0
Inorganic Chloride	mg/l	0.40	8 max	ASTM D5798
Copper	mg/kg	0.05	0.1 max	ASTM D1688M
Solvent washed gum	mg/100 ml	0.10	5.0 max	ASTM D 381
Benzene	vol%	0.00	0.06 max	ASTM D 5580
Olefins	vol%	0.02	5.00 max	ASTM D 6550
Aromatics	vol%	0.01	0.71 max	ASTM D 5580
Sulfur	mass ppm	3.34	30 max	ASTM D 5453

Properties for Fuel Grade Ethanol Used for Blending "RE20" Road Aging Fuel at CPG - Batch 2

Batch Analysis				
Parameter	**Units**	**Results**	**Specifications**	**ASTM Test Method**
Visual Appearance		Clear and Bright	Clear and Bright	ASTM D4806
Apparent Proof		200	200 min	ASTM D 891
Karl Fisher Moisture	vol%	0.9	1.0 max	ASTM D 203
Acidity	mass %	0.004	0.007 max	ASTM D 1613
pHe		7.3	6.5 min 9.0 max	ASTM D 6423
GC Composition Results				
Ethanol	vol%	98.6	92.1 min	ASTM D 5501
Methanol	vol%	0.1	0.5 max	ASTM D 5501
Denaturant	vol%	2	1.96 min 5.0 max	ASTM D 5501
Total Sulfate	mass ppm	0.20	4 max	EPA 300.0
Inorganic Chloride	mg/l	0.80	8 max	ASTM D5798
Copper	mg/kg	0.10	0.1 max	ASTM D1688M
Solvent washed gum	mg/100 ml	0.20	5.0 max	ASTM D 381
Benzene	vol%	0.00	0.06 max	ASTM D 5580
Olefins	vol%	0.01	5.00 max	ASTM D 6550
Aromatics	vol%	0.01	0.71 max	ASTM D 5580
Sulfur	mass ppm	1.97	30 max	ASTM D 5453

12.4 On-Road Aging Summary

Quarter 1 Road Aging Summary

Vehicle #	Q1 Aging Start Date	Q1 Aging End Date	Q1 Start Odometer	Q1 End Odometer	Q1 Elapsed Days from Start	Q1 Miles per Drive
1E0	07/07/10	10/08/10	69737	74426	93	26.1
1E20	07/07/10	10/08/10	80374	85109	93	26.3
2E0	07/07/10	10/08/10	39724	44425	93	26.1
2E20	07/07/10	10/08/10	43697	48354	93	25.9
3E0	07/07/10	10/08/10	41688	46403	93	26.2
3E20	07/07/10	10/08/10	27719	32350	93	25.7
4E0	06/21/10	09/20/10	4380	9081	91	26.1
4E20	06/21/10	09/20/10	4428	9075	91	25.8
5E0	11/08/10	03/09/11	70447	75153	121	26.1
5E20	11/08/10	03/09/11	71820	76633	121	26.7
6E0	07/07/10	11/01/10	79414	84100	117	26.0
6E20	07/07/10	11/01/10	85853	90538	117	26.0
7E0	07/08/10	10/11/10	78695	83443	95	26.4
7E20	07/08/10	10/11/10	64340	69076	95	26.3
8E0	06/17/10	09/16/10	23836	28464	91	25.7
8E20	06/17/10	09/16/10	19167	23801	91	25.7
9E0	07/08/10	10/11/10	81734	86456	95	26.2
9E20	07/08/10	10/11/10	61927	66595	95	25.9
10E0	07/08/10	10/07/10	39146	43903	91	26.4
10E20	07/08/10	10/07/10	34719	39468	81	26.4

Quarter 2 Road Aging Summary

Vehicle #	Q2 Aging Start Date	Q2 Aging End Date	Q2 Start Odometer	Q2 End Odometer	Q2 Elapsed Days from Start	Q2 Miles per Drive
1E0	12/13/10	04/28/11	74696	79504	136	26.7
1E20	12/13/10	04/28/11	85498	90301	136	26.7
2E0	12/16/10	03/15/11	44943	49762	89	26.8
2E20	12/16/10	03/15/11	48850	53686	89	26.9
3E0	12/07/10	03/10/11	46766	51479	93	26.2
3E20	12/07/10	03/10/11	32905	37650	93	26.4
4E0	11/08/10	02/15/11	9658	14446	99	26.6
4E20	11/08/10	02/15/11	9633	14355	99	26.2
5E0	04/25/11	08/07/11	75422	80090	104	25.9
5E20	04/25/11	08/07/11	76941	81619	104	26.0
6E0	12/18/10	03/23/11	84341	88959	95	25.7
6E20	12/18/10	03/23/11	90773	95379	95	25.6
7E0	12/15/10	03/21/11	83706	88472	96	26.5
7E20	12/15/10	03/21/11	69386	74133	96	26.4
8E0	11/13/10	02/20/11	28715	33388	99	26.0
8E20	11/13/10	02/20/11	24139	28801	99	25.9
9E0	01/12/11	05/01/11	86847	91603	109	26.4
9E20	01/12/11	05/01/11	66905	71646	109	26.3
10E0	12/10/10	03/17/11	44163	48897	97	26.3
10E20	12/10/10	03/17/11	39729	44450	97	26.2

Quarter 3 Road Aging Summary

Vehicle #	Q3 Aging Start Date	Q3 Aging End Date	Q3 Start Odometer	Q3 End Odometer	Q3 Elapsed Days from Start	Q3 Miles per Drive
1E0	05/31/11	09/12/11	79717	84422	104	26.1
1E20	05/31/11	09/12/11	90541	95246	104	26.1
2E0	04/26/11	08/08/11	50060	54893	104	26.9
2E20	04/26/11	08/08/11	53954	58769	104	26.8
3E0	04/13/11	07/30/11	51736	56455	108	26.2
3E20	04/13/11	07/29/11	37913	42460	107	25.3
4E0	03/29/11	06/28/11	14699	19416	91	26.2
4E20	03/29/11	06/28/11	14606	19405	91	26.7
5E0	09/03/11	01/11/12	80490	85299	130	26.7
5E20	09/03/11	01/11/12	81929	86679	130	26.4
6E0	05/13/11	08/23/11	89312	93947	102	25.8
6E20	05/13/11	08/23/11	95716	100414	102	26.1
7E0	05/17/11	08/25/11	88764	93576	100	26.7
7E20	05/17/11	08/25/11	74396	79143	100	26.4
8E0	04/01/11	07/01/11	33652	38262	91	25.6
8E20	04/01/11	07/01/11	29048	33617	91	25.4
9E0	06/15/11	09/22/11	91820	96497	99	26.0
9E20	06/15/11	09/22/11	71864	76541	99	26.0
10E0	05/11/11	08/20/11	49158	54005	101	26.9
10E20	05/11/11	08/20/11	44710	49503	101	26.6

Quarter 4 Road Aging Summary

Vehicle #	Q4 Aging Start Date	Q4 Aging End Date	Q4 Start Odometer	Q4 End Odometer	Q4 Elapsed Days from Start	Q4 Miles per Drive
1E0	10/07/11	02/17/12	84739	89525	133	26.6
1E20	10/07/11	02/17/12	95552	100383	133	26.8
2E0	09/10/11	01/10/12	55210	59969	122	26.4
2E20	09/10/11	01/10/12	59033	63883	122	26.9
3E0	08/25/11	01/04/12	56721	61470	132	26.4
3E20	08/25/11	01/04/12	42907	47652	132	26.4
4E0	08/31/11	12/14/11	19759	24687	105	27.4
4E20	08/31/11	12/14/11	19738	24640	105	27.2
5E0	02/21/12	06/11/12	85369	90040	111	26.0
5E20	02/21/12	06/11/12	86749	91521	111	26.5
6E0	09/30/11	02/14/12	94217	98768	137	25.3
6E20	09/30/11	02/14/12	100670	105364	137	26.1
7E0	10/16/11	02/17/12	93890	98683	124	26.6
7E20	10/16/11	02/17/12	79459	84254	124	26.6
8E0	09/22/11	01/02/12	38560	43187	102	25.7
8E20	09/22/11	01/02/12	33961	38560	102	25.6
9E0	10/22/11	02/20/12	96779	101352	121	25.4
9E20	10/22/11	02/20/12	76774	81577	121	26.7
10E0	09/25/11	02/05/12	54265	58985	133	26.2
10E20	09/25/11	02/05/12	49762	54509	133	26.4

12.5 Vehicle Details, in Randomized Order

CRC E-91 Summary - Vehicle Descriptions and Characteristics

VIN	Model Year	Make	Model	Body Style	Engine Size (L)	# of Cylinders	Trim	Trim Details	Doors	Transmission	Fuel Tank Size (Gal)	Fuel Tank Material	Fuel During Study	Miles Driven/Year	Build Date	Engine Family	Evap Family	OK to Cap Load Canister?	Service Port for Canister?	Applicable EPA Evaporative Emissions Standard	Applicable EPA Exhaust Emissions Standard
308146	2004	Chrysler	PT Cruiser	Wagon	2.4	4	Base	B7DV	4	Auto	15	Plastic	E0	13000	03/2004	4CRXV02.4VE0	4CRXR0101GBB	No	Yes	Enhanced Evap 100% Phase-In, 2.5g	T2B5
260543							Base	B7FL					E20	14000	11/2003	4CRXV02.4VE0	4CRXR0101GBB				
282013	2003	Buick	LeSabre	Sedan	3.8	6	CUSTOM		4	Auto	18	Plastic	E0	11000	05/2003	3GMXV03.8044	3GMXR0133910	No	Yes	Enhanced Evap 100% Phase-In, 2.5g	T2B8
185961							CUSTOM						E20	9000	11/2002	3GMXV03.8044	3GMXR0133910				
072711	2009	Toyota	Corolla	Sedan	1.8	4	S	ZRE142L DEMSKA	4	Manual	13.2	Plastic	E0	23000	07/2008	9TYXV01.8BEA	9TYXR0115P12	Yes	No	Federal Tier2 2009 LDV, 0.65g	T2B5
036538							S	ZRE142L DEMSKA					E20	19000	04/2008	9TYXV01.8BEA	9TYXR0115P12				
184491	2002	VW	Jetta	Sedan	2	4	GLS		4	Auto	14.5	Plastic	E0	10000	05/2002	2VWXV02.0223	2VWXR0110234	No	Yes	Enhanced Evap 100% Phase-In, 2.5g	ULEV
075306							GLS						E20	8000	10/2001	2VWXV02.0223	2VWXR0110234				
063675	2007	Honda	CRV	SUV	2.4	4	EX		4	Auto	15.3	Plastic	E0	13000	02/2007	7HNXT02.4FKR	7HNXR0140BBA	Yes	No	Federal Tier2 2004 LDV/LLDT, 1.2g	T2B5
097869							EX						E20	11000	05/2007	7HNXT02.4FKR	7HNXR0140BBA				
613939	2007	Nissan	Pathfinder	SUV	4	6	SE	K	4	Auto	21.1	Plastic	E0	23000	10/2006	7NSXTO4.0G6A	7NSXR0132PBA	No	Yes	Federal Tier2 2004 LDV/LLDT, 1.2g	T2B5
622063							SE	C					E20	23000	11/2006	7NSXTO4.0G6A	7NSXR0132PBA				
077601	2010	Toyota	Prius	Sedan	1.8	4	LEVEL 2		4	CVT HEV	11.9	Plastic	E0	8000	10/2009	ATYXV01.8HC3	ATYXR0110P42	No	No	Federal Tier2 2009 LDV, 0.65g	CA LEV-II SULEV
079220							LEVEL 2						E20	8000	10/2009	ATYXV01.8HC3	ATYXR0110P42				
161187	2008	Ford	Taurus	Sedan	3.5	6	SEL	J	4	Auto	20	Plastic	E0	21000	01/2008	8FMXV03.5VEP	8FMXR0145KBK	Yes	No	Federal Tier2 2004 LDV/LLDT, 1.2g	T2B5
183925							SEL	J + spoiler					E20	14000	07/2008	8FMXV03.5VEP	8FMXR0145KBK				
143459	2004	Pontiac	Grand Am	Sedan	3.4	6	GT		4	Auto	14.1	Plastic	E0	7000	09/2003	4GMXV03.8042	4GMXR0124919	No	Yes	Enhanced Evap 100% Phase-In, 2.5g	T2B5
125523							GT		2				E20	7000	07/2003	4GMXV03.8042	4GMXR0124919				
617691	2004	Dodge	Neon	Sedan	2	4	SXT	H7DV	4	Auto	12.5	Plastic	E0	12000	05/2004	4CRXV02.0VH0	4CRXR0101GBA	Yes	No	Enhanced Evap 100% Phase-In, 2.5g	T2B8
623609							SE	H7DV					E20	13000	05/2004	4CRXV02.0VH0	4CRXR0101GBA				

12.6 Master Dataset

ID	Baseline Tests #1 - Pre Instrumentation, Program Start, No Aging - Performed at ETC																												
	FTP-75 Weighted Summary									1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test										
	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	1/29/10	115705	0.0767	0.4658	339.8	0.0738	0.0115	0.0655	25.90	1/29/10	S3_1510	0.091	0.0030	0.020	1/31/10	S3_1511	0.593	0.014	0.047	0.570	0.047	0.158	1.163	24.229
CRCE91_1E20	1/29/10	115706	0.0981	0.6395	339.0	0.0684	0.0105	0.0879	25.94	1/29/10	S4_1484	0.087	-0.0127	0.006	1/31/10	S4_1485	0.578	0.001	0.053	0.568	-0.014	0.057	1.146	23.875
CRCE91_2E0	1/23/10	212112	0.0303	0.5613	414.5	0.0251	0.0083	0.0231	21.25	1/23/10	S5_1724	0.042	NA	NA	1/26/10	S4_1477	0.321	0.004	0.030	0.365	0.005	0.028	0.686	14.292
CRCE91_2E20	1/23/10	212113	0.0382	0.5735	414.2	0.0435	0.0091	0.0300	21.26	1/23/10	S5_1725	0.041	NA	NA	1/26/10	S3_1505	0.267	0.022	0.013	0.340	-0.006	0.019	0.607	12.646
CRCE91_3E0	1/16/10	115644	0.0548	0.6310	436.5	0.0159	0.0064	0.0486	20.17	1/16/10	S5_1719	0.067	NA	NA	1/19/10	S3_1502	0.186	0.023	0.037	0.160	-0.011	0.037	0.346	7.208
CRCE91_3E20	1/16/10	115643	0.0423	0.4827	449.9	0.0059	0.0040	0.0383	19.59	1/16/10	S5_1716	0.086	NA	NA	1/19/20	S3_1473	0.216	0.021	0.061	0.173	0.016	0.065	0.389	8.104
CRCE91_4E0	4/27/10	116211	0.0059	0.0519	139.1	0.0009	0.0010	0.0054	63.04	4/27/10	S3_1590	0.011	0.0101	0.000	4/29/10	S3_1591	0.138	-0.002	0.010	0.139	0.014	0.023	0.277	5.771
CRCE91_4E20	4/27/10	116189	0.0058	0.0394	138.8	0.0009	0.0007	0.0051	63.17	4/24/10	S3_1588	0.012	-0.0044	0.001	4/27/10	S3_1589	0.105	-0.016	0.015	0.101	0.015	0.019	0.206	4.292
CRCE91_5E0	1/20/10	115659	0.0587	0.4744	479.0	0.0333	0.0063	0.0525	18.46	1/20/10	S3_1494	0.016	NA	NA	1/23/10	S3_1504	0.164	0.013	0.024	0.201	0.005	0.031	0.365	7.604
CRCE91_5E20	1/20/10	115658	0.0642	0.7759	488.8	0.0307	0.0095	0.0551	18.01	1/20/10	S4_1474	0.068	NA	NA	1/23/10	S4_1475	0.369	-0.016	0.049	0.486	0.005	0.069	0.855	17.813
CRCE91_6E0	3/3/10	115900	0.0799	0.7399	385.1	0.0484	0.0069	0.0732	22.84	3/2/10	S4_1517	0.064	-0.0004	0.002	3/5/10	S4_1518	0.412	0.003	0.014	0.378	0.024	0.013	0.79	16.458
CRCE91_6E20	2/28/10	212336	0.0404	0.5401	366.5	0.0481	0.0053	0.0360	24.03	2/28/10	S4_1514	0.048	-0.0081	0.003	3/2/10	S4_1516	0.255	-0.004	0.017	0.227	0.014	0.017	0.482	10.042
CRCE91_7E0	2/13/10	212262	0.0254	0.1183	398.6	0.1265	0.0058	0.0213	22.13	2/13/10	S4_1502	0.035	0.0053	0.003	2/16/10	S4_1503	0.440	0.024	0.023	0.724	-0.018	0.027	1.164	24.250
CRCE91_7E20	2/15/10	115811	0.0396	0.1623	432.3	0.0964	0.0062	0.0350	20.41	2/15/10	S3_1532	0.078	0.0220	0.012	2/17/10	S3_1533	0.440	0.024	0.033	0.689	0.000	0.044	1.129	23.521
CRCE91_8E0	3/22/10	116016	0.0434	0.4742	282.8	0.0386	0.0059	0.0376	31.12	3/22/10	S3_1568	0.016	0.0011	0.007	3/24/10	S3_1569	0.182	0.028	0.044	0.239	0.024	0.060	0.421	8.771
CRCE91_8E20	3/24/10	116026	0.0418	0.4422	289.6	0.0287	0.0055	0.0364	30.40	3/24/10	S4_1540	0.025	-0.0126	0.004	3/26/10	S4_1541	0.326	0.022	0.019	0.395	0.017	0.034	0.721	15.021
CRCE91_9E0	2/16/10	115821	0.0380	0.5585	347.2	0.0393	0.0069	0.0312	25.35	2/16/10	S4_1504	0.040	0.0126	0.013	2/19/10	S4_1505	0.292	0.021	0.029	0.321	0.001	0.035	0.613	12.771
CRCE91_9E20	2/26/10	115875	0.0232	0.3725	333.7	0.0380	0.0055	0.0178	26.40	2/26/10	S3_1547	0.026	NA	NA	3/1/10	S3_1550	0.343	0.011	0.060	0.401	0.020	0.061	0.744	15.500
CRCE91_10E0	2/20/10	115850	0.0349	0.4418	365.1	0.0051	0.0036	0.0313	24.19	2/20/10	S3_1537	0.035	0.0118	0.019	2/23/10	S3_1540	0.213	0.073	0.069	0.218	0.056	0.099	0.431	8.979
CRCE91_10E20	2/23/10	115858	0.0305	0.3187	359.0	0.0076	0.0029	0.0277	24.55	2/23/10	S3_1544	0.057	0.0057	0.028	2/26/10	S3_1545	0.194	0.012	0.094	0.189	0.021	0.111	0.383	7.979

ID	Baseline Tests #2 - Post Instrumentation, Program Start, No Aging - Performed at ETC																							
	FTP-75 Weighted Summary									1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test									
	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	2/5/10	115743	0.0855	0.6639	335.6	0.0710	0.0101	0.0756	26.20	2/5/10	S4_1492	0.066	0.013	0.010	2/7/10	S4_1494	0.726	0.024	0.101	0.677	-0.005	0.087	1.403	29.229
CRCE91_1E20	2/4/10	115736	0.0758	0.3699	342.0	0.0697	0.0078	0.0681	25.75	2/4/10	S3_1516	0.068	0.015	0.017	2/6/10	S3_1517	0.551	-0.003	0.070	0.565	0.011	0.083	1.116	23.250
CRCE91_2E0	2/1/10	115723	0.0542	0.7291	414.9	0.0294	0.0100	0.0445	21.21	2/1/10	S3_1512	0.038	0.004	0.008	2/3/10	S3_1513	0.283	0.004	0.031	0.396	0.011	0.046	0.679	14.146
CRCE91_2E20	2/2/10	115729	0.0697	0.7984	407.8	0.0469	0.0136	0.0564	21.57	2/2/10	S4_1487	0.033	-0.012	0.002	2/4/10	S4_1488	0.284	-0.014	0.015	0.339	-0.015	0.021	0.623	12.979
CRCE91_3E0	2/8/10	115767	0.0601	0.9201	443.2	0.0344	0.0089	0.0514	19.85	2/8/10	S4_1498	0.039	0.053	0.009	2/8/10	S4_1499	0.189	0.009	0.035	0.200	-0.018	0.040	0.389	8.104
CRCE91_3E20	2/6/10	115750	0.0216	0.3108	441.5	0.0050	0.0025	0.0192	19.97	2/6/10	S3_1519	0.032	0.003	0.026	2/9/10	S3_1523	0.201	0.020	0.186	0.209	0.007	0.144	0.410	8.542
CRCE91_4E0	5/2/10	411088	0.0066	0.1067	138.3	0.0009	0.0009	0.0058	63.44	5/1/10	S3_1594	0.008	0.000	0.001	5/4/10	S3_1595	0.108	0.016	0.019	0.105	0.001	0.019	0.213	4.438
CRCE91_4E20	5/4/10	116256	0.0071	0.0545	138.2	0.0012	0.0016	0.0062	63.48	5/4/10	S3_1596	0.006	0.000	0.001	5/6/10	S3_1597	0.094	0.013	0.016	0.105	-0.006	0.022	0.199	4.146
CRCE91_5E0	2/11/10	115788	0.0662	0.6145	490.0	0.0352	0.0067	0.0598	17.97	2/11/10	S4_1500	0.025	0.011	0.009	2/11/10	S4_1501	0.203	0.001	0.032	0.296	-0.003	0.041	0.499	10.396
CRCE91_5E20	2/9/10	115769	0.0728	0.6887	499.6	0.0379	0.0078	0.0652	17.62	2/9/10	S3_1524	0.041	-0.001	0.018	2/9/10	S3_1525	0.253	0.011	-0.005	0.381	0.049	0.065	0.634	13.208
CRCE91_6E0	3/10/10	115939	0.0540	0.4090	372.7	0.0532	0.0060	0.0482	23.63	3/10/10	S4_1529	0.087	0.008	0.006	3/12/10	S4_1530	0.400	0.013	0.014	0.353	0.017	0.011	0.753	15.688
CRCE91_6E20	3/8/10	115921	0.0684	0.5972	370.5	0.0528	0.0060	0.0625	23.75	3/8/10	S3_1559	0.049	0.009	0.006	3/10/10	S3_1560	0.229	0.009	0.024	0.213	0.005	0.029	0.442	9.208
CRCE91_7E0	3/6/10	115917	0.0419	0.2468	407.5	0.0906	0.0063	0.0357	21.64	3/6/10	S4_1523	0.035	-0.009	0.012	3/8/10	S4_1524	0.357	0.007	0.023	0.374	0.007	0.023	0.731	15.229
CRCE91_7E20	3/3/10	115899	0.0447	0.3630	433.1	0.1083	0.0055	0.0408	20.35	3/2/10	S3_1555	0.048	0.020	0.014	3/5/10	S3_1556	0.339	0.010	0.035	0.353	0.006	0.046	0.692	14.417
CRCE91_8E0	3/26/10	116042	0.0427	0.3404	281.2	0.0415	0.0055	0.0373	31.32	3/26/10	S3_1571	0.020	0.009	0.010	3/28/10	S3_1572	0.151	0.024	0.041	0.157	0.011	0.054	0.308	6.417
CRCE91_8E20	3/28/10	116048	0.0338	0.5753	280.2	0.0321	0.0051	0.0289	31.45	3/28/10	S4_1545	0.018	0.012	0.003	3/30/10	S4_1546	0.259	0.036	0.023	0.281	0.032	0.027	0.540	11.250
CRCE91_9E0	3/16/10	212416	0.0150	0.3501	337.6	0.0384	0.0051	0.0102	26.10	3/10/10	S4_1528	0.058	-0.007	0.013	3/18/10	S3_1565	0.331	0.015	0.070	0.366	0.008	0.085	0.697	14.521
CRCE91_9E20	3/14/10	115959	0.0247	0.3591	335.4	0.0325	0.0050	0.0198	26.27	3/14/10	S3_1562	0.027	-0.006	0.010	3/16/10	S3_1563	0.315	0.005	0.070	0.401	0.013	0.093	0.716	14.917
CRCE91_10E0	3/14/10	115958	0.0238	0.3961	363.5	0.0077	0.0028	0.0211	24.24	3/14/10	S4_1533	0.023	0.026	0.011	3/16/10	S4_1534	0.187	0.050	0.042	0.183	0.020	0.070	0.370	7.708
CRCE91_10E20	3/16/10	212415	0.0151	0.2339	355.0	0.0077	0.0030	0.0128	24.84	3/16/10	S4_1535	0.023	-0.006	0.021	3/18/10	S4_1536	0.167	0.001	0.069	0.162	-0.008	0.074	0.329	6.854

	Baseline Tests #3 - Post Instrumentation, Program Start, No Aging - Performed at CPG ONLY on vehicles being tested at CPG during the study																							
	FTP-75 Weighted Summary									1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test									
ID	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	3/10/10	548011100108–5	0.0660	0.4510	337.6	0.0542	0.0096	0.0566	26.22	3/10/10	548011100108-6	0.088	0.0117	0.014	3/12/10	548011100108-7	0.607	0.003	0.077	0.530	-0.004	0.084	1.137	23.689
CRCE91_1E20	3/10/10	548011100109–5	0.0824	0.3880	343.3	0.0563	0.0101	0.0725	23.97	3/10/10	548011100109-6	0.069	0.0056	0.008	3/12/10	548011100109-7	0.629	0.005	0.060	0.557	0.000	0.060	1.186	24.715
CRCE91_2E0	3/5/10	548011100100–5	0.0698	1.0640	436.4	0.0256	0.0178	0.0524	20.25	3/5/10	548011100100-6	0.042	0.0008	0.006	3/7/10	548011100100-7	0.280	0.001	0.028	0.291	0.000	0.027	0.571	11.899
CRCE91_2E20	3/5/10	548011100101–5	0.0562	0.5380	410.6	0.0526	0.0118	0.0446	20.04	3/5/10	548011100101-6	0.072	0.0241	0.007	3/7/10	548011100101-7	0.493	0.221	0.021	0.445	0.205	0.021	0.937	19.525
CRCE91_3E0	3/16/10	548011100126–5	0.0203	0.2600	448.3	0.0044	0.0050	0.0155	19.78	3/16/10	548011100126-6	0.038	-0.1431	0.032	3/18/10	548011100126-7	0.132	NA	NA	0.155	NA	NA	0.287	5.981
CRCE91_3E20	3/16/10	548011100127–5	0.0173	0.2520	455.7	0.0049	0.0038	0.0136	19.46	3/16/10	548011100127-6	0.030	0.0107	0.016	3/18/10	548011100127-7	0.125	0.010	0.061	0.175	0.009	0.050	0.300	6.260
CRCE91_4E0	Vehicles were not tested at CPG, therefore no test #3 was performed																							
CRCE91_4E20																								
CRCE91_5E0	3/23/10	548011100135–5	0.0880	1.1360	502.5	0.0108	0.0073	0.0809	17.59	3/23/10	548011100135-6	0.025	-0.0109	0.014	3/25/10	548011100135-7	0.182	0.012	0.033	0.566	0.016	0.040	0.748	15.590
CRCE91_5E20	3/23/10	548011100134–5	0.0398	0.4730	523.7	0.0309	0.0073	0.0336	16.92	3/23/10	548011100134-6	0.034	0.0070	0.014	3/25/10	548011100134-7	0.304	-0.010	0.040	0.835	0.016	0.044	1.140	23.740
CRCE91_6E0	4/13/10	548011100182–5	0.0426	0.3750	405.1	0.0478	0.0049	0.0378	21.87	4/13/10	548011100182-6	0.090	0.0299	0.004	4/15/10	548011100182-7	0.400	0.030	0.015	0.347	0.004	0.016	0.747	15.648
CRCE91_6E20	4/13/10	548011100183–5	0.0454	0.3920	382.2	0.0438	0.0050	0.0409	23.17	4/13/10	548011100183-6	0.065	-0.0055	0.005	4/15/10	548011100183-7	0.260	0.001	0.016	0.234	0.000	0.020	0.494	10.289
CRCE91_7E0	4/25/10	548011100223–5	0.0418	0.3300	426.1	0.0673	0.0053	0.0373	20.80	4/25/10	548011100223-6	0.036	NA	NA	4/27/10	548011100223-7	0.392	NA	NA	0.406	NA	NA	0.797	16.614
CRCE91_7E20	4/25/10	548011100224–5	0.0247	0.1360	431.5	0.0776	0.0040	0.0215	20.55	4/25/10	548011100224-6	0.069	0.0772	0.004	4/27/10	548011100224-7	0.368	0.052	0.025	0.388	-0.006	0.034	0.756	15.755
CRCE91_8E0	Vehicles were not tested at CPG, therefore no test #3 was performed																							
CRCE91_8E20																								
CRCE91_9E0	4/16/10	548011100197–5	0.0267	0.4090	358.1	0.0204	0.0069	0.0211	24.73	4/16/10	548011100197-6	0.028	-0.0013	0.015	4/18/10	548011100197-7	0.397	0.002	0.061	0.380	0.003	0.050	0.778	16.213
CRCE91_9E20	4/16/10	548011100198–5	0.0138	0.2290	349.5	0.0259	0.0038	0.0105	25.37	4/16/10	548011100198-6	0.047	0.0095	0.038	4/18/10	548011100198-7	0.434	-0.001	0.236	0.384	0.006	0.191	0.818	17.037
CRCE91_10E0	4/22/10	548011100214–4	0.0169	0.4700	378.8	0.0050	0.0017	0.0152	23.38	4/22/10	548011100214-5	0.022	-0.0177	0.023	4/24/10	548011100214-6	0.209	0.065	0.043	0.214	0.044	0.069	0.423	8.818
CRCE91_10E20	4/22/10	548011100213-4	0.0174	0.4710	379.0	0.0073	0.0031	0.0150	23.37	4/22/10	548011100213-5	0.013	NA	NA	4/24/10	548011100213-6	0.243	NA	NA	0.214	NA	NA	0.457	9.514

ID	Baseline Tests #4 - Post Instrumentation, Program Start, No Aging - Performed at CPG ONLY on vehicles being tested at CPG during the study																								
	FTP-75 Weighted Summary										1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test									
	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	3/26/10	548011100153-5	0.0677	0.5450	337.7	0.0727	0.0123	0.0555	26.20	3/26/10	548011100153-6	0.079	0.003	0.010	3/28/10	548011100153-7	0.639	-0.003	0.087	0.557	0.003	0.089	1.196	24.920
CRCE91_1E20	3/26/10	548011100152-5	0.0701	0.4200	338.8	0.0604	0.0102	0.0600	26.12	3/26/10	548011100152-6	0.085	0.005	0.007	3/28/10	548011100152-7	0.655	0.004	0.059	0.536	-0.007	0.058	1.191	24.822
CRCE91_2E0	3/31/10	548011100161-5	0.0481	0.7710	424.1	0.0207	0.0088	0.0393	20.86	3/31/10	548011100161-6	0.041	-0.006	0.007	4/2/10	548011100161-7	0.260	0.005	0.025	0.323	0.000	0.027	0.583	12.151
CRCE91_2E20	3/31/10	548011100162-5	0.0558	0.6280	412.5	0.0258	0.0117	0.0442	21.46	3/31/10	548011100162-6	0.032	-0.006	0.004	4/2/10	548011100162-7	0.357	0.096	0.019	0.461	0.075	0.020	0.818	17.047
CRCE91_3E0	4/6/10	548011100169-5	0.0371	0.6020	456.3	0.0122	0.0076	0.0297	19.41	4/6/10	548011100169-6	0.061	0.191	0.009	4/8/10	548011100169-7	0.153	0.020	0.038	0.237	0.004	0.038	0.390	8.130
CRCE91_3E20	4/6/10	548011100170-5	0.0273	0.5040	456.1	0.0143	0.0059	0.0215	19.42	4/6/10	548011100170-6	0.027	-0.001	0.024	4/8/10	548011100170-7	0.205	0.009	0.117	0.250	0.025	0.051	0.455	9.473
CRCE91_4E0	Vehicles were not tested at CPG, therefore no test #4 was performed																								
CRCE91_4E20																									
CRCE91_5E0	10/5/10	548011100709-4	0.0393	0.4340	494.9	0.0275	0.0059	0.0337	17.92	10/5/10	548011100709-5	0.025	-0.010	0.020	10/7/10	548011100709-6	0.275	0.034	0.031	0.376	0.027	0.031	0.651	13.568
CRCE91_5E20	10/5/10	548011100710-4	0.0396	0.4693	511.3	0.0272	0.0078	0.0322	17.36	10/5/10	548011100710-5	0.023	-0.008	0.007	10/7/10	548011100710-6	0.339	0.046	0.026	0.405	0.040	0.031	0.744	15.505
CRCE91_6E0	4/29/10	548011100240-5	0.0472	0.5960	405.4	0.0508	0.0083	0.0408	21.83	4/29/10	548011100240-6	0.067	-0.005	0.006	5/1/10	548011100240-7	0.511	0.016	0.019	0.433	0.027	0.014	0.944	19.664
CRCE91_6E20	4/29/10	548011100239-5	0.0524	0.5180	387.2	0.0498	0.0054	0.0470	22.86	4/29/10	548011100239-6	0.065	-0.001	0.009	5/1/10	548011100239-7	0.266	0.007	0.032	0.234	-0.020	0.023	0.500	10.419
CRCE91_7E0	5/1/10	548011100254-5	0.0213	0.0950	428.5	0.0868	0.0046	0.0180	20.70	5/1/10	548011100254-6	0.047	0.010	0.009	5/3/10	548011100254-7	0.399	-0.004	0.031	0.412	-0.002	0.030	0.811	16.894
CRCE91_7E20	5/2/10	548011100252-5	0.0312	0.1700	440.5	0.0916	0.0048	0.0270	20.13	5/2/10	548011100252-6	0.060	0.026	0.011	5/4/10	548011100252-7	0.410	0.029	0.029	0.459	0.016	0.028	0.870	18.120
CRCE91_8E0	Vehicles were not tested at CPG, therefore no test #4 was performed																								
CRCE91_8E20																									
CRCE91_9E0	5/4/10	548011100261-5	0.0214	0.7100	359.3	0.0276	0.0070	0.0153	24.62	5/4/10	548011100261-6	0.035	0.001	0.015	5/6/20	548011100379	0.349	0.053	0.107	0.339	-0.017	0.099	0.688	14.324
CRCE91_9E20	5/4/10	548011100260-5	0.0163	0.4180	351.7	0.0352	0.0050	0.0120	25.19	5/4/10	548011100260-6	0.064	-0.004	0.076	5/6/10	548011100380	0.347	0.000	0.025	0.355	0.004	0.014	0.702	14.620
CRCE91_10E0	5/13/10	548011100292-4	0.0190	0.3120	373.1	0.0115	0.0029	0.0162	23.74	5/6/10	548011100264-6	0.022	-0.007	0.012	5/8/10	548011100264-7	0.213	0.043	0.064	0.206	0.062	0.073	0.419	8.738
CRCE91_10E20	5/23/10	548011100303-4	0.0188	0.2960	369.3	0.0053	0.0026	0.0165	24.00	5/6/10	548011100265-6	0.031	-0.013	0.027	5/8/10	548011100265-7	0.238	0.001	0.089	0.228	0.012	0.082	0.465	9.697

ID	Permeation Tests - Program Start, No Aging										1 Hr Test		
	2 Hr Test												
	Test Date	Test ID #	Absolute Permeation Leak Rate, mg/hr	Absolute Tank Pressurization Leak Rate, mg/hr	Absolute Fuel Pump On Leak Rate, mg/hr	Relative Tank Pressurization Leak Rate, mg/hr	Relative Fuel Pump On Leak Rate, mg/hr	Innova Ethanol, mg/hr	Innova Methanol, mg/hr	Innova R134a, mg/hr	Test Date	Test ID#	Leak Rate, grams
CRCE91_1E0	05/27/10	548011100306-4	38.2	40.5	37.2	2.3	-3.3	-1.2	2.5	6.1	05/11/10	548011100271-5	0.0898
CRCE91_1E20	06/15/10	548011100360-4	37.9	42.9	39.2	5.0	-3.7	-1.6	10.3	12.6	06/15/10	548011100360-7	0.0818
CRCE91_2E0	05/27/10	548011100307-5	20.5	0.9	42.4	-19.6	41.5	-1.2	2.5	6.1	05/27/10	548011100307-8	0.0496
CRCE91_2E20	06/15/10	548011100359-4	25.8	17.9	20.3	-7.9	2.4	7.5	-0.4	2.9	06/15/10	548011100359-7	0.1040
CRCE91_3E0	06/08/10	548011100341-5	12.5	8.8	3.4	-3.7	-5.4	-1.8	2.6	3.6	06/08/10	548011100341-8	0.0380
CRCE91_3E20	06/15/10	548011100361-5	10.6	10.2	3.2	-0.4	-7.0	0.1	0.2	5.0	06/15/10	548011100361-8	0.0380
CRCE91_4E0	05/27/10	S1_1411	7.1	8.1	7.6	1.0	-0.5	-2.2	0.2	1.1	05/27/10	S1_1409	0.0210
CRCE91_4E20	06/16/10	S1_1426	6.6	6.1	2.6	-0.5	-3.5	-10.4	6.2	-5.1	06/16/10	S1_1427	0.0140
CRCE91_5E0	11/08/10	548011100813-4	12.6	16.5	-0.1	4.0	-16.7	-4.8	4.7	2.3	11/08/10	548011100813-7	0.0304
CRCE91_5E20	11/08/10	548011100814-4	20.3	15.4	12.0	-5.0	-3.4	4.7	2.5	1.2	11/08/10	548011100814-7	0.0483
CRCE91_6E0	06/11/10	548011100353-5	26.4	25.9	95.2	-0.5	69.3	-4.7	3.5	3.2	06/11/10	548011100353-8	0.1378
CRCE91_6E20	06/18/10	548011100366-5	17.8	13.3	18.0	-4.5	4.7	-1.8	1.3	2.9	06/18/10	548011100366-8	0.0650
CRCE91_7E0	06/11/10	548011100354-5	23.0	23.8	25.9	0.8	2.1	0.7	-0.3	3.6	06/11/10	548011100354-8	0.0825
CRCE91_7E20	06/25/10	548011100381-4	25.7	23.3	20.1	-2.4	-3.2	-0.2	5.1	4.5	06/18/10	548011100368-8	0.0603
CRCE91_8E0	05/20/10	S1_1409	11.4	7.9	6.3	-3.5	-1.6	0.3	1.8	1.2	05/20/10	S1_1406	0.0230
CRCE91_8E20	06/09/10	S1_1420	18.7	15.2	20.0	-3.5	4.8	2.3	3.7	-22.2	06/09/10	S1_1421	0.0340
CRCE91_9E0	06/30/10	548011100391-5	48.5	43.0	99.6	-5.5	56.6	-2.8	3.7	3.6	06/30/10	548011100391-8	0.0662
CRCE91_9E20	06/30/10	548011100392-5	17.9	20.0	22.8	2.1	2.8	-4.6	5.6	5.4	06/30/10	548011100392-8	0.0477
CRCE91_10E0	06/11/10	548011100355-5	12.5	12.7	15.9	0.2	3.2	1.0	2.2	4.5	06/11/10	548011100355-8	0.0869
CRCE91_10E20	06/18/10	548011100369-5	12.8	9.9	9.1	-2.9	-0.8	-4.6	5.1	6.3	06/18/10	548011100369-8	0.0381

ID	48 Hour Test											
	Test Date	Test ID#	Grams - Day 1	Grams - Day 2	Grams - Total 48	Innova - Ethanol Grams - Day 1	Innova - Methanol Grams - Day 1	Innova - R134a Grams Day 1	Innova - Ethanol Grams - Day 2	Innova - Methanol Grams - Day 2	Innova - R134a Grams Day 2
CRCE91_1E0	06/11/10	548011100271-9	0.808	0.710	1.518	0.003	0.023	0.093	0.007	0.019	0.103
CRCE91_1E20	06/15/10	548011100360-8	0.689	0.538	1.227	0.181	0.061	0.053	0.135	0.066	0.059
CRCE91_2E0	05/27/10	548011100307-9	0.257	0.215	0.473	-0.002	0.015	0.031	-0.001	0.013	0.031
CRCE91_2E20	06/15/10	548011100359-8	0.412	0.408	0.820	0.259	0.005	0.012	0.237	0.034	0.026
CRCE91_3E0	06/08/10	548011100341-9	0.154	0.136	0.290	0.011	0.010	0.046	0.001	0.016	0.043
CRCE91_3E20	06/15/10	548011100361-9	0.152	0.097	0.249	0.029	0.022	0.052	0.009	0.025	0.042
CRCE91_4E0	05/27/10	S1_1410	0.099	0.073	0.172	0.010	0.042	0.022	0.019	0.019	0.027
CRCE91_4E20	06/05/10	S1_1417	0.080	0.120	0.200	-0.470	0.694	0.179	-0.010	0.029	0.007
CRCE91_5E0	11/08/10	548011100813-8	0.220	0.245	0.465	0.006	0.022	0.035	0.015	0.009	0.037
CRCE91_5E20	11/08/10	548011100814-8	0.265	0.297	0.562	0.077	0.027	0.025	0.098	0.010	0.033
CRCE91_6E0	06/11/10	548011100353-9	0.495	0.408	0.903	0.014	0.024	0.037	0.028	-0.001	0.010
CRCE91_6E20	06/18/10	548011100366-9	0.275	0.215	0.491	0.029	0.004	0.016	0.023	0.009	0.019
CRCE91_7E0	06/11/10	548011100354-9	0.333	0.308	0.641	-0.010	0.017	0.030	-0.005	0.015	0.032
CRCE91_7E20	06/18/10	548011100368-9	0.521	0.621	1.143	0.052	0.015	0.431	0.041	0.021	0.882
CRCE91_8E0	05/21/10	S1_1407	0.209	0.189	0.398	0.001	0.004	0.000	0.015	0.039	0.055
CRCE91_8E20	06/09/10	S1_1422	0.272	0.268	0.540	0.135	0.039	0.010	0.146	0.039	0.038
CRCE91_9E0	06/30/10	548011100391-9	0.341	0.264	0.605	0.031	0.014	0.121	-0.007	0.013	0.105
CRCE91_9E20	06/30/10	548011100392-9	0.390	0.317	0.707	0.238	0.009	0.015	0.200	0.017	0.012
CRCE91_10E0	06/11/10	548011100355-9	0.161	0.135	0.296	0.031	0.059	0.067	0.025	0.057	0.069
CRCE91_10E20	06/18/10	548011100369-9	0.162	0.135	0.297	0.035	0.003	0.073	0.002	0.023	0.074

ID	Permeation Tests - 90 Days of Aging																								
	2 Hr Test										1 Hr Test			48 Hour Test											
	Test Date	Test ID #	Absolute Permeation Leak Rate, mg/hr	Absolute Tank Pressurization Leak Rate, mg/hr	Absolute Fuel Pump On Leak Rate, mg/hr	Relative Tank Pressurization Leak Rate, mg/hr	Relative Fuel Pump On Leak Rate, mg/hr	Innova Ethanol, mg/hr	Innova Methanol, mg/hr	Innova R134a, mg/hr	Test Date	Test ID #	Leak Rate, Grams	Test Date	Test ID #	Grams - Day 1	Grams - Day 2	Grams - Total 48 Hrs	Innova - Ethanol Grams - Day 1	Innova - Methanol Grams - Day 1	Innova - R134a Grams Day 1	Innova - Ethanol Grams - Day 2	Innova - Methanol Grams - Day 2	Innova - R134a Grams Day 2
CRCE91_1E0	10/18/10	548011100760-4	80.1	116.9	52.5	36.9	-64.4	-0.2	1.9	4.9	10/18/10	548011100760-7	0.1149	10/18/10	548011100760-8	0.756	0.700	1.456	0.044	0.023	0.104	0.049	0.007	0.101
CRCE91_1E20	10/18/10	548011100762-4	44.3	32.8	32.8	-11.5	-0.1	5.0	11.4	5.5	10/18/10	548011100762-7	0.1179	10/18/10	548011100762-8	0.957	0.841	1.798	0.248	0.045	0.061	0.239	0.027	0.063
CRCE91_2E0	12/07/10	548011100876-4	17.2	23.2	21.4	6.0	1.8	-30.6	34.5	10.4	12/07/10	548011100876-7	0.0636	12/07/10	548011100876-8	0.289	0.259	0.548	0.003	0.085	0.025	-0.011	0.068	0.025
CRCE91_2E20	10/21/10	548011100770-4	23.7	24.5	22.8	0.8	-1.8	7.1	2.0	2.0	10/21/10	548011100770-7	0.0593	10/21/10	548011100770-8	0.437	0.477	0.913	0.260	0.024	0.018	0.278	0.018	0.023
CRCE91_3E0	11/05/10	548011100811-4	11.0	8.5	14.8	-2.5	6.3	-3.3	6.3	2.5	11/05/10	548011100811-7	0.0289	11/05/10	548011100811-8	0.113	0.118	0.231	0.007	0.008	0.040	-0.004	0.020	0.037
CRCE91_3E20	11/05/10	548011100812-4	8.3	5.7	4.5	-2.6	-1.2	-5.0	4.6	1.3	11/05/10	548011100812-7	0.0370	11/05/10	548011100812-8	0.120	0.120	0.240	0.025	0.016	0.032	0.051	0.003	0.031
CRCE91_4E0	09/23/10	S1_1474	1.3	9.9	0.4	8.5	-9.5	-0.8	1.8	-0.2	09/23/10	S1_1475	0.0060	09/24/10	S1_1476	0.068	0.049	0.117	-0.014	0.073	0.020	-0.015	0.071	0.030
CRCE91_4E20	09/29/10	S1_1480	3.3	-4.5	-0.4	-7.7	4.1	-3.0	3.6	1.3	09/29/10	S1_1481	0.0060	10/01/10	S1_1482	0.060	0.052	0.112	-0.002	0.023	0.023	0.009	0.057	0.032
CRCE91_5E0	03/09/11	548011110288-4	18.6	18.5	12.2	0.0	-6.4	9.2	21.8	0.8	03/09/11	548011110288-7	0.0569	03/09/11	548011110288-8	0.259	0.251	0.510	0.014	0.158	0.027	0.006	0.006	0.043
CRCE91_5E20	03/09/11	548011110287-4	11.1	7.6	10.0	11.1	2.4	-9.6	16.7	2.8	03/09/11	548011110287-7	0.0404	03/09/11	548011110287-8	0.311	0.268	0.580	0.078	0.041	0.030	0.084	0.017	0.024
CRCE91_6E0	11/17/10	548011100834-4	54.5	45.4	59.4	-9.1	14.0	3.1	12.7	-5.1	11/17/10	548011100834-7	0.1078	11/17/10	548011100834-8	0.460	0.373	0.834	0.016	0.032	0.035	0.029	-0.005	0.033
CRCE91_6E20	11/17/10	548011100835-4	14.9	26.2	22.9	11.3	-3.3	2.0	5.3	-1.5	11/17/10	548011100835-7	0.0877	11/17/10	548011100835-8	0.261	0.226	0.487	0.065	0.016	0.026	0.046	0.017	0.027
CRCE91_7E0	11/09/10	548011100815-4	25.9	51.2	45.0	25.3	-6.1	-12.6	12.1	4.9	11/09/10	548011100815-7	0.0572	11/09/10	548011100815-8	0.352	0.298	0.650	0.006	0.008	0.026	0.020	0.006	0.026
CRCE91_7E20	11/17/10	548011100838-4	23.5	19.5	23.6	-4.0	4.1	3.4	9.7	-1.4	11/17/10	548011100838-7	0.0852	11/17/10	548011100838-8	0.369	0.353	0.721	0.001	-0.006	-0.001	0.137	-0.002	0.017
CRCE91_8E0	09/17/10	S1_1466	6.2	5.9	5.4	-0.3	-0.5	-0.5	4.5	-31.4	09/17/10	S1_1467	0.0170	09/20/10	S1_1468	0.127	0.131	0.258	-0.010	0.024	0.025	0.040	0.005	0.035
CRCE91_8E20	10/04/10	S1_1483	16.0	14.6	9.9	-1.4	-4.7	NA	NA	NA	10/04/10	S1_1484	0.0380	10/05/10	S1_1487	0.243	0.223	0.466	0.069	-0.002	0.020	0.135	0.043	0.042
CRCE91_9E0	01/11/11	548011110022-4	68.3	116.4	110.0	48.1	-6.4	-8.1	6.3	11.8	12/28/10	548011100961-7	0.0356	12/28/10	548011100961-8	0.275	0.224	0.498	-0.019	0.007	0.212	-0.013	0.015	0.150
CRCE91_9E20	11/11/10	548011100825-4	30.7	13.8	13.8	-16.9	0.0	13.6	5.2	1.5	11/20/10	548011100848-3	0.0631	11/20/10	548011100848-4	0.406	0.323	0.729	0.243	0.009	0.014	0.184	0.007	0.014
CRCE91_10E0	11/12/10	548011100827-4	12.7	12.0	13.5	-0.5	-4.6	3.0	2.7	-3.5	11/12/10	548011100827-7	0.0261	11/12/10	548011100827-8	0.141	0.122	0.263	0.021	0.017	0.041	0.025	0.016	0.032
CRCE91_10E20	11/12/10	548011100826-4	18.3	13.8	13.4	-4.6	-0.4	5.9	10.6	-7.4	11/12/10	548011100826-7	0.0307	11/12/10	548011100826-8	0.190	0.161	0.351	0.062	0.015	0.072	0.076	-0.007	0.051

	Baseline Tests - 90 Days of Aging																									
	FTP-75 Weighted Summary									1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test											
ID	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 Methanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 Methanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	11/22/10	548011100847-4	0.0930	0.5997	328.9	0.0825	0.0162	0.0770	26.90	11/22/10	548011100847-5	0.05453	0.01208	0.01761	11/24/2010	548011100847-6	0.694	0.038	0.000	0.182	0.529	-0.007	0.025	0.155	1.223	25.471
CRCE91_1E20	11/23/10	548011100853-4	0.0865	0.7191	344.8	0.0635	0.0120	0.0745	25.65	11/23/10	548011100853-5	0.17992	0.01139	0.01101	11/25/2010	548011100853-6	0.813	0.012	0.038	0.065	0.529	0.046	0.004	0.049	1.342	27.967
CRCE91_2E0	11/23/10	548011100854-4	0.0600	0.7720	421.2	0.0237	0.0122	0.0479	21.03	11/23/10	548011100854-5	0.03862	-0.00269	0.00563	11/25/2010	548011100854-6	0.291	0.001	0.114	0.022	0.328	0.023	0.071	0.008	0.619	12.887
CRCE91_2E20	11/30/10	548011100855-4	0.0609	0.5470	417.5	0.0262	0.0148	0.0464	21.25	11/30/10	548011100855-5	0.17472	0.02637	0.00539	12/2/2010	548011100855-6	0.405	0.035	0.033	0.024	0.388	0.045	0.014	0.020	0.793	16.518
CRCE91_3E0	12/3/10	548011100869-4	0.0226	0.2960	441.9	0.0057	0.0071	0.0156	20.08	12/3/10	548011100869-5	0.02106	0.0093	0.01212	12/5/2010	548011100869-6	0.133	0.007	0.014	0.035	0.172	0.004	0.008	0.035	0.305	6.364
CRCE91_3E20	12/3/10	548011100871-4	0.0186	0.2722	448.5	0.0053	0.0050	0.0138	19.81	12/3/10	548011100871-5	0.01887	-0.02619	0.01984	12/5/2010	548011100871-6	0.150	0.028	0.001	0.065	0.171	0.006	0.014	0.042	0.321	6.678
CRCE91_4E0	10/22/10	411685	0.0075	0.0536	128.7	0.0013	0.0007	0.0068	68.46	10/22/10	S3_1669	0.007	NA	NA	10/26/2010	S3_1670	0.084	0.013	0.066	0.031	0.078	0.017	0.026	0.014	0.162	3.375
CRCE91_4E20	10/26/10	411699	0.0051	0.0429	135.8	0.0012	0.0009	0.0042	64.89	10/26/10	S3_1673	0.008	NA	NA	10/28/2010	S3_1674	0.103	0.018	0.041	0.029	0.086	-0.015	-0.028	-0.022	0.189	3.938
CRCE91_5E0	3/29/11	548011110418-4	0.0717	0.6457	490.2	0.0287	0.0068	0.0650	18.08	3/29/11	548011110418-5	0.04686	-0.02194	0.0045	3/31/2011	548011110418-6	0.244	0.005	0.137	0.031	0.282	0.010	0.103	0.031	0.527	10.975
CRCE91_5E20	4/16/11	548011110478-4	0.0389	0.7446	526.8	0.0545	0.0091	0.0308	16.83	4/16/11	548011110478-5	0.04213	0.00615	0.01339	4/18/2011	548011110478-6	0.410	0.079	0.015	0.031	0.485	0.054	0.021	0.032	0.896	18.656
CRCE91_6E0	12/14/10	548011100905-4	0.0435	0.3626	400.1	0.0462	0.0050	0.0398	22.09	12/14/10	548011100905-5	0.1537	-0.00425	0.0051	12/16/2010	548011100905-6	0.524	0.011	0.022	0.040	0.431	0.007	0.013	0.032	0.955	19.896
CRCE91_6E20	12/14/10	548011100906-4	0.0478	0.6273	387.8	0.0768	0.0055	0.0424	22.75	12/14/10	548011100906-5	0.04053	0.00132	0.00575	12/14/2010	548011100906-6	0.243	0.017	0.013	0.026	0.220	0.011	0.010	0.034	0.463	9.649
CRCE91_7E0	12/9/10	548011100882-4	0.0233	0.0766	414.5	0.0826	0.0043	0.0200	21.32	12/9/10	548011100882-5	0.03413	0.01689	0.00249	12/11/2010	548011100882-6	0.372	-0.003	0.010	0.029	0.459	-0.011	0.013	0.021	0.831	17.304
CRCE91_7E20	12/9/10	548011100883-4	0.0242	0.1076	439.8	0.0936	0.0046	0.0205	20.10	12/9/10	548011100883-5	0.02463	0.01997	0.00032	12/11/2010	548011100883-6	0.345	0.050	0.003	0.018	0.379	0.005	0.022	0.036	0.724	15.081
CRCE91_8E0	10/15/10	411658	0.0381	0.4030	281.2	0.0337	0.0046	0.0337	31.28	10/14/10	S1_1490	0.005	-0.0078	0.001	10/17/2010	S1_1492	0.167	0.005	-0.010	0.041	0.221	0.022	0.026	0.063	0.388	8.083
CRCE91_8E20	11/4/10	411722	0.0369	0.4260	275.7	0.0347	0.0040	0.0330	31.90	11/4/10	S3_1682	0.01	NA	NA	11/6/2010	S3_1683	0.258	0.047	0.037	0.039	0.312	-0.049	-0.028	-0.034	0.570	11.875
CRCE91_9E0	12/21/10	548011100920-4	0.0158	0.3301	353.2	0.0315	0.0049	0.0115	25.03	12/21/10	548011100920-5	0.0323	-0.03009	0.03798	12/23/2010	548011100920-6	0.330	-0.009	0.014	0.232	0.347	-0.010	0.017	0.161	0.677	14.096
CRCE91_9E20	12/21/10	548011100921-4	0.0135	0.2161	345.7	0.0293	0.0037	0.0105	25.55	12/21/10	548011100921-5	0.0351	-0.00062	0.00535	12/23/2010	548011100921-6	0.311	0.057	0.014	0.009	0.312	0.041	0.013	0.008	0.623	12.982
CRCE91_10E0	12/6/10	548011100874-4	0.0208	0.3210	364.6	0.0080	0.0023	0.0188	24.30	12/6/10	548011100874-5	0.0176	0.00394	0.01475	12/8/2010	548011100874-6	0.144	0.015	0.012	0.045	0.149	0.016	0.013	0.058	0.293	6.108
CRCE91_10E20	12/6/10	548011100875-4	0.0157	0.2182	366.5	0.0074	0.0025	0.0137	24.18	12/6/10	548011100875-5	0.04119	-0.0163	0.02025	12/8/2010	548011100875-6	0.182	0.026	0.022	0.073	0.179	0.023	0.010	0.072	0.361	7.519

ID	Permeation Tests - 180 Days of Aging																							
	2 Hr Test										1 Hr Test			48 Hour Test										
	Test Date	Test ID #	Absolute Permeation Leak Rate, mg/hr	Absolute Tank Pressurization Leak Rate, mg/hr	Absolute Fuel Pump On Leak Rate, mg/hr	Relative Tank Pressurization Leak Rate, mg/hr	Relative Fuel Pump On Leak Rate, mg/hr	Innova Ethanol, mg/hr	Innova Methanol, mg/hr	Innova R134a, mg/hr	Test Date	Test ID #	Leak Rate, grams	Test Date	Test ID #	Grams - Day 1	Grams - Day 2	Grams - Total 48 Hrs	Innova - Ethanol Grams - Day 1	Innova - Methanol Grams - Day 1	Innova - R134a Grams Day 1	Innova - Ethanol Grams - Day 2	Innova - Methanol Grams - Day 2	Innova - R134a Grams Day 2
CRCE91_1E0	05/06/11	548011110549-4	50.4	101.9	114.8	51.5	11.0	-2.8	3.8	5.3	05/06/11	548011110549-7	0.0962	05/06/11	548011110549-8	0.641	0.578	1.220	0.018	0.016	0.083	-0.002	0.024	0.081
CRCE91_1E20	05/06/11	548011110550-4	50.2	37.5	30.5	50.2	-12.7	8.3	4.2	5.6	05/06/11	548011110550-7	0.0938	05/06/11	548011110550-8	1.104	0.967	2.079	0.291	0.048	0.063	0.259	0.049	0.064
CRCE91_2E0	03/23/11	548011110383-4	18.6	17.1	17.1	-1.5	-0.1	10.4	-6.2	1.1	03/18/11	548011110383-7	0.0619	03/18/11	548011110383-8	0.280	0.242	0.522	0.040	0.114	0.021	0.027	0.101	0.019
CRCE91_2E20	03/18/11	548011110361-4	32.7	33.7	29.1	1.0	-4.6	19.0	13.2	5.1	03/18/11	548011110361-7	0.1112	03/18/11	548011110361-8	0.595	0.531	1.123	0.295	0.170	0.018	0.276	0.143	0.012
CRCE91_3E0	03/15/11	548011110338-4	12.1	2.7	6.7	-9.4	4.0	-2.7	11.7	1.7	03/15/11	548011110338-7	0.0735	03/15/11	548011110338-8	0.159	0.146	0.305	0.010	0.104	0.039	0.006	0.088	0.035
CRCE91_3E20	03/15/11	548011110339-4	8.2	6.0	2.3	-2.1	-3.7	NA	NA	NA	03/15/11	548011110339-7	0.0356	03/15/11	548011110339-8	0.113	0.093	0.204	0.119	0.280	0.215	0.016	0.045	0.036
CRCE91_4E0	02/18/11	S1-1561	6.3	2.3	4.8	-4.0	2.4	-18.3	11.6	-2.2	02/18/11	S1-1562	0.0080	02/18/11	S1-1563	0.062	0.051	0.113	NA	NA	NA	NA	NA	NA
CRCE91_4E20	02/21/11	S1-1564	5.9	5.6	10.2	-0.3	4.6	-13.8	8.4	-0.5	02/21/11	S1-1566	0.0040	02/21/11	S1-1567	0.066	0.058	0.124	-0.003	0.035	0.019	0.036	0.015	0.024
CRCE91_5E0	08/10/11	548011111035-4	10.5	4.4	6.7	-6.1	2.3	25.6	-16.8	-9.2	08/10/11	548011111035-7	0.0190	08/10/11	548011111035-8	0.195	0.180	0.375	0.008	0.012	0.018	0.008	0.110	0.176
CRCE91_5E20	08/10/11	548011111036-4	24.2	20.7	26.0	-3.5	5.4	4.4	10.4	4.3	08/10/11	548011111036-7	0.0451	08/10/11	548011111036-8	0.357	0.379	0.740	0.107	0.037	0.028	0.126	0.008	0.022
CRCE91_6E0	04/08/11	548011110467-4	68.6	55.9	25.2	-12.7	-30.8	0.7	6.8	2.2	04/08/11	548011110467-7	0.0828	04/08/11	548011110467-8	0.504	0.404	0.908	0.037	0.093	0.031	0.005	0.101	0.028
CRCE91_6E20	04/08/11	548011110468-4	17.9	23.2	16.7	5.3	-6.5	1.8	6.2	2.6	04/08/11	548011110468-7	0.0971	04/08/11	548011110468-8	0.278	0.243	0.514	0.074	0.108	0.026	0.049	0.104	0.041
CRCE91_7E0	04/19/11	548011110495-4	29.6	35.6	63.0	6.0	27.4	-22.3	21.9	5.0	04/12/11	548011110476-7	0.0767	04/12/11	548011110476-8	0.454	0.362	0.815	0.009	0.028	0.018	-0.004	0.028	0.027
CRCE91_7E20	04/12/11	548011110477-4	36.1	33.9	36.7	-2.2	2.8	-0.6	5.4	4.1	04/12/11	548011110477-7	0.0662	04/12/11	548011110477-8	0.658	0.586	1.245	0.108	0.040	0.033	0.103	0.025	0.029
CRCE91_8E0	02/28/11	S1-1574	8.7	10.3	7.6	8.7	1.6	-14.6	7.4	-1.6	02/28/11	S1-1575	0.0230	02/28/11	S1-1576	0.240	0.213	0.452	-0.011	0.040	0.028	0.027	0.033	0.041
CRCE91_8E20	02/24/11	S1-1569	19.2	17.6	19.0	-1.6	1.4	-15.1	14.1	0.4	02/24/11	S1-1570	0.0440	02/25/11	S1-1573	0.341	0.350	0.690	0.116	0.036	0.033	0.170	0.028	0.045
CRCE91_9E0	05/13/11	548011110597-4	23.2	26.4	20.0	3.1	-6.4	NA	NA	NA	05/13/11	548011110597-7	0.0489	05/13/11	548011110597-8	0.265	0.184	0.449	0.013	-0.007	0.018	0.002	0.010	0.016
CRCE91_9E20	05/13/11	548011110598-4	40.1	34.7	39.8	-5.5	5.2	24.2	-8.7	-0.6	05/13/11	548011110598-7	0.0359	05/13/11	548011110598-8	0.519	0.378	0.059	0.054	0.010	0.004	0.292	-0.003	-0.003
CRCE91_10E0	04/15/11	548011110487-4	17.6	13.1	18.5	-4.5	5.4	-10.7	11.0	1.4	04/15/11	548011110487-7	0.0302	04/15/11	548011110487-8	0.174	0.149	0.323	0.022	0.075	0.050	0.012	0.076	0.060
CRCE91_10E20	04/15/11	548011110488-4	16.0	10.2	9.3	-5.8	-0.9	0.6	6.8	3.9	04/15/11	548011110488-7	0.0295	04/15/11	548011110488-8	0.209	0.171	0.381	0.060	0.099	0.072	0.041	0.095	0.074

	Baseline Tests - 180 Days of Aging																									
	FTP-75 Weighted Summary									1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test											
ID	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 Methanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 Methanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	5/24/2011	548011110652-4	0.0738	0.4532	340.0	0.0781	0.0149	0.0594	26.02	5/24/2011	548011110652-5	0.055	-0.004	0.016	5/26/2011	548011110652-6	0.567	0.002	0.021	0.115	0.492	0.024	0.004	0.078	1.059	22.059
CRCE91_1E20	5/24/2011	548011110653-4	0.0923	0.5595	357.4	0.0814	0.0188	0.0741	24.77	5/24/2011	548011110653-5	0.120	-0.003	0.011	5/26/2011	548011110653-6	0.768	0.056	0.018	0.060	0.513	0.013	0.039	0.052	1.281	26.677
CRCE91_2E0	4/19/2011	548011110493-4	0.0585	0.8056	412.8	0.0248	0.0126	0.0506	21.45	4/19/2011	548011110493-5	0.031	-0.014	0.006	4/21/2011	548011110493-8	0.333	0.013	0.079	0.033	0.366	0.019	0.064	0.031	0.699	14.559
CRCE91_2E20	4/19/2011	548011110494-4	0.0656	0.5183	400.2	0.0308	0.0157	0.0558	22.16	4/19/2011	548011110494-5	0.027	-0.007	0.025	4/21/2011	548011110494-6	0.557	0.096	0.082	0.017	0.557	0.058	0.084	0.024	1.114	23.214
CRCE91_3E0	4/5/2011	548011110451-4	0.0379	1.2001	477.9	0.0165	0.0093	0.0287	18.51	4/5/2011	548011110451-5	0.031	0.084	0.009	4/7/2011	548011110451-6	0.126	0.024	0.074	0.033	0.142	0.009	0.057	0.032	0.268	5.592
CRCE91_3E20	4/5/2011	548011110453-4	0.0353	1.1564	487.5	0.0143	0.0058	0.0295	18.17	4/5/2011	548011110453-5	0.022	-0.010	-0.023	4/7/2011	548011110453-6	0.140	0.017	0.026	0.044	0.179	0.015	0.028	0.032	0.319	6.654
CRCE91_4E0	3/16/2011	412069	0.0091	0.0634	134.7	0.0024	0.0010	0.0081	65.31	3/16/2011	S1_1580	0.000	-0.007	-0.001	3/18/2011	S1_1581	0.090	-0.032	0.023	0.017	0.070	0.005	0.009	0.023	0.160	3.333
CRCE91_4E20	3/21/2011	412091	0.0097	0.0669	134.2	0.0001	0.0010	0.0088	65.55	3/20/2011	S1_1582	0.001	-0.020	-0.002	3/23/2011	S1_1583	0.108	-0.031	0.034	0.019	0.095	0.024	0.012	0.027	0.203	4.229
CRCE91_5E0	8/30/2011	548011111134–4	0.0489	1.7096	509.7	0.0505	0.0086	0.0406	17.33	8/30/2011	548011111134-5	0.012	0.012	0.013	9/1/2011	548011111134-6	0.199	-0.010	0.015	0.028	0.428	-0.002	0.007	0.036	0.628	13.079
CRCE91_5E20	8/30/2011	548011111135–4	0.0598	1.8878	523.4	0.0545	0.0115	0.0487	16.89	8/30/2011	548011111135-5	0.029	-0.028	0.012	9/1/2011	548011111135-6	0.475	0.043	0.032	0.035	1.168	0.030	0.032	0.042	1.643	34.231
CRCE91_6E0	5/4/2011	548011110543-4	0.0653	0.5734	404.0	0.0606	0.0058	0.0598	21.94	5/4/2011	548011110543-5	0.067	-0.002	0.004	5/6/2011	548011110543-6	0.522	0.022	0.092	0.036	0.446	0.018	0.081	0.030	0.969	20.184
CRCE91_6E20	4/30/2011	548011110515-4	0.0540	0.5612	381.2	0.0653	0.0058	0.0485	23.27	4/30/2011	548011110515-5	0.045	NA	NA	5/2/2011	548011110515-6	0.272	NA	NA	NA	0.240	0.012	0.198	0.063	0.512	10.669
CRCE91_7E0	5/10/2011	548011110556-4	0.0265	0.1602	421.6	0.0735	0.0048	0.0223	21.05	5/10/2011	548011110556-5	0.039	0.007	0.004	5/12/2011	548011110556-6	0.446	-0.003	0.014	0.031	0.441	-0.004	0.013	0.026	0.887	18.474
CRCE91_7E20	5/10/2011	548011110557-4	0.0225	0.0758	423.6	0.0642	0.0044	0.0187	20.95	5/10/2011	548011110557-5	0.058	0.013	0.021	5/12/2011	548011110557-6	0.537	0.015	0.028	0.089	0.571	0.002	0.033	0.160	1.108	23.086
CRCE91_8E0	3/24/2011	412103	0.0388	0.3384	276.3	0.0376	0.0050	0.0340	31.80	3/24/2011	S1_1586	0.006	0.002	0.003	3/26/2011	S1_1587	0.177	NA	NA	NA	0.205	NA	NA	NA	0.382	7.958
CRCE91_8E20	3/28/2011	116958	0.0692	0.5410	278.3	0.0367	0.0061	0.0595	31.53	3/27/2011	S1_1588	0.009	-0.020	0.008	3/30/2011	S1_1589	0.267	0.017	0.039	0.034	0.280	0.050	0.018	0.053	0.547	11.396
CRCE91_9E0	6/7/2011	548011110718-4	0.0173	0.2801	350.3	0.0348	0.0052	0.0128	25.31	6/7/2011	548011110718-5	0.031	0.006	0.006	6/9/2011	548011110718-6	0.268	-0.009	0.012	0.015	0.268	0.001	0.008	0.014	0.536	11.159
CRCE91_9E20	6/7/2011	548011110719-4	0.0143	0.2343	349.1	0.0515	0.0043	0.0108	25.39	6/7/2011	548011110719-5	0.040	-0.004	0.005	6/9/2011	548011110719-6	0.368	0.176	0.002	0.003	0.340	0.122	0.019	0.008	0.708	14.741
CRCE91_10E0	5/3/2011	548011110533-4	0.0500	0.7245	370.7	0.0074	0.0029	0.0473	23.88	5/3/2011	548011110533-5	0.023	-0.015	0.019	5/5/2011	548011110533-6	0.167	0.010	0.046	0.050	0.152	0.016	0.030	0.058	0.319	6.646
CRCE91_10E20	5/3/2011	548011110534-4	0.0190	1.0794	372.9	0.0122	0.0027	0.0167	23.72	5/3/2011	548011110534-5	0.024	0.019	0.013	5/5/2011	548011110534-6	0.211	0.035	0.078	0.067	0.195	0.026	0.068	0.067	0.406	8.458

	Permeation Tests - 270 Days of Aging																								
	2 Hr Test											1 Hr Test			48 Hour Test										
ID	Test Date	Test ID #	Absolute Permeation Leak Rate, mg/hr	Absolute Tank Pressurization Leak Rate, mg/hr	Absolute Fuel Pump On Leak Rate, mg/hr	Relative Tank Pressurization Leak Rate, mg/hr	Relative Fuel Pump On Leak Rate, mg/hr	Innova Ethanol, mg/hr	Innova Methanol, mg/hr	Innova R134a, mg/hr	Test Date	Test ID #	Leak Rate, grams	Test Date	Test ID #	Grams - Day 1	Grams - Day 2	Grams - Total 48 Hrs	Innova - Ethanol Grams - Day 1	Innova - Methanol Grams - Day 1	Innova - R134a Grams Day 1	Innova - Ethanol Grams - Day 2	Innova - Methanol Grams - Day 2	Innova - R134a Grams Day 2
CRCE91_1E0	09/13/11	548011111177-4	55.3	117.2	105.5	62.0	11.7	0.0	0.0	0.0	09/13/11	548011111177-7	0.0730	09/13/11	548011111177-8	0.693	0.601	1.297	0.004	0.010	0.061	-0.013	0.018	0.060
CRCE91_1E20	09/13/11	548011111178-4	64.6	57.2	63.5	-7.5	6.4	0.0	0.0	0.0	09/13/11	548011111178-7	0.0949	09/13/11	548011111178-8	1.209	1.165	2.374	0.296	0.041	0.057	0.319	0.014	0.058
CRCE91_2E0	08/19/11	548011111060-4	21.3	18.2	21.5	-3.1	3.3	-2.0	3.3	4.2	08/19/11	548011111060-7	0.0593	08/19/11	548011111060-8	0.454	0.409	0.863	0.049	0.052	0.022	0.041	0.044	0.022
CRCE91_2E20	08/16/11	548011111061-4	25.1	36.2	29.9	11.1	-6.2	4.7	5.4	4.9	08/16/11	548011111061-7	0.1000	08/16/11	548011111061-8	0.885	0.772	1.657	0.344	0.038	0.020	0.305	0.042	0.027
CRCE91_3E0	08/04/11	548011111007-4	5.1	7.7	5.2	2.6	-2.5	-11.4	1.0	12.9	08/04/11	548011111007-7	0.0288	08/04/11	548011111007-8	0.094	0.101	0.194	0.018	0.016	0.042	-0.009	0.014	0.046
CRCE91_3E20	08/04/11	548011111008-4	10.4	15.7	7.6	5.3	-8.1	3.9	9.3	1.5	08/04/11	548011111008-7	0.0230	08/04/11	548011111008-8	0.136	0.129	0.129	0.090	0.030	0.026	0.000	0.030	0.026
CRCE91_4E0	07/18/11	915433	7.1	8.4	8.2	1.2	-0.2	-3.7	2.2	0.8	07/18/11	915434	0.0030	07/18/11	915434	0.050	0.040	0.090	-0.003	0.037	0.021	0.001	0.047	0.028
CRCE91_4E20	07/27/11	100971	1.2	0.9	0.3	-0.3	-0.6	-9.3	5.2	-0.6	07/27/11	915540	0.0100	07/27/11	915540	0.077	0.056	0.133	0.014	0.053	0.022	-0.006	0.087	0.031
CRCE91_5E0	01/18/12	548011120031-4	15.1	11.7	16.8	-3.3	5.1	-5.8	5.9	1.1	01/18/12	548011120031-7	0.0229	01/18/12	548011120031-8	0.160	0.143	0.303	-0.016	0.028	0.031	0.020	-0.009	0.028
CRCE91_5E20	01/18/12	548011120033-4	24.2	20.7	26.0	-3.5	5.4	4.4	10.4	4.3	01/18/12	548011120033-7	0.0852	01/18/12	548011120033-8	0.263	0.251	0.509	0.046	0.052	0.024	0.066	0.023	0.024
CRCE91_6E0	08/29/11	548011111132-4	66.9	29.9	38.3	-37.0	8.4	0.0	0.0	0.0	08/29/11	548011111132-7	0.1179	08/29/11	548011111132-8	0.467	0.389	0.856	0.011	0.012	0.020	-0.006	0.022	0.024
CRCE91_6E20	08/29/11	548011111133-4	17.2	26.4	29.9	9.3	3.5	0.0	0.0	0.0	08/29/11	548011111133-7	0.1400	08/29/11	548011111133-8	0.279	0.230	0.501	0.067	0.016	0.030	0.062	0.006	0.036
CRCE91_7E0	09/20/11	548011111210-4	32.6	49.0	56.0	16.4	7.2	0.0	0.0	0.0	09/20/11	548011111210-7	0.1861	09/20/11	548011111210-8	0.646	0.597	1.243	0.029	0.006	0.011	-0.025	0.033	0.022
CRCE91_7E20	09/20/11	548011111211-4	44.0	40.8	43.4	-3.3	2.6	0.0	0.0	0.0	09/20/11	548011111211-7	0.1115	09/20/11	548011111211-8	0.581	0.490	1.071	0.192	0.022	0.025	0.167	0.010	0.049
CRCE91_8E0	08/16/11	1296	8.8	7.2	6.9	-1.6	-0.3	-11.0	4.5	0.8	08/16/11	1304	0.0060	08/17/11	1343	0.117	0.125	0.242	0.037	0.015	0.033	0.059	0.007	0.079
CRCE91_8E20	08/12/11	1260	8.3	9.7	8.0	1.4	-1.6	-6.8	3.8	0.0	08/12/11	1263	0.0170	08/12/11	1267	0.393	0.177	0.570	0.111	0.019	0.037	0.096	0.039	0.044
CRCE91_9E0	09/23/11	548011111236-4	115.1	117.0	206.6	1.8	89.6	0.0	0.0	0.0	09/23/11	548011111236-7	0.0770	09/23/11	548011111236-8	0.694	0.355	1.048	0.000	0.018	0.025	-0.008	0.012	0.019
CRCE91_9E20	09/23/11	548011111237-4	46.0	46.7	51.4	0.7	4.7	0.1	0.0	0.0	09/23/11	548011111237-7	0.0944	09/23/11	548011111237-8	0.680	0.476	1.156	0.567	-0.006	0.016	0.442	0.014	0.014
CRCE91_10E0	08/26/11	548011111114-4	12.6	14.4	6.7	1.8	7.7	0.0	0.0	0.0	08/26/11	548011111114-7	0.0201	08/26/11	548011111114-8	0.150	0.128	0.278	0.015	0.027	0.049	0.011	0.027	0.050
CRCE91_10E20	08/26/11	548011111115-4	14.2	13.4	5.6	-0.7	-7.8	0.0	0.0	0.0	08/26/11	548011111115-7	0.0483	08/26/11	548011111115-8	0.174	0.148	0.320	0.068	0.008	0.065	0.052	0.009	0.053

	Baseline Tests - 270 Days of Aging																									
	FTP-75 Weighted Summary									1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test											
ID	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 Methanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 Methanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	10/4/2011	548011111224–4	0.0804	0.4644	329.9	0.0810	0.0133	0.0674	26.86	10/4/2011	548011111224-5	0.047	0.006	0.008	10/6/2011	548011111224-6	0.635	-0.002	0.014	0.060	0.532	0.003	0.008	0.057	1.168	24.324
CRCE91_1E20	10/4/2011	548011111225–4	0.0875	0.6684	341.9	0.0814	0.0160	0.0719	25.89	10/4/2011	548011111225-5	0.062	0.011	0.008	10/6/2011	548011111225-6	1.018	0.094	0.024	0.053	1.223	0.061	0.031	0.066	2.240	46.675
CRCE91_2E0	9/7/2011	548011111149–4	0.0788	0.7915	412.4	0.0298	0.0192	0.0606	21.50	9/7/2011	548011111149-5	0.046	0.005	0.005	9/9/2011	548011111149-6	0.325	0.019	0.050	0.027	0.341	0.036	0.031	0.024	0.666	13.878
CRCE91_2E20	9/7/2011	548011111150–4	0.0747	0.6641	401.9	0.0373	0.0208	0.0551	22.05	9/7/2011	548011111150-5	0.027	-0.004	0.008	9/9/2011	548011111150-6	0.368	0.082	0.025	0.015	0.394	0.057	0.036	0.019	0.762	15.876
CRCE91_3E0	9/15/2011	548011111192–4	0.0568	0.5025	469.4	0.0158	0.0110	0.0461	18.92	9/15/2011	548011111192-5	0.026	0.034	0.002	9/17/2011	548011111192-6	0.121	0.021	0.004	0.034	0.140	0.007	0.006	0.035	0.261	5.443
CRCE91_3E20	8/22/2011	548011111087–4	0.0263	0.3736	441.5	0.0054	0.0058	0.0207	20.08	8/22/2011	548011111087-5	0.025	NA	NA	8/25/2011	548011111087-6	0.136	0.090	0.030	0.026	0.129	0.045	0.070	0.033	0.265	5.526
CRCE91_4E0	8/23/2011	4101427	0.0132	0.0670	134.8	0.0008	0.0014	0.0119	65.63	8/23/2011	101423	0.000	-0.010	0.002	8/25/2011	101431	0.072	0.006	0.024	0.026	0.065	0.011	0.033	0.032	0.137	2.854
CRCE91_4E20	8/23/2011	4101430	0.0211	0.0777	138.8	0.0002	0.0014	0.0197	63.73	8/23/2011	101426	0.000	0.095	-0.298	8/25/2011	101434	0.099	-0.083	0.132	-0.008	0.088	0.020	0.069	0.022	0.187	3.896
CRCE91_5E0	2/13/2012	548011120108–4	0.0416	0.3964	490.4	0.0451	0.0048	0.0372	18.10	2/13/2012	548011120108-5	0.019	0.010	0.006	2/15/2012	548011120108-6	0.166	0.009	0.011	0.026	0.188	-0.001	0.015	0.038	0.354	7.372
CRCE91_5E20	2/13/2012	548011120109–4	0.0696	0.8980	498.4	0.0532	0.0098	0.0610	17.78	2/13/2012	548011120109-5	0.037	-0.039	0.020	2/15/2012	548011120109-6	0.375	-0.009	0.076	0.028	0.441	0.043	0.003	0.030	0.815	16.984
CRCE91_6E0	9/27/2011	548011111199–4	0.0686	0.4430	397.0	0.0860	0.0061	0.0647	22.34	9/27/2011	548011111199-5	0.066	0.010	0.007	9/29/2011	548011111199-6	0.505	-0.002	0.016	0.037	0.441	-0.010	0.014	0.033	0.946	19.708
CRCE91_6E20	9/27/2011	548011111200–4	0.0636	0.6046	383.7	0.0662	0.0060	0.0598	23.08	9/27/2011	548011111200-5	0.030	0.005	0.015	9/29/2011	548011111200-6	0.253	-0.001	0.027	0.084	0.210	0.022	-0.003	0.051	0.462	9.631
CRCE91_7E0	10/11/2011	548011111319–4	0.0286	0.0916	406.5	0.0874	0.0045	0.0247	21.88	10/11/2011	548011111319-5	0.046	0.005	0.000	10/13/2011	548011111319-6	0.551	0.013	0.001	0.030	0.527	-0.003	0.015	0.021	1.078	22.460
CRCE91_7E20	10/11/2011	548011111325–4	0.0332	0.3101	424.4	0.0634	0.0049	0.0290	20.94	10/11/2011	548011111325-5	0.065	NA	NA	10/13/2011	548011111325-6	0.440	NA	NA	NA	0.437	NA	NA	NA	0.877	18.264
CRCE91_8E0	9/12/2011	4101846	0.0493	0.4850	271.6	0.0288	0.0047	0.0447	32.27	9/12/2011	101847	0.003	-0.009	0.007	9/14/2011	101853	0.145	0.018	0.002	0.034	0.200	0.013	0.017	0.050	0.345	7.188
CRCE91_8E20	9/15/2011	4101945	0.0761	0.5608	264.3	0.0294	0.0071	0.0692	33.13	9/14/2011	101944	0.004	0.009	0.009	9/17/2011	101950	0.245	0.060	0.030	0.048	0.353	0.071	0.028	0.046	0.598	12.458
CRCE91_9E0	10/18/2011	548011111279–4	0.0230	0.3912	345.2	0.0315	0.0052	0.0186	25.72	10/18/2011	548011111279-5	0.023	-0.010	0.000	10/20/2011	548011111279-6	0.262	0.002	0.008	0.015	0.246	0.006	0.006	0.012	0.508	10.586
CRCE91_9E20	10/18/2011	548011111280–4	0.0132	0.2209	343.0	0.0339	0.0038	0.0099	25.89	10/18/2011	548011111280-5	0.040	0.024	0.025	10/20/2011	548011111280-6	0.294	0.071	0.007	0.013	0.255	0.058	0.002	0.010	0.549	11.447
CRCE91_10E0	9/21/2011	548011111201–4	0.0188	0.6062	373.3	0.0093	0.0024	0.0167	23.77	9/21/2011	548011111201-5	0.019	-0.014	0.011	9/23/2011	548011111201-6	0.148	0.016	0.014	0.044	0.141	0.006	0.016	0.056	0.289	6.030
CRCE91_10E20	9/21/2011	548011111222–4	0.0209	0.5947	366.6	0.0093	0.0024	0.0185	24.16	9/21/2011	548011111222-5	0.017	-0.023	0.021	9/23/2011	548011111222-6	0.164	0.038	0.002	0.062	0.163	0.012	0.017	0.075	0.327	6.817

	Permeation Tests - 360 Days of Aging																								
	2 Hr Test										1 Hr Test			48 Hour Test											
ID	Test Date	Test ID #	Absolute Permeation Leak Rate, mg/hr	Absolute Tank Pressurization Leak Rate, mg/hr	Absolute Fuel Pump On Leak Rate, mg/hr	Relative Tank Pressurization Leak Rate, mg/hr	Relative Fuel Pump On Leak Rate, mg/hr	Innova Ethanol, mg/hr	Innova Methanol, mg/hr	Innova R134a, mg/hr	Test Date	Test ID #	Leak Rate, grams	Test Date	Test ID #	Grams - Day 1	Grams - Day 2	Grams - Total 48 Hrs	Innova - Ethanol Grams - Day 1	Innova - Methanol Grams - Day 1	Innova - R134a Grams Day 1	Innova - Ethanol Grams - Day 2	Innova - Methanol Grams - Day 2	Innova - R134a Grams Day 2
CRCE91_1E0	02/23/12	548011120152-4	53.4	108.5	94.5	55.1	-14.0	-0.6	8.4	2.1	02/23/12	548011120152-7	0.107	02/23/12	548011120152-8	0.738	0.640	1.378	0.037	0.038	0.048	0.021	0.032	0.049
CRCE91_1E20	03/06/12	548011120151-4	84.3	76.6	60.8	-7.7	-15.8	21.0	19.5	5.1	03/06/12	548011120151-7	0.084	03/06/12	548011120151-8	1.038	0.953	1.986	0.272	0.046	0.075	0.300	0.021	0.063
CRCE91_2E0	01/20/12	548011120029-4	19.1	19.4	17.5	0.3	-1.8	-8.3	8.1	6.8	01/20/12	548011120029-7	0.047	01/20/12	548011120029-8	0.248	0.218	0.464	0.022	0.050	0.018	0.038	0.028	0.018
CRCE91_2E20	01/20/12	548011120057-4	21.6	29.5	210.4	7.9	180.9	-1.5	7.6	1.7	01/20/12	548011120057-7	0.077	01/20/12	548011120057-8	0.438	0.374	0.812	0.261	0.010	0.023	0.250	-0.007	0.018
CRCE91_3E0	01/12/12	548011120011-4	18.3	15.5	9.2	-2.8	-6.3	-1.5	13.9	2.9	01/10/12	548011120011-7	0.080	01/10/12	548011120011-8	0.155	0.135	0.290	0.070	0.070	0.041	0.057	0.056	0.042
CRCE91_3E20	01/12/12	548011120012-4	8.1	5.7	6.0	-2.4	0.3	-20.3	22.5	4.8	01/10/12	548011120012-7	0.022	01/10/12	548011120012-8	0.117	0.114	0.231	0.010	0.065	0.030	0.027	0.037	0.033
CRCE91_4E0	12/19/11	103514	4.0	0.6	7.3	-3.4	6.7	-4.2	0.1	0.9	12/19/11	103531	0.001	12/19/11	103534	0.050	0.036	0.086	0.010	-0.005	0.023	-0.007	0.018	0.025
CRCE91_4E20	12/28/11	103676	5.2	7.2	1.2	2.0	-6.0	-1.8	-1.2	1.2	12/16/11	103479	0.005	12/16/11	103483	0.058	0.047	0.105	0.008	0.010	0.022	0.035	-0.001	0.026
CRCE91_5E0	06/12/12	548011120493-4	15.2	13.5	13.1	-1.7	-0.4	-18.2	10.1	15.8	06/12/12	548011120493-7	0.032	06/12/12	548011120493-8	0.211	0.194	0.407	0.005	0.041	0.026	0.005	0.041	0.026
CRCE91_5E20	06/12/12	548011120494-4	26.6	22.2	27.3	-4.4	5.1	5.9	2.9	3.4	06/12/12	548011120494-7	0.038	06/12/12	548011120494-8	0.420	0.452	0.872	0.121	0.075	0.021	0.141	0.050	0.027
CRCE91_6E0	02/17/12	548011120129-4	46.4	43.8	46.1	-2.7	2.3	-3.3	4.0	3.1	02/17/12	548011120129-7	0.081	02/17/12	548011120129-8	0.478	0.403	0.833	0.012	0.012	0.031	0.009	0.012	0.019
CRCE91_6E20	02/17/12	548011120348-4	39.9	58.4	31.7	18.5	-26.7	-9.3	8.8	0.7	02/17/12	548011120130-7	0.059	02/17/12	548011120130-8	0.294	0.236	0.530	0.074	0.010	0.045	0.079	-0.007	0.048
CRCE91_7E0	03/14/12	548011120158-4	60.4	68.6	154.9	60.4	8.3	-119.7	109.0	18.4	03/14/12	548011120158-7	0.123	03/14/12	548011120158-8	0.767	0.959	1.726	0.007	0.067	0.026	-0.028	0.096	0.027
CRCE91_7E20	02/28/12	548011120159-4	49.7	49.1	54.5	-0.5	5.4	-0.4	11.3	2.8	02/28/12	548011120159-7	0.150	02/28/12	548011120159-8	0.784	0.849	1.633	0.205	0.041	0.039	0.170	0.077	0.058
CRCE91_8E0	01/17/12	7100103864	5.6	3.1	7.1	-2.4	4.0	-7.7	0.4	1.9	01/19/12	103869	0.018	01/19/12	103872	0.153	0.152	0.305	0.008	0.011	0.034	0.062	-0.002	0.042
CRCE91_8E20	01/26/12	7100104047	12.7	9.1	10.4	-3.6	1.3	0.6	-0.3	1.6	01/22/12	103942	0.030	01/22/12	103945	0.304	0.264	0.568	0.081	0.026	0.040	0.096	0.026	0.044
CRCE91_9E0	03/07/12	548011120173-4	115.1	117.0	206.6	1.8	89.6	-2.8	3.2	4.8	03/07/12	548011120173-7	0.047	03/07/12	548011120173-8	0.286	0.214	0.500	-0.023	0.036	0.014	0.002	0.014	0.006
CRCE91_9E20	02/29/12	548011120164-4	48.4	37.2	26.4	-11.2	-10.9	10.2	5.1	0.6	02/29/12	548011120164-7	0.147	02/29/12	548011120164-8	0.588	0.423	1.011	0.457	0.000	0.013	0.364	-0.019	0.008
CRCE91_10E0	02/07/12	548011120094-4	15.0	13.1	7.7	-1.9	-5.4	-0.9	2.4	3.8	02/07/12	548011120094-7	0.048	02/07/12	548011120094-8	0.167	0.142	0.309	0.043	0.030	0.043	0.017	0.039	0.069
CRCE91_10E20	02/07/12	548011120095-4	14.7	11.9	10.1	-2.8	-1.9	-56.2	62.8	12.3	02/07/12	548011120095-7	0.056	02/07/12	548011120095-8	0.183	0.153	0.337	0.032	0.060	0.065	0.008	0.048	0.071

	Baseline Tests - 360 Days of Aging																									
	FTP-75 Weighted Summary									1 Hr Hot Soak Evap Emissions Test					2 Day Variable Temperature Diurnal Evaporative Emissions Test											
ID	Date of test	Test ID #	HC, g/mi	CO, g/mi	CO2, g/mi	NOx, g/mi	CH4, g/mi	THC-CH4, g/mi	MPG	Date of test	Test ID #	FID, g	Ethanol, g	R134a, g	Date of test	Test ID #	Day#1 FID, g	Day#1 Ethanol, g	Day#1 Methanol, g	Day#1 R134a, g	Day#2 FID, g	Day#2 Ethanol, g	Day#2 Methanol, g	Day#2 R134a, g	Total 2-Day FID Result, g	Average Leak Rate, mg/hr
CRCE91_1E0	3/27/2012	548011120283-4	0.0853	0.5653	332.5	0.0788	0.0116	0.0743	26.65	3/27/2012	548011120283-5	0.056	-0.025	0.003	3/29/2012	548011120283-6	0.601	0.013	0.015	0.049	0.451	0.006	0.026	0.049	1.052	21.914
CRCE91_1E20	3/27/2012	548011120284-4	0.0805	0.7815	333.0	0.1096	0.0209	0.0614	26.55	3/27/2012	548011120284-5	0.084	0.011	0.012	3/29/2012	548011120284-6	1.125	0.172	0.040	0.063	0.758	0.155	0.007	0.063	1.883	39.235
CRCE91_2E0	2/14/2012	548011120110-4	0.0564	0.5472	410.0	0.0293	0.0150	0.0419	21.62	2/14/2012	548011120110-5	0.033	0.011	0.004	2/16/2012	548011120110-6	0.278	0.017	0.039	0.017	0.323	0.003	0.039	0.027	0.600	12.508
CRCE91_2E20	2/14/2012	548011120111-4	0.0698	0.7234	408.5	0.0411	0.0196	0.0508	21.65	2/14/2012	548011120111-5	0.045	0.016	0.006	2/16/2012	548011120111-6	0.466	0.097	0.011	0.023	0.486	0.069	0.010	0.021	0.952	19.835
CRCE91_3E0	2/3/2012	548011120078-4	0.0373	0.4641	435.5	0.0055	0.0101	0.0273	20.34	2/3/2012	548011120078-5	0.051	0.150	0.002	2/5/2012	548011120078-6	0.149	0.017	0.071	0.045	0.171	0.044	0.037	0.037	0.321	6.677
CRCE91_3E20	2/3/2012	548011120079-4	0.0354	0.3667	448.3	0.0081	0.0116	0.0240	19.80	2/3/2012	548011120079-5	0.017	-0.012	0.010	2/5/2012	548011120079-6	0.115	0.036	0.020	0.037	0.107	0.028	0.022	0.031	0.222	4.625
CRCE91_4E0	1/13/2012	1103828	0.0081	0.0551	133.5	0.0005	0.0017	0.0064	65.84	1/13/2012	103827	0.001	-0.005	0.003	1/15/2012	103833	0.086	-0.007	0.003	0.026	0.070	0.006	0.005	0.025	0.156	3.250
CRCE91_4E20	1/23/2012	1103962	0.0115	0.0571	135.0	0.0011	0.0013	0.0103	65.08	2/2/2012	104177	0.000	0.000	0.002	1/25/2012	103987	0.115	-0.008	0.002	0.025	0.100	-0.001	0.019	0.027	0.215	4.479
CRCE91_5E0	7/3/2012	548011120548-4	0.0876	1.7881	496.0	0.0510	0.0136	0.0751	17.83	7/3/2012	548011120548-5	0.009	-0.026	0.009	7/5/2012	548011120548-6	0.208	-0.004	0.047	0.032	0.216	0.011	0.030	0.029	0.423	8.817
CRCE91_5E20	7/18/2012	548011120582-4	0.0464	0.9577	511.4	0.0609	0.0101	0.0350	17.35	7/18/2012	548011120582-5	0.073	-0.004	0.008	7/20/2012	548011120582-6	0.502	0.046	0.027	0.030	0.602	0.026	0.040	0.034	1.104	23.010
CRCE91_6E0	4/4/2012	548011120313-4	0.0571	0.4286	390.6	0.0660	0.0103	0.0523	22.66	4/4/2012	548011120313-5	0.043	-0.046	0.005	4/6/2012	548011120313-6	0.502	0.021	0.010	0.029	0.414	0.006	0.005	0.029	0.916	19.089
CRCE91_6E20	5/3/2012	548011120395-4	0.0629	0.5602	385.0	0.0785	0.0070	0.0564	23.00	5/3/2012	548011120395-5	0.040	-0.984	0.099	5/5/2012	548011120395-6	0.277	-0.024	0.076	0.048	0.246	-0.015	0.043	0.048	0.523	10.886
CRCE91_7E0	4/19/2012	548011120356-4	0.0306	0.1499	425.0	0.0674	0.0048	0.0265	20.88	4/19/2012	548011120356-5	0.079	-0.007	0.014	4/21/2012	548011120356-6	0.775	0.000	0.055	0.029	1.106	-0.008	0.054	0.034	1.881	39.192
CRCE91_7E20	4/19/2012	548011120357-4	0.0910	0.6692	422.8	0.0652	0.0109	0.0816	20.92	4/19/2012	548011120357-5	0.100	0.007	0.004	4/21/2012	548011120357-6	0.952	0.022	0.047	0.046	1.227	0.009	0.054	0.048	2.178	45.385
CRCE91_8E0	3/2/2012	4104593	0.0695	0.4624	270.3	0.0355	0.0053	0.0643	32.42	3/2/2012	104591	0.014	0.009	0.010	3/4/2012	104596	0.229	-0.030	0.068	0.100	0.268	0.017	0.011	0.121	0.497	10.354
CRCE91_8E20	2/20/2012	4104463	0.0530	0.5460	278.0	0.0327	0.0063	0.0469	31.52	2/20/2012	104458	0.006	-0.015	0.008	2/25/2012	104467	0.237	0.006	0.082	0.102	0.257	0.049	0.038	0.155	0.494	10.292
CRCE91_9E0	4/3/2012	548011120298-4	0.0207	0.3600	344.4	0.0245	0.0028	0.0183	25.76	4/3/2012	548011120298-5	0.029	0.003	0.023	4/5/2012	548011120298-6	0.301	0.008	0.011	0.012	0.334	0.006	0.010	0.005	0.635	13.229
CRCE91_9E20	4/3/2012	548011120299-4	0.0187	0.2833	346.8	0.0382	0.0060	0.0136	25.55	4/3/2012	548011120299-5	0.056	0.080	0.005	4/5/2012	548011120299-6	0.339	0.069	0.011	0.009	0.341	0.053	0.013	0.011	0.680	14.157
CRCE91_10E0	3/13/2012	548011120174-4	0.0192	0.3201	360.7	0.0075	0.0020	0.0176	24.56	3/13/2012	548011120174-5	0.025	-0.016	0.032	3/15/2012	548011120174-6	0.156	0.034	0.015	0.076	0.156	0.034	0.015	0.076	0.312	6.498
CRCE91_10E20	3/13/2012	548011120175-4	0.0173	0.4017	353.5	0.0096	0.0027	0.0152	25.03	3/13/2012	548011120175-5	0.033	-0.022	0.018	3/15/2012	548011120175-6	0.193	0.030	0.014	0.077	0.176	0.017	0.019	0.076	0.369	7.689