Ford Motor Company

Automotive Safety Office
Environmental and Safety Engineering

December 12, 2005

Ms. Kathleen C. DeMeter, Director
Office of Defects Investigation Safety Assurance
National Highway Traffic Safety Administration
400 Seventh Street, S.W.
Washington, D.C. 20590

Dear Ms. DeMeter:

Subject: DP05-005 – Request for Information

In a December 1, 2005 e-mail communication, Cheryl Rose of your office requested that Ford Motor Company (Ford) provide information relating to DP05-005. Answers to these specific questions are set forth below. In our usual manner, after each numeric designation, we have set forth verbatim the request for information, followed by our response.

1. The importance of having a specific air to fuel ratio in the combustion cycle.

Air-fuel ratio is important from two perspectives - (a) combustion limits and (b) functional attributes of combustion.

(a) Combustion limit:
Lean limit - the maximum air to fuel ratio at which combustion is possible; above this limit there is too much air and combustion is virtually quenched by the excess air.
Rich limit - the minimum air to fuel ratio at which combustion is possible; below this limit there is too much fuel and combustion is not possible.

(b) The functional attributes of combustion include emissions, performance, and fuel efficiency. Within the combustion limits there is an ideal mixture called stoichiometry that is the ideal mixture of fuel and air where all fuel is converted to CO_2 and H_2O. Above stoichiometry (lean), fuel efficiency is a little better but tailpipe emissions degrade because catalyst function is degraded; below stoichiometry (about 10% rich) power is better, but emissions are degraded. Managing air-fuel ratio is then a balancing act with respect to fuel economy, emissions, and performance.

If an air fuel mixture is outside the combustion limits there will be no combustion.

2. How this specific air to fuel ratio is affected when the spark plug/ignition coil pack assembly comes loose from an engine cylinder, including how this impacts the potential for unburnt fuel to ignite.

The potential for unburnt fuel to ignite is minimal because the air-fuel mixture would not likely be within combustion limits. When the air-fuel mixture exits the chamber, it is diluted by the atmosphere and is significantly above the lean limit. The potential for combustion would be virtually quenched by the excess air.

3. How the On-Board Diagnostics (OBD) detect a misfire within an engine cylinder.

On-Board Diagnostics (OBD) uses a notched wheel with a magnetic sensor that is mounted to the end of the crankshaft, which allows the engine computer to continually calculate the acceleration of the crankshaft. Misfires create instantaneous decelerations in the crankshaft that are measurable by the engine computer. The number of misfiring combustion cycles are then counted and algorithms evaluate the resulting effect on emissions. This logic is largely prescribed by the Environmental Protection Agency, not the manufacturer.

4. What happens to the fuel injection process within a particular engine cylinder once a misfire is detected by the OBD, including how this impacts the potential for unburnt fuel to ignite.

When the computer algorithm evaluates that there is too much misfire (as prescribed by the regulation) the fuel to the cylinder is turned off for over a minute. The computer makes one more attempt to activate fuel to determine if the misfire continues. If misfire continues, the fuel to that cylinder is turned off permanently with the intent that the customer will have the vehicle serviced.

In addition to the above requested information, in our December 1, 2005 phone conversation, Ms. Rose also requested clarification of information regarding specific manufacturing process changes, implementation dates and engine management strategies related to this subject. The following questions, followed by our response specifically address that request.

1. Provide more detail on the tooling change and process changes that took place in 1999 and 2001 as an interim fix for the cross-threading issue on the V-engines.

Original process:
Step 1 - Zero torque spark plug (air tool)
Step 2 - Torque to 16-20Nm final torque (DC Run down), monitor at 6-12Nm, and final torque must be reached within 0-360 degrees.

New process: (addressed the possibility of applying installation torque for more than 25 degrees of rotation)
Step 1 - Zero torque spark plug (air tool).
Step 2 - Torque to 16-20Nm final torque (DC Run down) start monitor at 6-12Nm, and final torque must be reached within 3-25 degrees.

The other major action to address cross threading was the addition of an alignment feature to lead the plug into the hole.

2. Provide incorporation dates for the implementation of longer threads on the 4.6L, 5.4L, and 6.8L engines

Timeline - reference launch dates for engines.
96MY 4.6L 2V launched at Windsor Engine Plant (WEP) (limited production every year thru 04MY-short thread)

97MY	5.4L 2V launched at WEP (short thread)
97MY	6.8L 2V launched at WEP (short thread)
99MY	5.4L 4V launched at WEP (short thread)
01.5MY	5.4L 4V production moved to REP (short thread)
04MY	5.4L 3V launched at WEP (long thread)
05MY	4.6L 3V launched at REP (long thread)
05MY	6.8L 3V launched at WEP (long thread)

Timeline for 2v/4v plug thread changes:
December 1996 - 4.6L 4V head alignment feature added
February 1997 - 4.6L 2V head alignment feature added
September 2000 - WEP 2V head alignment feature modified (4.6L, 5.4L and 6.8L)
November 2002 – WEP introduced long threads on 2V (no 4V at WEP)(4.6L, 5.4L and6.8L)
May 2003 - REP introduced long threads on 4V (4.6L and 5.4L)
November 2003 - REP introduced long threads on 2V and modified alignment feature

3. Provide the time of detection of misfire vs. the time when fuel is shut off to a cylinder.

The Failure Mode Effects Management (FMEM) activates as soon as the PCM determines that a misfire is taking place. The longest lead calculations are those for catalyst damage. At 2000 rpm, it would take no more than 6 seconds for the fuel to shut off to a cylinder. The same calculation at 4000 rpm would shut off the fuel in no more than 3 seconds.

4. Could a plug still be sparking after an alleged ejection? For how many cycles would this continue?

The FMEM does not shut off spark, only fuel, so the coil is still being energized. For arching across the electrode, the spark plug needs to be grounded. If the plug is ungrounded but close enough to another ground source a spark could possibly discharge between the electrode and that ground. That distance needs to be comparable to the plug gap, as that distance grows the probability of sparking decreases.

If you have any further questions, please contact me.

Sincerely,

R. A. Nevi

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Assistant Director
Global Automotive Safety Compliance