

*Ford Motor Company*

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Automotive Safety Office  
Environmental & Safety Engineering

January 9, 2009

Ms. Kathleen C. DeMeter, Director  
Office of Defects Investigation Safety Assurance  
National Highway Traffic Safety Administration  
1200 New Jersey Avenue, S.E., W45-302  
Washington, DC 20590

Dear Ms. DeMeter:

Subject: PE08-063:NVS-212pco

The Ford Motor Company (Ford) response to the agency's November 6, 2008, letter concerning reports of alleged improper operation of the natural gas fuel pressure regulator resulting in excess release of natural gas into the engine compartment on 2003 and 2004 model year F-150 Series dual fuel natural gas vehicles (NGVs), and all other F-150 vehicles with the same subject component, is attached. Ford notes that the subject component was introduced into production in November 2001 on 2002 model year F-150 dual fuel NGVs. Because the prior level component is substantially the same as the subject component, Ford's response to this information request includes information pertaining to 1998 through 2004 model year dual fuel F-150 NGVs.

Natural gas is generally considered a safe, non-toxic fuel for motor vehicles. Compared to other common motor vehicle fuels such as gasoline or diesel fuel, natural gas has significantly higher upper and lower flammability limits and a significantly higher autoignition temperature. Furthermore, because natural gas is lighter than air it has a propensity to rise and rapidly disperse when released into the atmosphere and, because natural gas is odorless, an odorant is added to provide a ready means of leak detection at extremely low concentration levels when compared to the its lower flammability limit. Natural is not toxic to humans and poses no threat to soil, surface water, or groundwater.

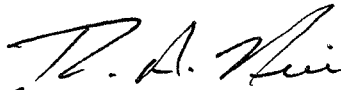
The subject vehicles include various features that complement the safe characteristics of natural gas in the event of a leak from the subject component. For example, the flow of natural gas from the storage tank is shut off whenever the vehicle is turned off, when the key is in the on position and the engine is not running, and when the vehicle is operating in gasoline mode, regardless of the position of the fuel selector switch located on the dashboard. Additionally, the subject vehicles are equipped with a vent tube that routes any vented natural gas from the fuel pressure regulator's pressure relief valve outside the engine compartment where it can quickly disperse into the atmosphere.



The circumstances associated with a natural gas leak from a fuel pressure regulator on the subject vehicles result in low concentration levels that present extremely low theoretical risk of combustion or inhalation risk, even in an enclosed area. Despite the number of reports of regulator valve leaks and valve replacements on these vehicles, the dearth of reports of fires, accidents, or injuries related to this subject with some of these vehicles having been in service for as long as ten years, supports this conclusion. Because of the very low probability of the occurrence of a combustible mixture of natural gas occurring in the presence of a suitable ignition source, and the non-toxic nature of natural gas, the subject of this information request does not pose an unreasonable risk to vehicular or human safety.

If you have any questions concerning this response, please feel free to contact me.

Sincerely,



James P. Vondale

Attachment

FORD MOTOR COMPANY (FORD) RESPONSE TO PE08-063

Ford's response to this Preliminary Evaluation information request was prepared pursuant to a diligent search for the information requested. While we have employed our best efforts to provide responsive information, the breadth of the agency's request and the requirement that information be provided on an expedited basis make this a difficult task. We nevertheless have made substantial effort to provide thorough and accurate information, and we would be pleased to meet with agency personnel to discuss any aspect of this Preliminary Evaluation.

The scope of Ford's investigation conducted to locate responsive information focused on Ford employees most likely to be knowledgeable about the subject matter of this inquiry and on review of Ford files in which responsive information ordinarily would be expected to be found and to which Ford ordinarily would refer. Ford notes that although electronic information was included within the scope of its search, Ford has not attempted to retrieve from computer storage electronic files that were overwritten or deleted. As the agency is aware, such files generally are unavailable to the computer user even if they still exist and are retrievable through expert means. To the extent that the agency's definition of Ford includes suppliers, contractors and affiliated enterprises for which Ford does not exercise day-to-day operational control, we note that information belonging to such entities ordinarily is not in Ford's possession, custody or control.

Ford has construed this request as pertaining to vehicles manufactured for sale in the United States, its protectorates and territories. Also, in the agency's information request, the subject vehicles were defined as "all 2003 -2004 dual fuel capable F-150 vehicles and all other F-150 Series vehicles equipped with the same subject component." The subject component was introduced into production in November 2001 on 2002 model year F-150 dual fuel natural gas vehicles (NGVs). Because the prior level component is substantially the same as the subject component, Ford's response to this information request includes information pertaining to 1998 through 2004 model year dual fuel F-150 NGVs.

Ford notes that some of the information being provided pursuant to this inquiry may contain personal information such as complete Vehicle Identification Numbers (VINs). Ford is producing such personal information in an unredacted form to facilitate the agency's investigation with the understanding that the agency will not make such personal information available to the public under FOIA Exemption 6, 5 U.S.C. 552(b)(6).

Answers to your specific questions are set forth below. As requested, after each numeric designation, we have set forth verbatim the request for information, followed by our response. Unless otherwise stated, Ford has undertaken to provide responsive documents dated up to and including November 6, 2008, the date of your inquiry. Ford has searched within the following offices for responsive documents: Ford Customer Service Division, Marketing and Sales Operations, Global Core Engineering, Office of the General Counsel, and Product Development.

Ford's responses to request numbers one through seven were previously provided to the agency on December 18, 2008.

Request 8

Describe all assessments, analyses, tests, test results, studies, surveys, simulations, investigations, inquiries and/or evaluations (collectively, "actions") that relate to, or may relate to, the alleged defect in the subject vehicles that have been conducted, are being conducted, are planned, or are being planned by, or for, Ford. For each such action, including the results and findings from the returned CNG fuel regulator by the complainant to Wickstram Ford in Barrington, Ill, provide the following information:

- a. Action title or identifier;
- b. The actual or planned start date;
- c. The actual or expected end date;
- d. Brief summary of the subject and objective of the action;
- e. Engineering group(s)/supplier(s) responsible for designing and for conducting the action; and
- f. A brief summary of the findings and/or conclusions resulting from the action.

For each action identified, provide copies of all documents related to the action, regardless of whether the documents are in interim, draft, or final form. Organize the documents chronologically by action.

Answer

Ford is construing this request broadly and is providing not only studies, surveys, and investigations related to the alleged defect, but also notes, correspondence, and other communications that were located pursuant to a diligent search for the requested information. Ford is providing the responsive non-confidential Ford documentation in Appendix F on the enclosed CD.

To the extent that the information requested is available, it is included in the documents provided. If the agency should have questions concerning any of the documents, please advise.

Ford is submitting additional responsive documentation as Appendix G with a request for confidentiality under separate cover to the agency's Office of the Chief Counsel pursuant to 49 CFR, Part 512. Additionally, Ford is providing a privilege log identifying responsive documents that have been withheld from production on the grounds that they are protected by attorney-client privilege in Appendix H on the enclosed CD.

In the interest of ensuring a timely and meaningful submission, Ford is not producing non-responsive materials or items containing little substantive information. Examples of the types of materials not being provided are meeting notices, raw data lists (such as part numbers or VINs) without any analytical content, duplicate copies, non-responsive elements of responsive materials, and draft electronic files for which later versions of the materials are being submitted. Through this method, Ford is seeking to provide the agency with substantive responsive materials in our possession in the timing set forth for our response. We believe our response meets this goal. Should the agency request additional materials, Ford will cooperate with the request.

The agency requested information pertaining to "results and findings from the returned CNG fuel regulator by the complainant to Wickstram Ford in Barrington, Ill." Although Ford received one fuel regulator from Wickstram Ford that was reportedly removed from the vehicle referenced in VOQ #10241036, records are insufficient to identify the specific regulator among those that have been evaluated by the supplier. Ford notes that regulators from other subject vehicles were obtained and disassembled in association with a September 2008 filing with the Environmental Protection Agency (EPA). Documents relating to analysis of those regulators are provided in Appendix G.

#### Request 9

Describe all modifications or changes made by, or on behalf of, Ford in the design, material composition, manufacture, quality control, supply, or installation of the subject component, from the start of production to date, which relate to, or may relate to, the alleged defect in the subject vehicles. For each such modification or change, provide the following information:

- a. The date or approximate date on which the modification or change was incorporated into vehicle production;
- b. A detailed description of the modification or change;
- c. The reason(s) for the modification or change;
- d. The part numbers (service and engineering) of the original component;
- e. The part number (service and engineering) of the modified component;
- f. Whether the original unmodified component was withdrawn from production and/or sale, and if so, when;
- g. When the modified component was made available as a service component; and
- h. Whether the modified component can be interchanged with earlier production components.

Also, provide the above information for any modification or change that Ford is aware of which may be incorporated into vehicle production within the next 120 days.

#### Answer

A table of the requested changes is provided in Appendix I on the enclosed CD.

#### Request 10

Provide an overall functional diagram along with cross sectional view of the fuel regulator to illustrate and describe the operation of the CNG fueled vehicle during normal engine startup and during vehicle operation including the operation and function of the CNG fuel regulator and the high pressure relief valve. What is the CNG tank pressure range during vehicle storage? What are the operating gas pressure ranges prior to and during engine startup and during normal vehicle operation? Is there a pressure gage in the instrument panel or any high pressure/low pressure warning indicator?

#### Answer

Overall functional diagrams and descriptions of operation of the natural gas fuel system on the subject vehicles are provided in Appendix J on the enclosed CD, organized by model year. Ford notes that it was unable to locate system description information for 1998 model year subject vehicles: however, system operation for these vehicles is substantively the same as for

1999 model year subject vehicles for which information is provided in Appendix J. Cross sectional views of the subject component with both the flat diaphragm design and the rolled diaphragm design, and descriptions of operation of the fuel pressure regulator and the pressure relief valve are also provided in Appendix J.

The natural gas storage tank pressure range is 0-3600 psig. When the engine is not running the storage tank valve is closed, isolating tank pressure from the rest of the fuel system. The fuel rail operating gas pressure range prior to and during engine startup and during normal vehicle operation is 60-150 psig. If the fuel rail pressure drops below 45-75 psig during vehicle operation, the storage tank valve will close and the vehicle will automatically switch to gasoline operation mode. If the pressure rises above 175 psig the pressure relief valve within the regulator will open and natural gas will be exhausted out of the engine compartment through a vent hose until the pressure drops below 175 psig at which time the pressure relief valve will close. Descriptions of operation of the fuel gage, the Alt/Gas indicator, and the malfunction indicator lamp are also provided in Appendix J.

#### Request 11

Produce one each of the following:

- a. Exemplar sample of each base design version of the subject component and the next design version;
- b. Field return sample of the subject component exhibiting the subject failure mode; and
- c. Any kits that have been released, or developed, by Ford for use in service repairs to the subject component/assembly which relate, or may relate, to the alleged defect in the subject vehicles.

#### Answer

One exemplar sample of the subject component, Fuel Pressure Regulator Assembly, part number 2L3Z-9C968-AB, is included with this submission. Also, one field return sample, (Serial #001543), is included with this submission. Based on results of a flow test conducted by the supplier, Ford believes that this sample is representative of other field return samples that have been identified with pintle damage. Because disassembly of a regulator will cause damage to certain internal components, this regulator has not been disassembled by either Ford or the supplier and is being provided to the agency fully assembled. Ford has not released any service kits related to the subject component.

#### Request 12

State the number of each of the following that Ford has sold that may be used in the subject vehicles by component name, part number (both service and engineering/production), model and model year of the vehicle in which it is used and month/year of the sale (including the cut-off date for sales, if applicable):

- a. Subject component; and
- b. Any kits that have been released, or developed, by Ford for use in service repairs to the subject component/assembly.

For each component part number, provide the supplier's name, address, and appropriate point of contact (name, title, and telephone number). Also identify by make, model, model year and number sold, any other vehicles of which Ford is aware that contain the

identical component, whether installed in production or in service, and state the applicable dates of production or service usage.

Answer

As the agency is aware, Ford service parts are sold in the U.S. to authorized Ford and Lincoln-Mercury dealers. Ford has no means by which to determine how many of the parts were actually installed on vehicles, the vehicle model or model year on which a particular part was installed, the reason for any given installation, or the purchaser's intended use of the components sold. During the course of Ford's investigation dealers have indicated that this service replacement regulator is frequently sold over the counter and, based on phone conversations, in one instance allegedly for a vehicle application other than the subject vehicles, implying that this component may be used in aftermarket conversion kits of which Ford is unaware.

Ford is providing the total number of Ford service replacement Fuel Pressure Regulator Assemblies by part number (both service and engineering) and year or month of sale, where available, as of November 24, 2008, in electronic form in Appendix K on the enclosed CD. Information pertaining to production and service usage for each part number, and supplier point of contact information is also included in Appendix K.

Request 13

Furnish Ford's assessment of the alleged defect in the subject vehicle, including:

- a. The causal or contributory factor(s);
- b. The failure mechanism(s);
- c. The failure mode(s);
- d. The risk to motor vehicle safety that it poses;
- e. What warnings, if any, the operator and the other persons both inside and outside the vehicle would have that the alleged defect was occurring or subject component was malfunctioning; and
- f. The reports included with this inquiry

Answer

Natural gas is generally considered a safe, non-toxic fuel for motor vehicles. According to information from the Alternate Fuel Vehicle Institute, natural gas has a higher fuel-to-air ratio requirement for combustion (4% - 16%) than either gasoline (1.3% - 7.6%) or diesel fuel (0.3% - 10%). Natural gas also has a substantially higher autoignition temperature (1,100 °F) than the 630 °F for gasoline and 125 °F for diesel fuel. Furthermore, because natural gas is lighter than air, it has a propensity to rise and rapidly disperse when released into the atmosphere resulting in lower concentration levels in contrast to gasoline and diesel fuel vapors that are heavier than air and tend to pool.

Because natural gas is odorless, an odorant is added to provide a ready means of leak detection at extremely low concentration levels. According to The International Association of Natural Gas Vehicles (IANGV), "an average person can easily detect the smell of natural gas at a concentration as low as 0.3% by volume in air." This concentration is more than 12 times lower (or over 90% lower) than the lower flammability limit for natural gas of 4%.

Natural gas leaks from a fuel pressure regulator on the subject vehicles could occur because of improper connection at an o-ring or fitting or malfunction within the regulator. In either case, Ford believes that natural gas leaks from a regulator on these vehicles would not likely result in concentration levels that would support any type of combustion or risk from inhalation.

In early 2008, Ford initiated actions to retrieve and analyze fuel pressure regulators from 2003 model year dual fuel NGVs in support of Ford's September 2008 submission of an Emission Defect Information Report to the EPA. Based on analysis of these regulators, Ford found that pintle seat damage or pintle stem fracture could occur. Higher pressure pulsations resulting from a new fuel management system introduced for the 2003 model year in combination with reduced lateral stability of the pintle valve within the regulator from a new rolling diaphragm design introduced in November 2001 appear to be principal factors in the observed pintle related damage. Changes in system pressure resulting from pintle damage may result in automatic switchover to gasoline mode while the vehicle is running, may result in the inability of the vehicle to start in natural gas mode, or the engine may exhibit driveability symptoms such as rough running and hesitation and, especially in the case of a fractured pintle stem, noisy operation of the pressure regulator would provide clear indication that vehicle service is required. This noise is generally referred to as a popping noise by an operator or technician. These related symptoms would no longer be present if an operator switched to gasoline operation, also providing indication that natural gas system service is required.

There will be no expulsion of natural gas from a regulator with a damaged pintle as long as the regulator pressure remains below 175 psig, although the malfunction indicator light on the instrument cluster will illuminate if the pressure rises to 150 psig. If the regulator pressure exceeds 175 psig, the regulator's pressure relief valve will open and natural gas will vent out the pressure relief valve through a vent hose outside the engine compartment until the pressure drops below 175 psig, at which point the pressure relief valve will close. The subject vehicles were built with a vent tube that routes vented natural gas from the regulator's pressure relief valve to a location outside the engine compartment where it is released into the atmosphere and quickly disperses. While a vehicle operator may detect an odor associated with this condition while driving and conclude that service is required, it would be an extremely remote set of circumstances under which a sufficient concentration level anywhere near that required for combustion in the presence of any ignition source could exist.

Should there be a natural gas leak at the regulator because of some other type of condition, such as from an improper connection relating to an o-ring or fitting, no appreciable build-up of natural gas concentration under the hood would be expected because of the slow leak rate and the propensity for natural gas to rise and disperse quickly. Again, while a vehicle operator may detect an odor associated with this condition and conclude that service is required, there is no reason to believe that a sufficient concentration level anywhere near that required for combustion in the presence of any ignition source could exist.

If a vehicle with a natural gas leak from the regulator is parked with the engine off, the maximum amount of gas that could be expelled from the vehicle would be limited to that contained within the fuel lines between the storage tank and the fuel rail, because the storage tank valve will be closed when the engine is not running, isolating tank pressure from the rest of the fuel system. With respect to the subject vehicles, the fuel line volume has been estimated to be approximately 300 ml. Even if the vehicle is parked in a very small garage of 10 feet wide by 18 feet long and 8 feet high, the maximum fuel to air ratio that could exist would be only 0.2%, which is 95% below the lower flammability limit of 4%. Additionally, the odorant added to natural gas is a ready means of leak detection that alerts anyone that may be nearby to the existence of a natural gas leak at an extremely low level of concentration when compared to its



lower flammability limit. Should a vehicle with a natural gas leak from the regulator for some reason be indoors with the engine running, the odorant would again provide an operator or technician notable indication to take appropriate remedial action which would be to simply turn off the engine which would stop the flow of natural gas from the storage tank. The records included with this response indicate operators and technicians frequently become aware of the existence of a natural gas leak on the subject vehicles based on the natural gas odor. As explained in Appendix J, the subject vehicles have built-in safety features that will automatically stop the flow of natural gas from the storage tank when the vehicle is turned off, when the key is in the on position and the engine is not running, or when the vehicle is operating in gasoline mode, regardless of the position of the fuel selector switch located on the dashboard.

As previously stated, in addition to the requirement for a narrow range of fuel to air ratio of between 4% and 16%, an ignition source with a temperature of at least 1,100 °F must also be present for combustion of natural gas to occur. Considering that the fuel pressure regulator on the subject vehicles is located near the top of the engine compartment, the fact that the regulator's pressure relief valve is vented outside the engine compartment, and the extremely low concentration levels that can exist because of the propensity for natural gas to rise and rapidly disperse when released into the atmosphere, it is extremely unlikely for any combustion of natural gas from a leaking regulator to ever occur on these vehicles. In fact, a review of the reports provided with this response finds none that allege any type of fire relating to this subject. Only one report of an engine compartment fire was found with no allegation or any evidence indicating the source of the alleged engine compartment fire relates to natural gas. In fact, this incident was originally reported as an accident, and was not reported to Ford until over two months after the alleged incident occurred.

In the opening resume for this preliminary evaluation, the agency stated that natural gas is toxic to humans. According to the U.S. Department of Energy Alternative Fuels and Advanced Vehicles Data Center, natural gas "is non-toxic, non-corrosive, and non-carcinogenic," (emphasis added) and "it presents no threat to soil, surface water, or groundwater." The IANGV supports this assessment, stating that "natural gas has no known toxic or chronic physiological effects." They further state that "exposure to a moderate concentration may result in a headache or similar symptoms due to oxygen deprivation but it is likely that the smell would be detected well in advance of concentrations being high enough for this to occur." Natural gas is classified as a simple asphyxiant, meaning that inhalation is the primary route of exposure and that any related symptoms are caused by oxygen deficiency because of the displacement of oxygen. As discussed above, the dispersion characteristics of natural gas make it unlikely that any leak from a regulator on these vehicles would result in concentration levels that would present any inhalation risk.

The circumstances associated with a natural gas leak from a regulator on these vehicles result in low concentration levels that present extremely low theoretical risk of combustion or inhalation risk, even in an enclosed area. Despite the number of reports of regulator valve leaks and valve replacements on these vehicles, the dearth of reports of fires, accidents, or injuries related to this subject with some of these vehicles having been in service for as long as ten years, supports this conclusion. Because of the very low probability of the occurrence of a combustible mixture of natural gas occurring in the presence of a suitable ignition source, and the non-toxic nature of natural gas, the subject of this information request does not pose an unreasonable risk to vehicular or human safety.

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