

CRC Research on Mid-Level Ethanol Blends

What is CRC?

- **The Coordinating Research Council (CRC) is a non-profit organization, established in 1942, that:**
 - **Directs, through committee action, engineering and environmental studies on the interactions of transportation fuels with vehicles and engines.**
- **The objective of CRC is:**
 - **To encourage and promote the arts and sciences by directing scientific cooperative research to develop the best possible combinations of fuels, lubricants, and the equipment in which they are used,**
 - **To afford a means of cooperation with the government on matters of national or international interest.**
- **Through CRC, professionals in the automotive and in the energy industries collaborate in research and often coordinate with government agencies such as DOE, EPA and others.**

Background -- CRC's Comprehensive E10+ Program

- **Drivers for undertaking an E10+ research program**
 - RFS mandates
 - Need to assess both vehicle emissions and performance (customer-related) impacts
- **Comprehensive program started in 2008 and is still underway**
 - Auto and oil industries led development
 - Other stakeholders included through a coordination group
 - CRC program consistent with EPA's June 2008 presentation on waiver approval requirements

EPA's E15 Partial Waivers

- **E15 allowed in 2001 and newer model year vehicles**
 - Not allowed in: pre-2001 vehicles, all heavy-duty, motorcycles and non-road equipment
- **E15 increases ethanol by 50% over earlier permissible levels**
 - Auto warranty concerns
 - Auto companies responses to Rep. Sensenbrenner
- **Lawsuit filed in DC Circuit Court by several groups**
 - Supreme Court likely to decide next steps

Excerpts from Auto Responses

	E15 Warranty	Excerpts from Sensenbrenner Response
Chrysler	No	We are not confident that our vehicles will not be damaged by E15
Ford	No	Ford does not support the introduction of E15 into the marketplace for the legacy fleet
General Motors	No	We are not confident that our vehicles will be undamaged by the use of E15.
Mercedes-Benz	No	Any ethanol blend above E10, including E15, will harm emission control systems in M-B engines
Honda	No	Vehicle engines were not designed or built to accommodate higher concentrations of ethanol
Mazda	No	The record fails to demonstrate that motor vehicles would not be damaged
Toyota	No	Toyota cannot recommend the use of fuel with greater than E10 for Toyota vehicles

Excerpts from Auto Responses

	E15 Warranty	Excerpts from Sensenbrenner Response
Nissan	No	We are not at all confident that there will not be damage to MY 2001 and later vehicles with E15
Volkswagen	No	Volkswagen agrees that EPA did not conduct an adequate test program when E15 was considered
Volvo	No	The risks related to emissions are greater than the benefits in terms of CO2 when using low-blend E15 for variants that are designed to E10.
BMW	No	The BMW Group engines and fuel supply systems can be damaged by misfueling with E15.
Hyundai	No	The EPA tests failed to conclusively show that the vehicles will not be subject to damage or increased wear.
Kia	No	EPA testing failed to determine that vehicles will not be subject to damage or increased wear.

2012 - 2013 Vehicle Gas Cap Warning



CRC Fuel Systems Durability Study

- **Objective:**
 - Determine if E20 or E15 blends could affect fuel system components which would potentially have a significant customer impact
- **Tests conducted in 2 phases**
 - Employed established testing procedures widely used within the automotive industry to evaluate and predict new product life
- **Components from 5 post-2001 model year vehicles tested in second phase (in model year order):**
 - 2001 Chevrolet Cavalier
 - 2003 Nissan Maxima
 - 2004 Ford Focus
 - 2004 Ford Ranger
 - 2007 Nissan Altima

How Were the Tests Conducted?

- Tests were done on fuel pumps and fuel level systems on popular post-2001 gasoline light-duty vehicles with actual fleet penetration likely greater than 29 million vehicles
- Fuel Pump System testing protocols
 - Soak (i.e., immersion)
 - Endurance test (i.e., “continuous” operation)
- Fuel Level System testing protocols
 - Measured changes in electrical signals going to fuel gauge and check engine light

Fuel Pump Durability Results

- Some pump systems passed with no problems on E15
- Other pump systems failed or exhibited other adverse effects on E15, but not E10 or E0
- E15 caused swelling in some pump impellers that moves fuel into the fuel line
- Showed obvious loss of vanes as a result of jamming against its housing that caused flow to halt



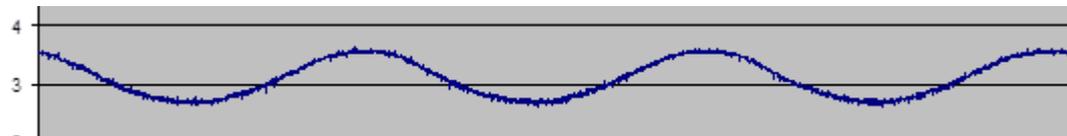
Example: Vanes actually broke off portions of the impeller

Fuel Level System Durability Testing Results

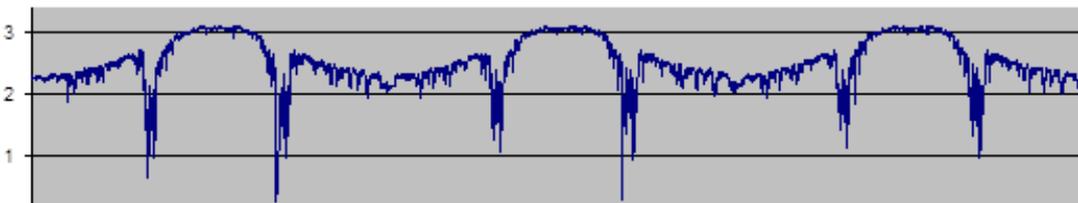
- Some systems operated on E15 with no problems
- Others resulted in “dirty” signals with E15, but not E10 or E0
- Fuel level system units must have a clean signal without spikes or open circuits. Dirty signals can cause erratic/false fuel gauge readings and/or malfunctioning on-board diagnostics (i.e., check engine lights).

Examples:

Acceptable signal



**Unacceptable
“dirty” signal**



CRC Engine Durability Study

- **Objective:**
 - Determine if E20 or E15 blends could affect engine components (e.g., valves, valve seats and guides) which would potentially have a significant customer impact.
- **8 Vehicles Tested (in duplicates):**
 - 2001 Honda CR-V, 2.0L I4
 - 2002 VW Jetta, 2.0L I4
 - 2004 Toyota Scion xA, 1.5L I4
 - 2005 Chevrolet Colorado, 3.5L I5
 - 2007 Ford Edge, 3.5L V6
 - 2007 Dodge Ram, 5.7L V8
 - 2009 Dodge Caliber, 2.4L I4
 - 2009 Chevrolet Aveo, 1.6L I4

Engine Durability Test Results

(Note: Vehicle No. Unrelated to Listing Order in Prior Slide)

Description (All Duplicates)	E20	E15	E0
Vehicle 1	Passed	Not Req'd	Not Req'd
Vehicle 2	Failed	Failed	Passed
Vehicle 3	Failed	Failed	Passed
Vehicle 4	Deemed Pass*	Not Req'd	Not Req'd
Vehicle 5	Deemed Pass*	Not Req'd	Not Req'd
Vehicle 6	Deemed Pass*	Not Req'd	Not Req'd
Vehicle 7	Passed	Not Req'd	Not Req'd
Vehicle 8	Failed	Failed	Failed**

*Deemed Pass vehicles did not pass all specified criteria but were not tested on E15 or E0 after a detailed review of the data with the respective OEM and CRC concluded that fuel was not a factor.

** Failure was less severe than on E20 or E15.

CRC Engine Durability Study – Conclusions

- The CRC engine durability study showed that some engines passed on E20 and E15.
- However, two popular gasoline engines used in light-duty automotive applications of vehicles from model years 2001 through 2009 failed with mechanical damage when operated on intermediate-level ethanol blends (E15 and E20).
 - Valve and valve seat damage
 - Consequence: Loss of compression, excess emissions, poor performance, engine repair
- Millions of vehicles on the road today have the same or characteristics similar to the two that failed.

Other CRC Mid-Level Ethanol Blends Projects

- **Evaporative Emissions Control Systems Durability on E20**
 - 2 of 10 vehicles showed increased evaporative emissions, but did not exceed certification standards
- **On-Board Diagnostics (OBD)**
 - Continued investigation of potential for false check engine light illuminations
- **Overview Report on the Entire CRC and Other Mid-Level Ethanol Blends Programs**

Conclusions

- **We have great confidence in the automotive engineers who sit on CRC committees and who design engines, emissions control systems and fuel systems to come up with the right tests to evaluate the effects of E15 in our customers' vehicles.**
- **CRC has been doing this kind of research for over 70 years – often with the participation and support of the ethanol industry and government agencies. CARB, EPA, RFA, DOE, Growth Energy, ASTM, and several states have all chosen CRC to execute similar projects over the years, so clearly CRC work is highly valued.**
- **CRC Final Reports available at <http://www.crcao.org>**