



U.S. Department
of Transportation
**National Highway
Traffic Safety
Administration**

ODI RESUME

Investigation: EA 05-015
 Prompted By: PE05-033
 Date Opened: 10/13/2005 Date Closed: 12/06/2006
 Principal Investigator: Cynthia Glass
 Subject: Windshield Leak Causes Electric Failures

Manufacturer: Ford Motor Company
 Products: 1999-2001 Ford Expedition
 Population: 653,471

Problem Description: Water leaks around the windshield causing a malfunction, failure or intermittent operation of safety-related electrical components.

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	63	1440	1503
Crashes/Fires:	0	10	10
Injury Incidents:	0	0	0
# Injuries:	0	0	0
Fatality Incidents:	0	0	0
# Fatalities:	0	0	0
Other*:	0	5903	5903

*Description of Other: Warranty Claims

Action: This Engineering Analysis is closed.

Engineer: Cynthia Glass
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Date: 12/06/2006
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Summary: Consumers alleged that when it rained or snowed, water leaked into the vehicle around the windshield. Moisture flowing through the seal that surrounds the front windshield follows a path through the seal into the Generic Electronic Module (GEM) and fuse box, and may cause the electrical components in the vehicle to malfunction.

Overall, the number of reports alleging wiper failures and lighting failures is relatively small. In reviewing a large sample of the 1,503 complaints for windshield leaks, ODI's analysis reveals that 0.04% of the total vehicle population reported improper windshield wiper operation and 0.01% of the total vehicle population reported lighting failures. The warranty claims reveal that approximately 0.10% of the population has been serviced for wiper malfunctions and 0.08% for lighting malfunctions as a result of windshield leaking.

ODI's analysis of the field performance statistics and available technical information has not established that a defect trend exists in the malfunction, failure or intermittent operation of the front windshield wipers or headlights.

See the attached summary report.

Background

The Office of Defects Investigation (ODI) opened a Preliminary Evaluation (PE05-033) on June 15, 2005, to investigate alleged windshield leaks causing electrical failures in Model Year (MY) 1999-2001 Ford Expedition sport utility vehicles (subject vehicles). On October 13, 2005, PE05-033 was upgraded to an Engineering Analysis (EA05-015) to further investigate the matter.

Population

The subject vehicle population is 653,471. See the table below.

1999	2000	2001	Total
240,610	237,836	175,025	653,471

Alleged Defect and Components Affected

The alleged defect refers to water leaks around the windshield causing a malfunction, failure, or intermittent operation of certain safety-related electrical components (wipers, headlights, and tail lights) in the subject vehicles. Consumers alleged that when it rained or snowed, water leaked into the vehicle around the windshield. Moisture flowing through the seal that surrounds the front windshield follows a path through the seal into the Generic Electronic Module (GEM) and fuse box and may cause the electrical components in the vehicle to malfunction. The GEM contains the computer hardware and software that controls various safety-related systems (wipers, headlights, and tail lights), as well as other systems (interior lighting, blower motor, radio, etc).

The GEM and fuse box are located in the interior of the vehicle, below the front windshield and in front of the drivers seating position. The GEM is a "black box design" ¹ located behind the instrument panel, in the area forward of the driver's left knee. The fuses are encased in a plastic box located underneath the steering column and instrument panel. Figure 1 shows the general location of the GEM and the fuse box in the vehicle. Figure 2 shows the layout and function of various fuses in the fuse box.

¹ While the functional specifications are set by the manufacturer, the detailed engineering responsibility resides completely in the hands of the supplier. The manufacturer prescribes the inputs and outputs only, while disregarding what is inside the box that makes the component operate. This approach is often used for off-the-shelf components. Ford out-sources the design and manufacturing of the GEM.



Figure 1: Location of the GEM and Fuse Box

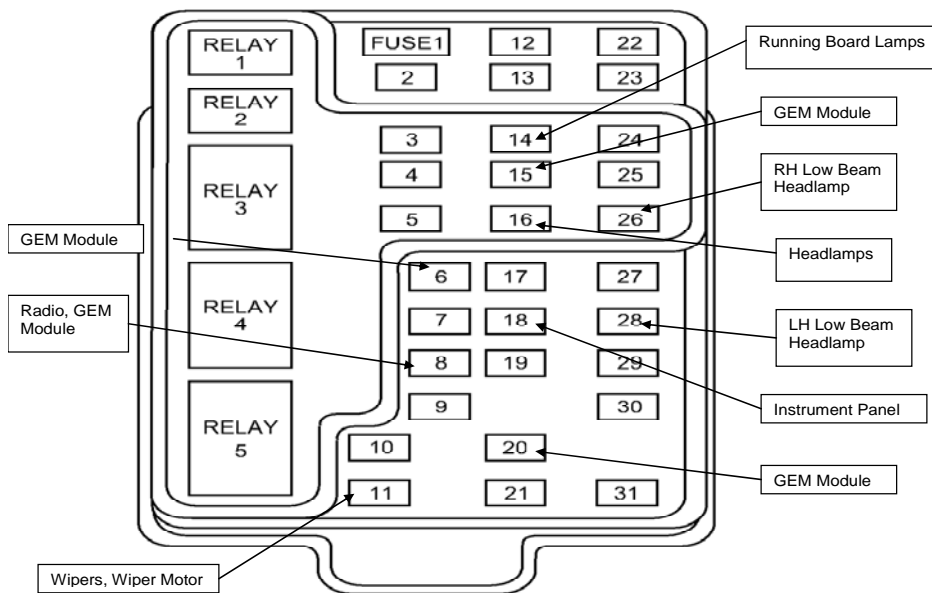


Figure 2: Fuse Box Layout

Failure/Malfunction Modes

Water intrusion into the subject vehicles may have several sources and follow any number of paths after entering the vehicle. Some of the sources contributing to water intrusion include those created by production variation of dimensional tolerances, improper repair or replacement of windshield glass. When a windshield leaks, the driver may observe water droplets on the interior of the windshield, water or moisture on the top of the instrument panel, wet carpet and erratic or unexpected electrical component behavior. The GEM and fuse box may suffer water exposure if the water follows a path in the area of the driver's side "A-pillar" and then into the interior of the vehicle behind the instrument panel. If water gets into the GEM and/or fuse box, erratic or unexpected electrical component behavior may occur.

Manufacturing Processes

Ford identified potential process errors that could result in windshield leaks allowing water to flow into the GEM and fuse box causing electrical component failure. As part of the installation process at the assembly plant, a continuous and steady bead of urethane adhesive is applied along the entire periphery of the front windshield. The purpose of this bead of urethane is to ensure a tight seal to the body of the vehicle, and to prevent water intrusion into the vehicle.

The manufacturer's control plans target the following aspects of the installation process that could result in a poor seal to the windshield:

- a. If air bubbles get in the urethane distribution nozzle, there may be skips in the application of the urethane to the vehicle's frame.
- b. If the urethane application start and end points do not overlap, there may be a gap or opening along the periphery of the windshield.
- c. If the urethane adheres to the body of the vehicle instead of the vehicle's frame, the windshield may be misaligned.
- d. If the windshield glass is re-used, there may not be a tight seal.

Ford conducts two types of water leak tests during production to observe the windshield seal for water leaks on the subject vehicles: a 5-minute water-dip test and a 20-minute water-soak test. Every vehicle is subjected to a 5-minute water-dip in a water spray chamber located on the assembly line. Additionally, ten vehicles from each shift are randomly chosen to be subjected to an off-line, 20-minute water-soak in a water booth.

Corrective Measures by Ford

To address windshield leaks in the subject vehicles, Ford issued special service messages (SSM) between April 19, 1997, and April 5, 2002 to advise the dealerships of repair procedures for the subject vehicles. Figure 3 below, summarizes the SSMs related to the alleged defect.

Date of Issue	Ford Article #	MY Expedition Affected	Description	Resolution
2/3/1999	99 02 03	1997 – 1999	The customer may report a water leak from the windshield. This may be caused by a skip or void in the production sealer somewhere around the periphery of the windshield.	Seal the entire windshield periphery to ensure repair of the leak
8/25/1999	13138	1998 - 2000	A Concern Definition Program for these vehicles with GEM concerns that require a module replacement.	Technician must call for approval before removing and/or replacing the module
4/5/2002	15773	1997 - 2002	Vehicles may exhibit various electrical conditions. This may be due to GEM/CJB water intrusion resulting from a windshield water leak.	Remove the GEM and CJB, separate them and inspect for water contamination or corrosion. If found in either component, replace both components and completely reseal the windshield.

Figure 3: Special Service Messages

Ford stated that SSM Article #15773 was issued to assist technicians in diagnosing some electrical system anomalies that did not follow a specific pattern or relate to a specific system or component. The SSM was intended to help technicians diagnose and repair the electrical anomalies quickly and completely. The referenced SSM is currently planned to become obsolete ten years from the date of issue on April 5, 2012.

ODI Investigation

ODI's principal concern was the potential for improper operation of the front windshield wipers, headlights and tail lights. The purpose of the windshield wipers and the headlights is to provide adequate visibility for the safe operation of the vehicle in darkness and wet weather conditions. The GEM and the fuse box control the operation of all of these components as well as the other electrical components in the subject vehicles. Proper sealing of the front windshield prevents water intrusion and contamination of the GEM and fuse box during vehicle operation under wet weather conditions.

Complaints

ODI reviewed all of the reports of water leaks around the windshield provided by both Ford and those reported to NHTSA by consumers. Figure 4 below is a summary count of all reports (duplicates included).

Report Type	EA Opened		EA Closed		Total
	ODI	Ford	ODI	Ford	
Owner Reports	39	703	62	769	831
Field Reports	0	614	0	671	671
Lawsuits/Legal Claims	0	20	0	20	20
Property Damage Claims	0	18	0	18	18
Fire Claims	0	10	0	10	10
Injury Incidents	0	0	0	0	0
Injuries	0	0	0	0	0
Fatal Incidents	0	0	0	0	0
Fatalities	0	0	0	0	0

Figure 4: Windshield Leak Reports

ODI conducted a detailed categorization of electrical failures found in the customer and technician comments in Ford's owner reports and field reports. ODI identified 1,440 reports, representing 0.2% of the total population of 653,471 vehicles. ODI reviewed 911 (63%) of the reports and identified 20 categories of component and electrical system malfunctions and 3 categories describing the environmental driving conditions. Descriptions of windshield wiper failures included front wipers, wipers fail off (the wipers will not turn on), wipers fail on (wipers will not turn off), and inoperative. Lighting failures included headlights, tail lights, and other exterior and interior lights. For each failed component, ODI calculated the percent of occurrence of owner and field reports, and the percent of occurrence with respect to the subject vehicle population. The owner and field report percentages shown are greater than 100% because many reports contained more than one comment and/or failed component. Figure 5 summarizes the results.

Failed Component	% of Reports	% of Population
Replace GEM	30.0%	0.07%
Replace Fuses/Fuse Box	23.0%	0.05%
Replace/Reseal Windshield	21.0%	0.05%
Electrical	20.0%	0.04%
Radio	17.0%	0.04%
Blower Motor	16.0%	0.04%
Wipers Inop	15.0%	0.03%
Lights	5.0%	0.01%
Wipers Fail On	5.0%	0.01%
Front Wipers	5.0%	0.01%
Window	5.0%	0.01%
Head Lights	3.0%	0.01%
Door Locks	3.0%	0.01%
Wipers Fail Off	2.0%	0.00%
Rear Wiper	2.0%	0.00%
Exterior Lights	1.3%	0.00%
Turn Signal	0.4%	0.00%
Seats	0.3%	0.00%
Tail Light	0.2%	0.00%
Mirrors	0.2%	0.00%

Figure 5: Summary of Electrical Components Failure

Component Failure Summary

- The most frequently reported components that were serviced as a result of a windshield leak are the GEM and the fuse box.
- There are a variety of vehicle systems allegedly affected by a windshield leak.
- 18.6% of the reports, (0.04% of the total vehicle population), mention windshield wiper failures.
- 6.4% of the reports, (0.01% of the total vehicle population), mention lighting failures.
- The owner and field reports alleging a windshield leak represents a very small percent (about 0.2%) of the total vehicle population (653,471).

Environmental Driving Conditions Summary

- 68% of the reports indicated that the customer saw moisture, water or a leak during or after experiencing an electrical failure.

- 15% of the reports indicated that it was raining when the electrical failure(s) occurred.
- Only 3% of the reports, (0.004% of the total vehicle population), stated that the component failure occurred while driving the vehicle.

The results of the categorization and analysis of the owner and field reports indicate that customers experience various electrical failures affecting a number of different systems. Overall, the number of reports alleging wiper failures and lighting failures is relatively small.

Warranty

Warranty claims related to water entering the vehicle around the windshield, provided during the PE05-033 and updated during the EA05-015, are shown in Figure 6. Of the 5,903 warranty claims for repairs of windshield leaks, 650, (11%), mention front and/or rear wiper operation problems, and 532 (9%) mention lighting operation problems. Therefore, approximately 0.10% of the total vehicle population has been serviced under warranty for wiper malfunctions and 0.08% for lighting malfunctions. This small number of claims does not establish a defect trend.

PE05-033	EA05-015	Total
5,883	20	5,903

Figure 6: Warranty Claims for Windshield Leak

Testing

ODI requested NHTSA’s Vehicle Research Technical Center (VRTC) to inspect and test a subject vehicle. The purpose of ODI’s test activity was to conduct an independent examination of the windshield performance in the rain, to evaluate windshield leak, to identify the water leak path, and to witness electrical component failure. VRTC acquired a MY 2001 Ford Expedition complaint vehicle with alleged windshield leaks and numerous intermittent, electrical anomalies. The owner stated that these anomalies occurred during medium to heavy rain and included, rear windshield wipers fail to turn on, interior and dash lighting do not turn on, radio and AC blower remain on when the ignition is off. It was also stated that water occasionally dripped on the driver’s foot.

VRTC conducted an ultrasonic leak test along the periphery of the windshield. The leak test indicated a leak along the driver’s side A-pillar at the bottom and across the top of the windshield. The driver’s side A-pillar lacked sufficient sealant along the bottom of the windshield. See Figure 7. The width of the sealant should be 30mm (1.2inches) along the

entire periphery of the windshield. It was also observed that the molding across the top of the windshield was misaligned. See Figure 8. These conditions created a potential opening for water to enter into the vehicle and the GEM and/or the fuse box. The GEM and fuse box in this vehicle were found to have significant contamination and/or corrosion due to water intrusion.

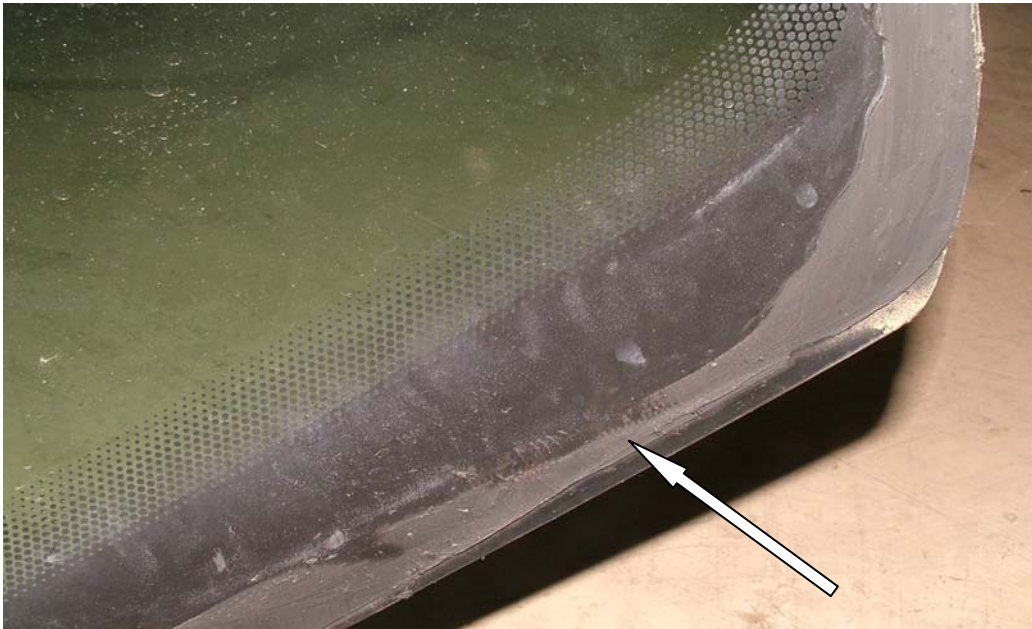


Figure 7: Insufficient Sealant

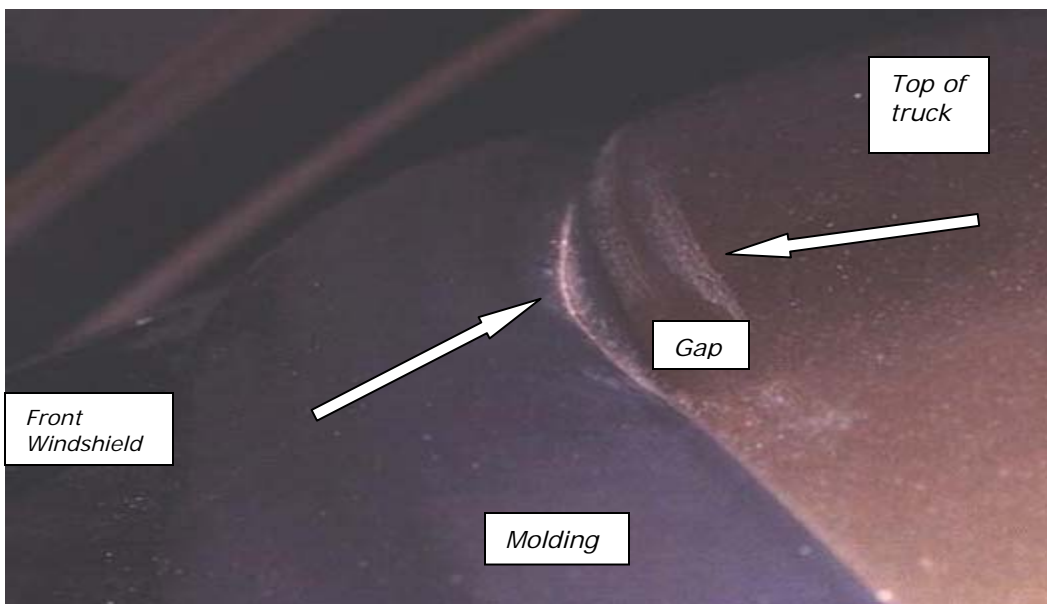


Figure 8: Misaligned Molding

VRTC also conducted a 20-minute water-soak test. ODI and VRTC developed a water-soak booth based on Ford's specifications for a 20-minute soak tank. Figure 9 shows a side view and Figure 10 shows a front view of the water-soak booth developed by ODI and VRTC.



Figure 9

Water-Soak Booth – Side View



Figure 10

Water-Soak Booth – Front View

Results of Testing

- There were gaps along the periphery of the windshield because the windshield glass was not properly sealed. There was insufficient sealant along the bottom of the glass, and the molding was misaligned across the top of the windshield.
- Initial inspection of the fuse box and GEM showed that both contained notable contamination and/or corrosion due to water intrusion.
- Testing in the water-soak booth was unable to show evidence of windshield wiper or head light malfunction, failure or intermittent operation.
- Testing in the water-soak booth was unable to show evidence of water intrusion into the vehicle, fuse box or GEM.

Manufacturer's Evaluation of the Alleged Defect

Ford states that when water follows a path along the driver's side A-pillar and then into the interior of the vehicle behind the instrument panel, the GEM and Fuse Box may suffer water exposure and the driver may observe erratic or unexpected electrical component behavior. The windshield leak locations identified in this investigation appear to occur at various points along the periphery of the windshield, and no specific location appears to predominate. Ford further states that it cannot be assumed that any vehicle reporting a windshield leak is in the same condition as built by Ford.

Ford states that windshield leaks can be the result of production variation, damage from road debris, or vehicle impacts. Ford also states that windshield leaks can be the result of aftermarket modifications, improper repair or replacement of windshield glass. "Most windshield repairs are completed by third party specialists and Ford cannot assure proper sealing of a windshield that may have been improperly replaced." Additionally, "leaks that occur after windshield replacement are not evidence of a defect under the Safety Act."

"The majority of reports that mention any effect on the wiper system mention such anomalies as uncommanded function or indicate that the wipers ceased to function as the vehicle was shifted out of "Park", which alerts an operator before the vehicle is driven that there is a wiper malfunction." Ford located only 20 reports out of a population of 653,471 vehicles, alleging a loss of wiper function while driving.

Ford estimated that at least 180,000 windshields have been replaced in the subject vehicles and that up to 70 percent of those repairs may have been improperly completed. Ford asserts that leaks that occur after windshield replacement are not evidence of a defect under the Safety Act.

With respect to owner awareness of a leaking windshield, Ford contends that owners typically witness indications of a leak prior to observing any type of electrical anomalies. If a windshield leak continues to be ignored, over time, more permanent damage may be sustained by electrical components and the issue can become chronic and require more costly repair.

Ford concludes that while the alleged defect is a source of dissatisfaction to owners, it does not constitute an unreasonable risk to the safe operation of vehicles. There have been no reported accidents or loss of control in an average of 68 months in service (Ford's response was provided in February 2006) due to windshield leaks.

ODI'S Assessment

In ODI's view, random windshield wiper and headlight failures while driving are serious concerns that pose a risk to safety. When these components fail, or function intermittently, the driver's ability to see outside of the vehicle is impaired and the loss of visibility increases the safety risk. However, ODI's analysis of the data shows that the incidence of failure for the safety-related systems due to windshield leaks (i.e. wipers, headlights, tail lights) is relatively low. Approximately 0.04% of the total vehicle population has been serviced under warranty for wiper malfunctions and 0.01% for lighting malfunctions.

A vehicle exhibiting windshield water leakage may not have a factory-installed windshield. Many of the subject vehicles have had windshield replacements, some under warranty and others by independent shops. When servicing the vehicle, Ford's technicians have no way of knowing if a windshield has been replaced or if it is original equipment. Most windshield repairs are performed under insurance, by third party specialists at non-Ford service facilities. ODI's analysis of the data indicates that the incidence of windshield wiper and headlight failure due to water leaks around the windshield seal in the subject vehicle population is relatively low. Overall, the number of reports alleging wiper failures and lighting failures is relatively small.

Reason for Closing

Notwithstanding the concerns articulated in this report, the evidence fails to disclose that leaks around the windshield seal resulting in malfunctions, failures or intermittent operation of safety-related electrical components are occurring frequently enough for ODI to pursue this matter as a defect resulting in an unreasonable risk to safety. Based on the above, the further expenditure of agency resources on this investigation does not appear to be warranted. The closing of this investigation does not constitute a finding by NHTSA that a safety-related defect does not exist. The agency may take further action if warranted by the circumstances.