



June 30, 2010

Scott Yon, Chief  
Vehicle Integrity Division  
Office of Defects Investigation  
National Highway Traffic Safety Administration  
1200 New Jersey Ave., S. E., Room W46-409  
Washington, D.C. 20590

N100150

NVS-212jfa  
PE10-015

Dear Mr. Yon:

This letter is General Motors (GM) response to your Preliminary Evaluation (PE) questions, dated May 20, 2010 to investigate allegations of gasoline or gasoline fuel vapor leaking from either the fuel tanks or fuel tank crossover tube/hose assembly in model year (MY) 2004 Chevrolet Corvette vehicles manufactured by GM.

Your requests and our corresponding replies are as follows:

1. **State the number of all subject vehicles GM has manufactured for sale in the United States. Separately, for each vehicle manufactured to date by GM, state the following:**
  - a. **Vehicle identification number (VIN);**
  - b. **Date of manufacture;**
  - c. **Date warranty coverage commenced; and**
  - d. **The State in the United States where the vehicle was originally sold or leased (or delivered for sale or lease).**

**For subparts "a" through "e," provide a table in Microsoft Access 2000, or a compatible format, entitled "PRODUCTION DATA."**

General Motors is providing the number of subject vehicles produced for sale or lease in the United States by make, model and model year in Table 1-1 below:

MAKE	MODEL	2004MY
CHEVROLET	CORVETTE	33,501

TABLE 1-1 SUBJECT VEHICLES

The production information requested in 1a-1d is provided on the ATT\_1\_GM disk; folder labeled "Q\_01"; refer to the Microsoft Access 2000 file labeled: "Q\_01\_PRODUCTION DATA".



2. **State the number of each of the following, received by GM, or of which GM is otherwise aware, which relate to, or may relate to, the alleged defect in the subject vehicles:**
- a. **Consumer complaints;**
  - b. **Field reports, including dealer field reports;**
  - c. **Reports involving a fire, crash, injury, or fatality, based on claims against the manufacturer involving a death or injury, notices received by the manufacturer alleging or proving that a death or injury was caused by the alleged defect in a subject vehicle, property damage claims, consumer complaints, or field reports;**
  - d. **Third-party arbitration proceedings where GM is or was a party to the arbitration; and,**
  - e. **Lawsuits, both pending and closed, in which GM is or was a defendant or codefendant.**

**For subparts "a" through "e," state the total number of each item (e.g., consumer complaints, reports from retailers, etc.) separately. Multiple incidents involving the same vehicles are to be counted separately. Multiple reports of the same incident are also to be counted separately (i.e., a consumer complaint and a field report involving the same incident in which a crash occurred are to be counted as a crash report, a field report and a consumer complaint). In addition, for item "c" provide a summary description of the alleged problem and causal and contributing factors and GM's assessment of the problem, with a summary of the significant underlying facts and evidence. For items "d" and "e," identify the parties to the action, as well as the caption, court, docket number, and date on which the complaint or other document initiating the action was filed.**

Table 2-1 below summarizes records that may relate to allegations of gasoline or gasoline fuel vapor leaking from either the fuel tanks or fuel tank crossover tube/hose assembly in the subject vehicles. GM has organized the records by the GM file number within each attachment. Refer to access database "Q\_03\_REQUEST NUMBER TWO DATA" for categories prescribed by the NHTSA.

GM is also aware of two claims that do not correspond with the alleged defect. However, because the claimant made reference to a generic fuel system related fire, GM is including these records. These additional records are not included in Table 2-1, but are included in "Q\_03\_REQUEST NUMBER TWO DATA". The column entitled "In Table 2-1" designates whether the record is in Table 2-1.

Type of Report	GM Reports	Subcategories				
		Corresponding to NHTSA Reports	Number with Property Damage	Number with Crash	Number with Fire	Number with Injuries*
Owner Reports	132	6	0	0	0	0
Field Reports	92	0	0	0	0	0
Not-In-Suit Claims	0	0	0	0	0	0
Subrogation Claims	0	0	0	0	0	0
Third Party Arbitration Proceedings	0	0	0	0	0	0
Product Liability Lawsuits	0	0	0	0	0	0
Total Reports (Including Duplicates)	224	6	0	0	0	0
Total Vehicles with Reports (Unique VIN)	211	6	0	0	0	0

TABLE 2-1: REPORT CLASSIFICATION - ALLEGATIONS OF GASOLINE OR GASOLINE FUEL VAPOR LEAKING FROM EITHER THE FUEL TANKS OR FUEL TANK CROSSOVER TUBE/HOSE IN THE SUBJECT VEHICLES

\* THERE WERE NO FATALITIES ASSOCIATED WITH THIS ISSUE

The sources of the requested information and the last date the searches were conducted are tabulated in Table 2-2 below.

Source System	Last Date Gathered
Customer Assistance Center	May 28, 2010
Technical Assistance Center	May 28, 2010
Field Information Network Database (FIND)	June 7, 2010
Field Product Report Database (FPRD)	June 7, 2010
Company Vehicle Evaluation Program (CVEP)	June 2, 2010
Captured Test Fleet (CTF)	June 2, 2010
Early Quality Feedback (EQF)	June 2, 2010
Legal/Employee Self Insured Services (ESIS)/Product Liability Claims/Lawsuits	June 3, 2010

TABLE 2-2: DATA SOURCES

3. Separately, for each item (complaint, report, claim, notice, or matter) within the scope of your response to Request No. 2, state the following information:
  - a. GM's file number or other identifier used;
  - b. The category of the item, as identified in Request No. 2 (i.e., consumer complaint, report from retailer, etc.);
  - c. Vehicle owner's name, address, and telephone number;
  - d. Vehicle identification number (VIN);
  - e. Vehicle date of manufacture;
  - f. Incident date;
  - g. Report or claim date;
  - h. Number of alleged fires;
  - i. Number of alleged injuries; and

**j. Number of alleged fatalities.**

**Provide this information in Microsoft Access 2000, or a compatible format, entitled "REQUEST NUMBER TWO DATA."**

The requested information is provided on the ATT\_1\_GM disk; folder labeled "Q\_03"; refer to the Microsoft Access 2000 file labeled "Q\_03\_REQUEST NUMBER TWO DATA".

**4. Produce copies of all documents related to each item within the scope of Request No. 2. Organize the documents separately by category (i.e., consumer complaints, reports from retailers, etc.) and describe the method GM used for organizing the documents.**

Copies of the records summarized in Table 2-1 are embedded in the file provided in ATT\_1\_GM disk; folder labeled "Q\_03"; refer to the Microsoft Access file labeled "Q\_03\_REQUEST NUMBER TWO DATA". GM has organized the records by the GM file number within each attachment.

To date, GM's investigation of the alleged defect has not included an assessment of the cause(s) of each incident responsive to request 2. Some incident reports may not contain sufficient reliable information to accurately assess cause.

**5. State a total count for all of the following categories of claims, collectively, that have been paid by GM that relate to, or may relate to, the alleged defect in the subject vehicles: warranty claims; extended warranty claims; claims for good will services that were provided; or similar adjustments and reimbursements; and warranty claims or repairs made in accordance with a procedure specified in a technical service bulletin or customer satisfaction campaign.**

**Separately, for each such claim, state the following information:**

- a. GM's claim number;**
- b. Vehicle owner's name and telephone number;**
- c. Vehicle identification number (VIN);**
- d. Vehicle date of manufacture;**
- e. Repair date;**
- f. Repairing facility's name, telephone number, city and state or ZIP code;**
- g. Labor operation number;**
- h. Problem code;**
- i. Replacement part number(s) and description(s);**
- j. Concern stated by customer; and**
- k. Comment, if any, by the technician or person(s) making the repair, and/or the person(s) processing the claim that relate to the claim and/or repair.**

**Provide this information in Microsoft Access 2000, or a compatible format, entitled "WARRANTY DATA."**

For the subject vehicles the regular warranty and goodwill warranty claims that may relate to the alleged defect are summarized by model and model year in Table 5-1. MIC extended service contract claims are summarized by model and model year in Table 5-2. The UWC extended service contract claims are summarized by model and model year in Table 5-3. A summary of all warranty claims and the information requested in 5(a-k), is provided on the ATT\_1\_GM disk; folder labeled "Q\_05"; refer to the Microsoft Access 2000 file labeled "Q\_05\_WARRANTY DATA". A list of the labor codes, customer complaint codes and trouble codes used to collect the warranty data is provided in response 6.

MAKE	MODEL	2004MY
CHEVROLET	CORVETTE	2,015

TABLE 5-1 REGULAR WARRANTY CLAIMS THAT MAY BE RELATED TO THE ALLEGED DEFECT

MAKE	MODEL	2004MY
CHEVROLET	CORVETTE	202

TABLE 5-2 MIC EXTENDED SERVICE CONTRACT CLAIMS THAT MAY BE RELATED TO THE ALLEGED DEFECT

MAKE	MODEL	2004MY
CHEVROLET	CORVETTE	5

TABLE 5-3 UWC EXTENDED SERVICE CONTRACT CLAIMS THAT MAY BE RELATED TO THE ALLEGED DEFECT

SOURCE SYSTEM	LAST DATE GATHERED
GART – regular warranty	May 26, 2010
MIC – extended service contract claims	May 27, 2010
UWC – extended service contract claims	May 25, 2010

TABLE 5-4: DATES PULLED

GM searched the GM Global Analysis and Reporting Tool (GART-regular warranty), the Motors Insurance Corporation (MIC-extended service contract claims) and the Universal Warranty Corporation (UWC-extended service contract claims) databases to collect the claims for this response.

GM's warranty database does not contain the following information: vehicle owner's name, telephone number or customer concern statement. GM is providing a field labeled "Verbatim Text" in response to request 5K (dealer/technician comment). The verbatim text is an optional field in the GM warranty system for the dealer to enter any additional comments that may be applicable to the warranty claim. The verbatim text field is not required to be completed for every warranty claim.

The warranty and service contract claim data provided has limited analytical value in analyzing the field performance of a motor vehicle component. The warranty records

do not contain sufficient information to establish the condition of the part at the time of the warranty correction; and service personnel may not consistently use the appropriate labor and trouble codes. Warranty numbers represent claims by our dealers for reimbursement for parts and labor costs incurred in performing warranty service for our customers.

A summary of warranty and service contract claims that may relate to the subject condition is provided on the ATT\_1\_GM disk; folder labeled "Q\_05"; refer to the Microsoft Access 2000 file labeled "Q\_05\_WARRANTY DATA".

- 6. Describe in detail the search criteria used by GM to identify the claims identified in response to Request No. 5, including the labor operations, problem codes, part numbers and any other pertinent parameters used. Provide a list of all labor operations, labor operation descriptions, problem codes, and problem code descriptions applicable to the alleged defect in the subject vehicles. State the terms of the new vehicle warranty coverage offered by GM on the subject vehicles (i.e., the number of months for which coverage is provided and the vehicles systems that are covered). Describe any extended warranty coverage option(s) related to the alleged defect that GM offered for the subject vehicles and state by option, model, and model year, the number of vehicles that are covered under each such extended warranty.**

The GM Global Analysis and Reporting Tool (GART-regular warranty) regular warranty database and the Motors Insurance Corp (MIC) extended service contract claims database were searched using the labor codes, listed in Table 6-1, that may be related to the alleged defect. All claims that contained a verbatim comment that indicated the alleged defect were included in the response to request 5. Claims with the customer codes listed in Table 6-2 and the trouble codes listed in Table 6-3 were also included in this response unless the claim contained a verbatim comment that clarified that a subject component or issue was not involved.

Universal Warranty Corporation (UWC) does not use labor codes or trouble codes.

The subject vehicles are covered by a bumper-to-bumper new vehicle warranty for three years or 36,000 miles, whichever occurs first. Many different extended warranty options are available through GM dealerships. They are offered at different prices and for varying lengths of time, based on customer's preference, up to 7 years from the date of purchase or up to a total of 100,000 vehicle miles.

Some of the VINs have multiple entries for various labor codes. The warranty claims reflect the number of labor operations used by dealers, which is higher than the number of actual visits to dealers for repairs.

LABOR CODE	DESCRIPTION:
L0120	Crossover Tube Replacement
L0160	Crossover Tube Replacement
L0260	Crossover Tube Replacement
L1260	Fuel Tank Replacement
L1280	Fuel Tank Replacement – Right Side
L1281	Fuel Tank Replacement – Left Side
L1282	Tank, Fuel – Both - Replace
Z1241	Product Liability/Investigation Rep Pr (Goodwill)
Z1242	PAR-Repairs/Reimbursement (Goodwill)
Z1243	Inspection-Product Allegation Resolution

TABLE 6-1 LABOR CODES USED IN WARRANTY AND MIC SEARCH

CUSTOMER CODE	DESCRIPTION:
VB	Broken
VE	Cracked
MJ	Customer Satisfaction
VG	Dent/Ding
321	Engine/Fuel/Exhaust - Check Engine" Light "
327	Engine/Fuel/Exhaust - Fluid Leaks
390	Engine/Fuel/Exhaust - Other Issues
MC	Failed Emissions
621	Features/Controls/Displays - Gauges/Warning Lights
OI	Fumes
OJ	Inoperative
327	Leak/Leaks
OP	Odor
PM	Poor Gas Mileage
MA	Product Campaign Claim
WG	Service Engine Soon

TABLE 6-2 CUSTOMER CODES USED IN WARRANTY AND MIC SEARCH

TROUBLE CODE	DESCRIPTION:
1D	Broken
1K	Cracked
4021	Interface (Gasket; Seal; Hose; Weld)-Damaged/Cracked
4061	Interface (Gasket; Seal; Hose; Weld)-Leaks
6021	Module/Component-Damaged/Cracked
6061	Module/Component-Leaks
OB	OBDII Code Used
1021	Surface (exterior)-Damaged/Cracked
4R	Weld Broken

TABLE 6-3 TROUBLE CODES USED IN WARRANTY AND MIC SEARCH

The number of extended service contracts on the subject vehicles that have been sold by MIC as of May 27, 2010 and UWC as of Jun 24, 2010 regardless of status (in-force, expired, cancelled) is contained in Tables 6-4 and 6-5.

MAKE	MODEL	2004MY
Chevrolet	Corvette	17,805

TABLE 6-4 SUBJECT VEHICLES - MIC EXTENDED SERVICE COVERAGE CONTRACTS SOLD  
(REGARDLESS OF STATUS; IN-FORCE, EXPIRED, CANCELLED)

MAKE	MODEL	2004MY
Chevrolet	Corvette	426

TABLE 6-5 SUBJECT VEHICLES - UWC EXTENDED SERVICE COVERAGE CONTRACTS SOLD  
(REGARDLESS OF STATUS; IN-FORCE, EXPIRED, CANCELLED)

7. **Produce copies of all service, warranty, and other documents that relate to, or may relate to, the alleged defect in the subject vehicles that GM has issued to any retailers or distributors, regional or zone offices, field offices, or other such entities. This includes, but is not limited to, bulletins, advisories, informational documents, training documents, or other documents or communications, with the exception of standard shop manuals. Also include the latest draft copy of any communication that GM is planning to issue within the next 120 days.**

There are no Technical Service Bulletins (TSB) that may relate to the subject condition and have been issued to dealers, regional or zone offices, field offices, fleet purchasers or other entities. The preceding information was collected from GM Service Operations and was completed on June 9, 2010.

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, GM. For each such action, provide the following information:**
- Action title or identifier;**
  - The actual or planned start date;**
  - The actual or expected end date;**
  - Brief summary of the subject and objective of the action;**
  - Engineering group(s)/supplier(s) responsible for designing and for conducting the action; and,**
  - 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.



The information listed in Table 8-1 below is a summary of actions that have been conducted, are being conducted, are planned or are being planned by or for GM regarding the subject condition on the subject vehicles as of 15 Jun 10. Documents and additional supporting information are included in the Attachments as noted in the table.

<p><b>Action 8-1: Design, Development and Validation of the fuel system</b>  <b>Start Date:</b> 29 Jul 99  <b>End Date:</b> 9 Dec 06  <b>Engineering Group:</b> GM Engineering  <b>Attachments:</b> ATT_2_GM_Conf disk; folder labeled "Q_08 GM Validation"  <b>Description:</b> GM's engineering documents  <b>Summary:</b> The fuel system for the subject vehicles passed all validation tests.</p>
<p><b>Action 8-2: Design, Development and Validation of the fuel system</b>  <b>Start Date:</b> 3 May 01  <b>End Date:</b> 20 Jan 05  <b>Engineering Group:</b> TI Automotive Engineering  <b>Attachments:</b> ATT_3_TI_Conf disk; folder labeled "Q_08 TI Validation"  <b>Description:</b> TI Automotive 's engineering documents  <b>Summary:</b> The fuel system for the subject vehicles passed all validation tests.</p>
<p><b>Action 8-3: Engineering changes</b>  <b>Start Date:</b> 8 Mar 04  <b>End Date:</b> 23 Jul 04  <b>Engineering Group:</b> GM Engineering  <b>Attachment:</b> ATT_2_GM_Conf disk; folder labeled "Q_08 GM Engineering changes"  <b>Description:</b> GM's engineering changes of the fuel system on the subject vehicles.  <b>Summary:</b> GM released information and engineering changes after start of production.</p>
<p><b>Action 8-4: Engineering changes</b>  <b>Start Date:</b> 26 Mar 04  <b>End Date:</b> 17 Jun 10  <b>Engineering Group:</b> TI Automotive Engineering  <b>Attachment:</b> ATT_3_TI_Conf disk; folder labeled "Q_08 TI Engineering changes"  <b>Description:</b> TI Automotive's engineering changes of the fuel system on the subject vehicles.  <b>Summary:</b> TI Automotive released information and engineering changes after start of production</p>
<p><b>Action 8-5: Fuel System Description</b>  <b>Date:</b> 28 Jun 10  <b>Group:</b> GM Customer Care and Aftersales  <b>Attachment:</b> ATT_2_GM_disk; folder labeled "Q_08_Fuel System Description"  <b>Description:</b> Fuel System Description.  <b>Summary:</b> GM's fuel system description from the Corvette service manual.</p>
<p><b>Action 8-6: GM Investigation</b>  <b>Start Date:</b> 21 Jul 04  <b>End Date:</b> 4 Nov 04  <b>Engineering Group:</b> GM Engineering  <b>Attachment:</b> ATT_2_GM_disk; folder labeled "Q_08 GM Investigation"  <b>Description:</b> Internal emails related to the alleged defect.  <b>Summary:</b> GM's internal investigation of the fuel system and its operation.</p>
<p><b>Action 8-7: GM Investigation</b>  <b>Start Date:</b> 7 Jun 04  <b>End Date:</b> Continuing  <b>Engineering Group:</b> GM Engineering  <b>Attachment:</b> ATT_2_GM_Conf disk; folder labeled "Q_08 GM Investigation"  <b>Description:</b> Internal presentations, Weibull projections, and FPE summary document related to the alleged defect.  <b>Summary:</b> GM's internal investigation of the fuel system and its operation. GM plans to update the FPE summary document with additional information that has recently been learned.</p>

<p><b>Action 8-8:</b> TI Automotive Investigation <b>Start Date:</b> 15 Oct 03 <b>End Date:</b> Continuing <b>Engineering Group:</b> TI Automotive Engineering <b>Attachment:</b> ATT_3_TI_Conf disk; folder labeled "Q_08 TI Investigation" <b>Description:</b> TI Automotive's internal investigation of the fuel system and its operation. <b>Summary:</b> TI Automotive is continuing its investigation of the alleged defect which includes obtaining and analyzing field-returned parts.</p>
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TABLE 8-1 SUMMARY OF ACTIONS

9. Describe all modifications or changes made by, or on behalf of, GM 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:
- The date or approximate date on which the modification or change was incorporated into vehicle production;
  - A detailed description of the modification or change;
  - The reason(s) for the modification or change;
  - The part numbers (service and engineering) of the original component;
  - The part number (service and engineering) of the modified component;
  - Whether the original unmodified component was withdrawn from production and/or sale, and if so, when;
  - When the modified component was made available as a service component; and,
  - Whether the modified component can be interchanged with earlier production components.

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

GM is providing a summary table of the changes and associated Engineering Work Orders (EWOs) that may relate to the subject components in the ATT\_2\_GM\_Conf disk; folder labeled "Q\_09".

**10. State the number of each of the following that GM 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 sale (including the cutoff date for sales, if applicable):**

- a. Subject component(s); and**
- b. Any kits that have been released, or developed, by GM for use in service repairs to the subject component(s)/assemblies.**

**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 and model year, any other vehicles of which GM is aware that contain the identical component(s), whether installed in production or in service, and state the applicable dates of production or service usage.**

An electronic summary table of the requested service part information for the subject components is provided on the ATT\_1\_GM disk; folder labeled "Q\_10"; refer to the Adobe file labeled "Q\_10\_Part Sales". GM does not offer any kits for use in service repairs specifically related to the alleged defect.

These sales numbers represent sales to dealers in the US and Canada. This data has limited analytical value in analyzing the field performance of a motor vehicle component because the records do not contain sufficient information to establish the reason for the part sale. It is not possible from this data to determine the number of these parts that have been installed in the subject vehicles or the number remaining in dealer or replacement part supplier inventory.

This table contains service part numbers, part description, part usage information including the GM vehicles that contain the identical component, part sales figures by month and calendar year, and the supplier's name and address, contact name and phone number.

**11. Furnish GM's assessment of the alleged defect in the subject vehicles 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, that the alleged defect was occurring or that the subject component was malfunctioning; and**
- f. The reports included with this inquiry.**

Description

The 2004 Chevrolet Corvette fuel system uses two fuel tanks joined by a flexible metal crossover hose assembly. The left side (driver side) tank is considered the primary, and the right side (passenger side) is secondary.

### Operation

When the fuel tanks are filled, fuel first fills the left tank. As the fuel rises to the level of the crossover hose inlet, fuel flows into the right tank. As fuel occupies the interconnected tanks, vapor is forced to vent from the tanks through the fill limiting vent valve (FLVV) in the right tank. When both tanks are full, the FLVV float in the right tank closes, preventing additional vapor from exiting the vent system which causes the pump to shut off.

When the engine is running, the turbine fuel pump in the left tank pressurizes the fuel feed pipe. The entire fuel supply system (i.e. lines), from the pump to the injectors, is pressurized. The turbine pump creates more pressure and more fuel flow than the engine needs. The primary fuel pressure regulator within the tank is designed to allow unused fuel to return to the left tank.

Some of the pressurized fuel is directed through a feed pipe inside the crossover hose, to a jet pump in the right tank. The jet pump relies on the Venturi effect to use pressurized fuel to draw fuel from the right hand tank. The combined fuel then flows from the right tank to the left tank through a return pipe inside the crossover hose. The jet pump is able to move enough fuel to ensure that all of the fuel in the right tank is consumed before the level in the left tank begins to drop. If the left tank is full, fuel will overflow back to the right hand tank through the crossover hose assembly at a rate of approximately 0.5 gallons per minute.

### Crossover Hose Assembly

The crossover hose assembly is made of corrugated flexible stainless steel. It is retained to each fuel tank by a collar and a CPA (Connector Position Assurance). With the CPA aside, the collar can be turned by hand. The fuel feed and fuel return pipes for the transfer pump are inside the crossover, and are sealed with O-rings. The crossover is sealed to each tank with two O-rings.

### Quick Connectors

The fuel tank connectors are hot-plate welded to the right and left side fuel tanks and are used to connect the crossover hose assembly.

a.) The causal or contributory factor(s);

GM's investigation suggests the primary factor affecting performance of the quick connector is processing parameters and equipment that resulted in degradation of the raw material during the compounding process. Another factor observed from field returns is variation in how the degraded quick connector material is hot-plate welded to the fuel tank. A third factor is mounting and loading of the tanks which makes the left hand tank quick connector more likely to experience higher stresses during in-vehicle use.

The fuel tank quick connector is an injection molded component using a glass-filled olefin material. Development and validation testing used resin material made from a single screw compounder at 250 RPM. Material for 2004 MY Corvette quick connectors was compounded at the tier 3 supplier's Dyersburg, Tennessee facility. Prior to September 30, 2003, the material was compounded on a single screw extruder at 250 RPM. The September 30, 2003 batch was blended at 1200 RPM using a twin screw extruder on the Mega Compounder. Material for the September 30, 2003 lot was processed at a temperature substantially in excess of the set point on the extruder, in some zones between 150° C and 250° C above set point. The January 7, 2004 batch was blended at 400 RPM using a twin screw extruder on the Super Compounder. Material for the January 7, 2004 batch was processed at 71° C above set point.

To maintain material quality the compounding process requires key processing parameters to be controlled. A few of the key processing parameters are: screw speed (rpm), screw design (pitch, single or double screw), and barrel temperature. Two key characteristics of the compounded material are melt flow index (HLMI, High Load Melt Index) and molecular weight. These characteristics are leading indicators of the moldability of the material and an indirect indication of the material's physical property, "fracture toughness" (measured in mm of elongation).

According to the material compounder, "Processing on the twin screw compounding lines using the "standard" screw profile for glass-filled olefins caused substantial molecular weight degradation, based on the melt flow rate increase". Testing of the September 30, 2003 material showed it had substantially lower elongation and it exhibited lower fracture toughness than the material used for validation. It also had melt flow rates substantially over specification (i.e. the material had low viscosity during the melt-flow test). GM recently determined the material manufactured on January 7, 2004 also did not meet the melt flow rate specifications. Fuel tanks using these quick connectors have warranty rates significantly below that of quick connectors from the September 30, 2003 batch, but still higher than those molded from material blended with the proper parameter process in the single screw compounder. All later material was made using a single screw compounder.

Fuel tanks with suspect quick connectors using material compounded on September 30, 2003 and January 7, 2004 were installed in vehicles produced from approximately October 22, 2003 through March 19, 2004. 2004 MY vehicles built before and after these time frames used material compounded with a single screw extruder and have warranty rates for the alleged defect is substantially lower than the suspect time period.

Warranty analysis indicates leaks occur at higher rates in hotter climates. This is theoretically due to increased levels and additional cycles of thermal expansion and contraction experienced by the fuel tank versus the duty cycle experienced in cooler climates.

The number of claims for fuel tank replacement varies for the left hand tank versus the right hand tank. Of the total fuel tank warranty claims in this investigation for fuel tank replacement due to fuel odor, fuel leaks, and Service Engine Soon (SES) lights, left hand fuel tanks were replaced 89% of the time. Right hand tanks warranty represented 11% of the fuel tank claims

The likelihood of replacing a left hand tank versus a right hand tank is related to how the fuel system is installed and how it operates. As the vehicle is being assembled, both the left hand tank and right hand tank are installed into the vehicle. By process, the crossover hose assembly is first attached to the left hand tank (from an operator standing below). The crossover hose is then manipulated to install it into the right hand tank. This process puts stress into both quick connectors. A guide bracket at the approximate centerline of the vehicle pulls the hose assembly rearward to clear a portion of the drive train. This puts a permanent bending moment on both quick connectors.

By design, the right hand tank is mounted tightly to its surrounding surfaces. The left hand tank has a 12-mm gap to its mounting surfaces that is filled with foam isolators. The purpose of the foam is to dampen noise related to fuel pump operation. This gap allows the left hand tank to move more than the right hand tank during driving maneuvers and as a result, the left hand quick connector experiences more load than the right hand. Additionally, since there is always more fuel in the left hand tank than right hand tank, even when both are full, the left hand quick connector will experience higher loads.

An illustration of this point is when the fuel system is approximately one half full. Under this condition, there is no fuel in the right hand tank, so there is only dynamic loading due to the mass of the tank itself. The left hand tank, on the other hand, is completely filled with fuel, and will experience dynamic loading as the vehicle is being driven. These loads are transferred to the quick connector on the left hand tank, but the crossover hose assembly guide bracket prevents this load from transferring to the right hand tank.

As indicated above, fuel fills the left hand tank and then flows through the crossover hose assembly to the right hand tank. On the right hand tank, fuel passes through an extension of the quick connector so if there is a crack it is not exposed directly to liquid fuel. The system then shuts off before the fuel level in the right hand tank reaches the area of the quick connector that may be cracked. For a fuel system more than half full, the lower portion of the left hand quick connector is continuously exposed to fuel. By contrast, any cracks on a right hand quick connector are exposed to vapor and will only be exposed to fuel during driving maneuvers that result in fuel slosh toward the left. As the vehicle is driven, the level of fuel in the right hand tank begins to decrease, and the likelihood that it could slosh and contact the quick connector is reduced.

b.) The failure mechanisms;

The failure mechanism of the quick connector is cracking at the intersection of the weld flange and quick connector body or between the quick connector and fuel tank.

c.) The failure mode(s);

Thermal expansion and contraction of the tanks, refueling, fuel movement within the tank, and road load inputs may cause previously stressed quick connectors to form cracks. The cracks may grow and allow fuel vapors or small amounts of fuel to escape.

In 2004, a series of tests were conducted on fuel tanks received from warranty returns. In one evaluation, a 2004 XLR was used to test a returned left hand tank with a leak rate equal to a 0.010" diameter orifice. During the first three refueling events of the fuel tank, no leaking fuel was observed. However, fuel odor was detected throughout the course of mileage accumulation. During the fourth refueling (10 GPM), fuel was observed leaking on the ground. A witness mark of 12" diameter was measured. This correlates to approximately 21 ml (0.71 oz). During the course of the drive evaluation of approximately 750 miles, neither the small leak nor large leak caused OBDII codes to be set. Upon completion of the fourth refueling, the tank was removed for evaluation and measurement. The crack had grown to an equivalent leak diameter of approximately 0.040". The tank was reinstalled in the vehicle and driven two additional days. During this time, an OBDII code was set, and the service engine soon message was displayed on the Driver Information Center. The tank was removed from the vehicle and measured again. The crack was found to be larger than an equivalent diameter of 0.040".

A similar test was performed using a 2004 Corvette and a returned left hand fuel tank. The results were similar. While odor was initially detected, fuel was only observed leaking on the ground while the vehicle was being filled with fuel. The crack was measured and had grown from approximately 0.025" equivalent diameter to approximately 0.040" equivalent diameter after several hundred miles of drive evaluation.

The observations from the series of tests were as follows:

- Data suggests the crack must grow beyond an equivalent leak diameter of 0.040", and a pressure driver (for example, back pressure while refueling) must be present for fuel to contact the ground. In addition, data suggests that a pressure driver is required for weeping to occur. The largest pressure mechanism for both conditions occurs during refueling.
- Tanks have been received from the field with cracks ranging from 0.010" to greater than 0.040" equivalent (leak rate) diameter.
- OBDII codes are set when the leak has an equivalent diameter of 0.040" or greater.
- Data collected from two drive evaluations suggest that the crack size started small and grew as the vehicle was driven.

- During GM's and TI's testing leaking fuel was not observed during standard customer driving conditions even when the crack was greater than 0.030" equivalent diameter
- Fuel odor can be noticed with cracks as small as 0.010" equivalent diameter

GM recently reviewed the raw data from a prior survey conducted by the fuel system supplier in 2005. Those results showed that fuel tank replacement claims break down as follows: 6.5% Fuel on the ground, 42.6% Undefined Leak, 36.5% Fuel Odor, and 14.4% SES light. Those where the customer complaint indicated a "fuel leak" were not specific enough to indicate the type of leak the customer noticed. However, those undefined fuel leaks were likely either fuel on the ground or fuel odor. Assuming the undefined fuel leaks are in the same ratio as the known fuel on the ground claims or odor claims, an estimate of percentage of claims that would be fuel on the ground would be calculated as follows:

$$\left( \frac{6.5\%}{36.5\% + 6.5\%} \right) * 42.6\% = 6.4\%$$

Adding an additional 6.4% of the undefined leaks to 6.5% fuel on the ground provides an estimate of percentage of the claims of actual fuel on the ground of 12.9%. For the suspect population (vehicles built from October 22, 2003 through March 19, 2004) the 36 MIS rate is 102 IPTV for the alleged defect. If this is then multiplied by the 12.9% estimate of claims for fuel on the ground, the result is 13.2 IPTV. Using only the first portion of the suspect build period where the warranty rate is 139 IPTV at 36 MIS, the estimated rate of fuel on the ground is 17.9 IPTV.

- 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

GM does not believe that the alleged defect represents an unreasonable risk to vehicle safety based upon the following reasons:

- The rate of fuel leaks on the ground is low, estimated at 13.2 – 17.9 IPTV at 36 MIS.
- Cracks are progressive, and the driver should smell vapor well before fuel is visible. Fuel odor is detectable at .010" equivalent orifice size.
- All cracks are located at the top of the fuel tank and most are in the vapor dome, above the fuel level.
- Leaks are more likely to be detected during refueling providing additional warning to the customer.
- Vehicle testing indicates it is most likely that liquid fuel will be observed during refueling and that a small quantity of fuel may escape.



- Maximum 21 ml (0.71 oz) making 12 inch diameter witness mark on ground
- Vehicle test demonstrated that a check-engine light was illuminated, an OBD II code was set, and the "Service Engine Soon" message was displayed in the Driver Information Center with a crack that has progressed to an equivalent diameter of approximately 0.040".
- There are no open electrical circuits or heat sources in the area to ignite fuel vapors and there is thermal shielding between the fuel tanks and the exhaust system.
- GM is unaware of any property damage or personal injuries that were alleged to have occurred due to a leaking fuel tank.

f.) The reports included with this inquiry.

While GM agrees that most of the VOQs report conditions that are consistent with the alleged defect, there are three that appear to report there is only a potential for a leak. GM believes the following VOQs are reporting a potential for a leak (10294565, 10299052, and 10294225).

\* \* \*

General Motors requested assistance and documents from suppliers in responding to item 8 and this response includes all those documents received from suppliers as of this date, except for some documents for which the supplier is still conducting a confidentiality determination. Moreover, these suppliers (TI Automotive, PolyOne and Viking) have indicated that they are reviewing additional documents responsive to this request and those will be provided as soon as GM receives them.

GM claims that certain information, in documents that are part of lawsuit and claims files maintained by the GM Legal Staff, is attorney work product and/or privileged. That information includes notes, memos, reports, photographs, and evaluations by attorneys (and by consultants; claims analysts, investigators, and engineers working at the request of attorneys). GM is producing responsive documents from claims files that are neither attorney work product nor privileged, and withholding those that are attorney work product and/or privileged.

This response is based on searches of GM locations where documents determined to be responsive to your request would ordinarily be found. As a result, the scope of this search did not include, nor could it reasonably include, "all of its past and present officers and employees, whether assigned to their principal offices or any of their field or other locations, including all of their divisions, subsidiaries (whether or not incorporated) and affiliated enterprises and all of their headquarters, regional, zone and other offices and their employees, and all agents, contractors, consultants, attorneys and law firms and other persons engaged directly or indirectly (e.g., employee of a consultant) by or under the control of GM (including all business units and persons previously referred to), who are

or, in or after 1999, were involved in any way with any of the following related to the alleged defect in the subject vehicles:

- a. Design, engineering, analysis, modification or production (e.g. quality control);
- b. Testing, assessment or evaluation;
- c. Consideration, or recognition of potential or actual defects, reporting, record-keeping and information management, (e.g., complaints, field reports, warranty information, part sales), analysis, claims, or lawsuits; or
- d. Communication to, from or intended for zone representatives, fleets, dealers, or other field locations, including but not limited to people who have the capacity to obtain information from dealers."

This response was compiled and prepared by this office upon review of the documents produced by various GM locations, and does not include documents generated or received at those GM locations subsequent to their searches.

Please contact me if you require further information about this response or the nature or scope of our searches.

Sincerely,

A handwritten signature in black ink, appearing to read 'G. P. Kent', with a long horizontal flourish extending to the right.

Gay P. Kent,  
Director, Product Investigations  
and Safety Regulations

Attachments