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

ODI RESUME

Investigation: EA04-006
Prompted By: Preliminary Evaluation (PE) 03-044
Date Opened: 02/23/2004 Date Closed: 02/10/2005
Principal Investigator: Scott Yon
Subject: Accelerator Pedal Sensor (ETC)

Manufacturer: Ford Motor Company
Products: MY 2002 - 2003 F Series And Excursion W/7.3L Diesel and PAP
Population: 98,636

Problem Description: The accelerator pedal sensor allegedly fails and causes a loss of motive power and or the inability to increase engine speed above idle.

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	9	326	331
Crashes/Fires:	2	4	5
Injury Incidents:	1	1	2
# Injuries:	1	1	2
Fatality Incidents:	0	0	0
# Fatalities:	0	0	0
Other*:	0	8,756	8,756

*Description of Other: Warranty Claims

Action: Close this Engineering Analysis, a defect trend has not been identified.

Engineer: *D. Scott Yon* 2/10/2005 Date: *02/10/2005*
Div. Chief: *Jeffrey L. Quandt* Date: *02/10/2005*
Office Dir.: *Kathleen C. DeMeter* Date: *02/10/2005*

Summary: Failure counts from ODI's analysis are stated above; see the additional problem experience discussion in the summary report. Ford data contained duplicative reports for 4 ODI complaints and 1 crash. Three crashes were allegedly due to intermittent operation of the electronic throttle control (ETC) pedal, one crash occurred when an ETC disabled vehicle was struck by another motorist, one report contained no detail. The injuries were minor. An issue involving fixed etc pedals was investigated also, however failure reports and populations are not shown above; see summary report for detail.

Although Ford has used ETC based throttle control systems for many years, the Power Adjustable Pedal (PAP) feature was new for MY 2002. The subject ETC sensor produces two output signals which the engine management system (EMS) utilizes to: 1) determine fueling requirements; and 2) perform sensor diagnostics. One signal is linearly proportional to throttle pedal position; the second is a digital signal. By design, the detection of a sensor fault results in the engine returning to (or remaining at) the idle state.

Ford identified a defect in the PAP ETC sensor which prematurely affected an output signal; the migration of internal sensor lubricant caused a loss of proportional signal. The failure mechanism is progressive and as the sensor deteriorates, the EMS will detect a fault, store a fault code, illuminate a warning lamp, and the engine may remain at/return to idle. In the early stages, normal operation can be regained by pedal re-application. The failure progresses until the engine remains at idle. The engine does not stall, power assisted steering and braking systems are unaffected.

Ford corrected the ETC sensor defect and conducted field service action (FSA) 03B03 to replace ETC pedals, addressing 50% of vehicles. At agency request to improve completion rate, Ford extended FSA 03B03 for 6 months. Based on ODI's analysis of available data, Ford's action has appropriately resolved the ETC sensor problem in the subject vehicles. The closing of the investigation does not constitute a finding by NHTSA that a safety-related defect does not exist, and should not be considered as having any precedential value or effect binding the agency in future defect investigations.

See the attached summary report for additional information.

SUMMARY REPORT - ENGINEERING ANALYSIS 04-006

DATE OPENED: February 23, 2004 **DATE CLOSED:** February 10, 2005

SUBJECT: Failure of the accelerator pedal sensor for the throttle control system.

SUBJECT VEHICLES: Engineering Analysis (EA) 04-006 involves model year (MY) 2002 and 2003 Ford Excursion SUV's and F Super Duty trucks equipped with 7.3 L diesel engine, electronic throttle control (ETC)[1], and optional Power Adjustable Pedals (PAP)[2]. The Office of Defects Investigation (ODI) also investigated certain vehicles equipped with 7.3L diesel and standard equipment (fixed) ETC pedals, see the section titled "ODI DISCUSSION – FIXED PEDALS" for further information.

SUBJECT COMPONENT: The PAP accelerator pedal (AP) assembly and its integral throttle position sensor[3].

ALLEGED DEFECT: When the accelerator pedal sensor fails, a condition occurs which 1) causes the engine speed not to increase when the accelerator is applied, or 2) causes the engine to return to the idle state while the accelerator is being applied. In either case, a loss of motive power may occur. However, the engine does not stall and there is no loss of power assist for steering or braking. In some driving situations, the lack of throttle response may prevent the driver from operating the vehicle as expected and increase the risk of crash and injury.

BASIS AND BACKGROUND: In February 2003, Ford announced Field Service Action (FSA) 03B03 to address performance failures of the AP sensor in the subject vehicles. Ford closed the FSA in April 2004. Ford's FSA documents state that the sensor fails prematurely and can cause a loss of acceleration. Through August 2003, ODI received 6 vehicle owner questionnaire (VOQ) reports expressing a safety concern due to an alleged failure of the AP sensor. One report alleged a crash occurred when a vehicle became disabled and was struck by another motorist as it sat roadside. Based on the FSA and VOQ reports, ODI opened Preliminary Evaluation (PE) 03-044 on September 26, 2003. During the PE, Ford did not provide complete complaint and warranty information for the vehicles involved in FSA 03B03. On February 24, 2004, ODI opened EA04-006 in order to obtain the missing information and analyze it; at that time ODI had identified 6 VOQs with 1 crash.

SYSTEM DESCRIPTION: The subject vehicles incorporate an ETC system for controlling engine speed and power. The system consists of a sensor that produces electrical signals in response to pedal application. An electromechanical control system uses the sensor signals to regulate fuel delivered to the diesel engine. There is no mechanical cable or linkage between the AP assembly and any other component.

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1 Ford has used ETC on vehicles equipped with 7.3L diesel engines for more than 10 years.

2 The PAP system allows the throttle and brake pedal to be adjusted longitudinally in relation to the operator. The optional system is only available on vehicles equipped with automatic transmission.

3 The subject components contain Ford service and engineering base part number 9F836.

The subject ETC system is a second generation design; the first generation system has the same control signal functionality but a different hardware configuration[4]. The PAP system was new for MY 2002 subject vehicle production.

The 7.3L diesel uses a mechanical fuel injection pump to control fuel quantity and timing. A fuel control lever located on the injection pump is actuated by an electric servo motor. A sensor in the AP assembly produces two output signals as the throttle pedal moves. The signals are monitored by the engine management system's electronic control unit (ECU). The ECU actuates the servo motor based on the AP sensor's output signals.

The AP sensor contains four printed tracks and four wipers. Two tracks are used to produce a proportional signal, and two are used to produce the Idle Validation Switch (IVS) signal. The wipers, which consist of bent metal fingers contacting the track surfaces, are mounted on a pivot arm that rotates (sweeps) when the pedal is pressed. The proportional tracks and wipers are intended to operate in a dry state (without the presence of a lubricant) while the IVS tracks and wipers require lubricant.

The transfer characteristics of the AP sensor's two output signals are shown in Chart 1. The ECU monitors the proportional signal to establish throttle pedal position. The IVS sensor produces a digital output that changes from a low to high state near the idle position. The ECU compares the two signals in relation to one another. If the signals are implausible, the throttle returns to the idle state and a Diagnostic Trouble Code (DTC) is set in ECU memory. Ford asserts that this functionality is required for compliance with FMVSS 124, the Federal standard for throttle control systems.

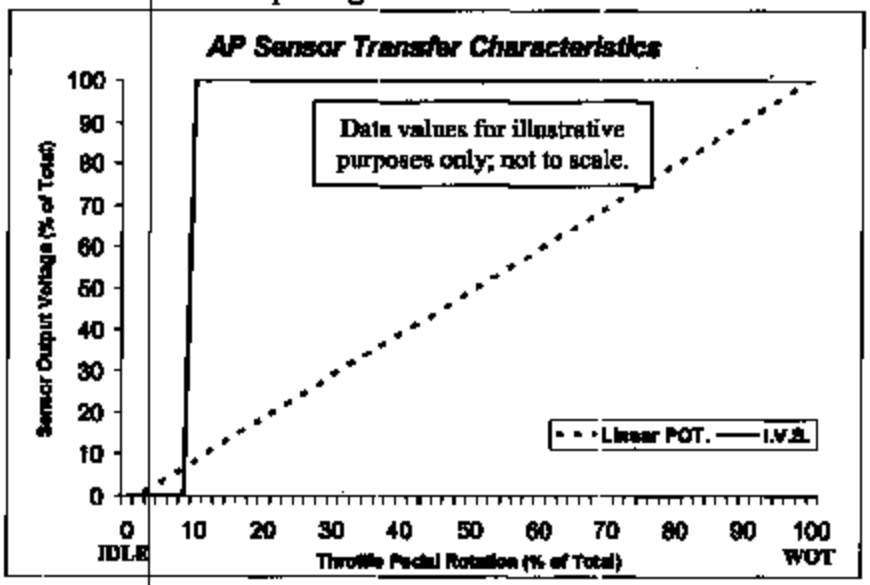
POPULATION: Table 1 shows subject vehicle counts by model and MY[5].

Table 1: Vehicle populations by Model and MY

	MY 2002	MY 2003	
EXCURSION	11784	4423	16207
SD250	31570	13888	45458
SD350	25879	10208	36087
SD450	378	110	488
SD550	301	97	398
	69912	28726	***98638***

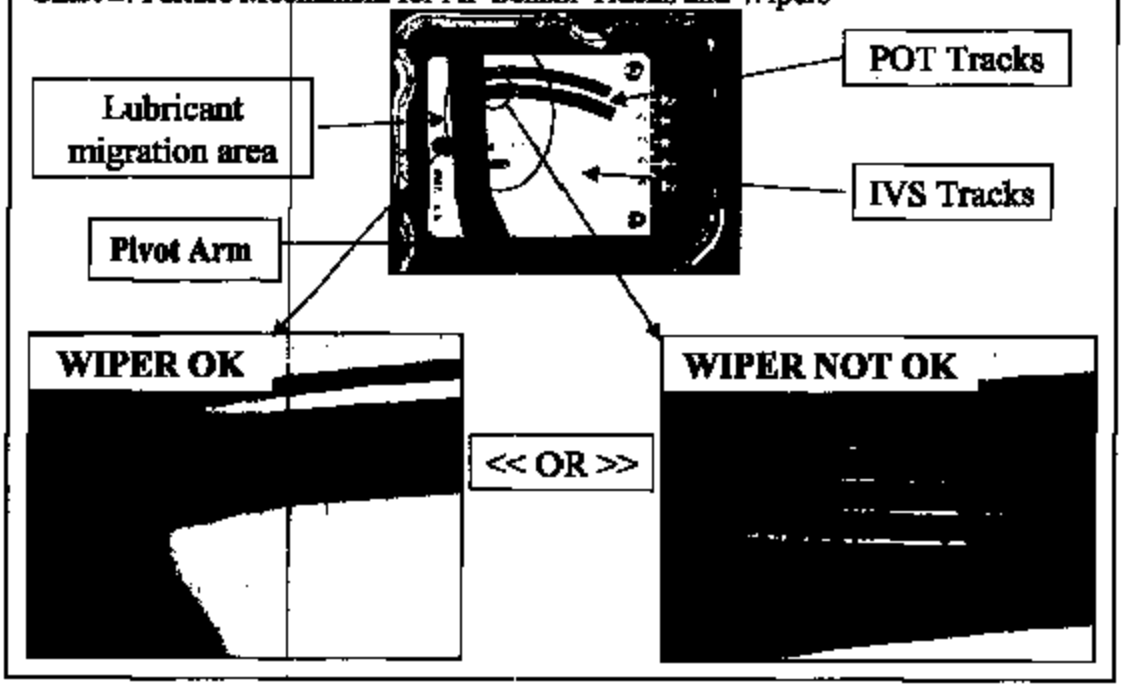
4 The first generation ETC system was used through MY 2000 production. A third generation system was introduced on MY 2003 trucks and SUVs equipped with 6.0L diesel engine. The 6.0L replaced the 7.3L engine as a running change during MY 2003 production, with the last 7.3L vehicles built late in CY 2002.
5 Subject vehicle production for MY2003 ended in November 2002 and the 7.3L diesel ceased production.

Chart 1: AP Sensor Output Signals



FAILURE MECHANISM: For the components addressed by FSA 03B03, incorrect lubricant and poor application techniques during manufacture and in-use environmental effects caused the lubricant to migrate from the IVS to the proportional track within the sensor. The lubricant created an abrasive slurry containing potentiometer track wear debris. The slurry collected on the potentiometer wiper. Cycling of the sensor through normal use of the throttle caused the wiper fingers to wear. As the wear progressed, the proportional signal became erratic and continued use resulted in a total signal loss. See the pictures in Chart 2.

Chart 2: Failure Mechanism for AP Sensor Tracks and Wipers



CORRESPONDENCE: During PE03-044 ODI sent an information request (IR) letter on October 10, 2003. The response was due on November 21, 2003. ODI granted an extension for the response to December 2, 2003. Portions of Ford's December response were submitted under a confidentiality request through NHTSA's Office of the Chief Counsel. In January 2004, ODI made an additional request that Ford responded to on February 27, 2004.

During EA04-006, ODI sent an IR on April 29, 2004, that Ford responded to on June 29, 2004. In response to further ODI requests, Ford provided copies of component drawings on August 13, 2004, a clarification to an earlier IR response (question15) on September 2, 2004, and notification of an extension to FSA 03B03 on December 1, 2004. Ford requested confidentiality through OCC for portions of these submissions.

Redacted copies of the non-confidential portions of the above documents are publicly available for download or review at NHTSA's ODI website, http://www-odi.nhtsa.dot.gov. Details on obtaining further information are also provided at the website.

PROBLEM EXPERIENCE: The failure report counts quoted in table 2 are based on ODI's analysis of NHTSA's Vehicle Owner Questionnaire (VOQ) reports and Ford IR data. For the summary, ODI counted reports containing sufficient information to indicate that a full or intermittent failure of the ETC system occurred (meaning that the engine remained at idle, returned to idle, or responded intermittently, when the accelerator was applied). Where identified, unrelated, ambiguous and or duplicate reports were eliminated. See the "ODI DISCUSSION" section for further detail.

Table 2: Failure Report Counts

FAILURE REPORT SUMMARY			
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Complaints:	9	326	331
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# Injuries:	1	1	2
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Other*:	0	8,756	8,756
*Description of Other: Warranty claims.			

In one crash report, the operator was moving the vehicle in close quarters when the accelerator failed to respond to initial applications, and then responded unexpectedly to subsequent applications causing the vehicle to strike a nearby object. In the second crash, the operator was making a low speed turn and the throttle's intermittent operation caused a momentary loss of control; the vehicle left the roadway and struck a fence. In a third, the accelerator returned to idle while the operator was accelerating in bumper-to-bumper traffic; a following vehicle failed to observe the subject vehicle's deceleration[6] and their bumpers

6 ODI notes that the brake lights did not illuminate in this situation. Vehicles with diesel engines may exhibit higher rates of closed throttle deceleration due to higher compression ratios.

contacted. A fourth report did not contain much detail; it appears the crash was minor. Two minor injuries, neither of which required emergency treatment, are alleged in these crashes.

In the fifth crash, the throttle stopped working entirely - leaving the vehicle at idle speed. The operator was able to move the vehicle to the side of the roadway. Another motorist, who was traveling in the same direction as the subject vehicle (but a few minutes behind it), veered off the road and struck the back of the disabled vehicle. The occupants of the struck vehicle were taken for emergency care but were released without treatment.

DESIGN, MATERIAL AND/OR PRODUCTION MODIFICATIONS: Ford revised the design of the AP sensor at the start of MY 2001 production. In the earlier design (GEN 1, supplied by Teleflex) the IVS and the linear potentiometer were separate and distinct components; the two devices were integrated into a single sensor in the revised design (GEN 2). Ford also chose a different component supplier for the GEN 2 AP assembly (Williams Controls). Beginning with MY 2002 production, PAP was offered as optional equipment for subject vehicles with automatic transmission. Ford chose Teleflex as the supplier for the PAP assembly.

In mid calendar year 2002, Ford became aware of high failure rates (via warranty analysis) for the subject component. Ford investigated and found the cause, which led to component changes and FSA 03B03. The volume of lubricant specified for the IVS track was reduced in September 2002 and a phenolic coating was added to the sensor circuit board (to act as a barrier for lubricant migration) in October 2002. The final countermeasures, introduced in November 2002, were the introduction of a non-migrating lubricant and use of automated lubricant application equipment (to control volume and location). GEN 2 vehicle production ceased shortly thereafter; however, the countermeasures continued for service component production. Although service part numbers remained unchanged, production part numbers did change (the parts could be distinguished) and Ford documents indicate that internal service stocks were purged once the improved component was available (and prior to FSA 03B03).

FORD'S POSITION: Ford consistently maintains that failure of the AP sensor does not represent a safety-related defect. The company states that the volume of warranty claims stems from many conditions resulting in AP replacement and that the "conditions may or may not include a verifiable malfunction of the accelerator pedal assembly and may or may not relate to engine performance." Ford also cites examples of incorrect service diagnosis and procedure. In Ford's view, post FSA 03B03 sensor performance is significantly improved (referencing fixed pedal warranty performance as a comparative basis), and proves that the countermeasures resolved AP failures. Ford notes that 4 of the 5 Ford crash reports occurred with pre-FSA 03B03 pedal assemblies. Ford also asserts that the low number of crashes and injuries confirms the AP malfunction does not pose an unreasonable risk to safety.

ODI DISCUSSION: The IVS tracks in the sensor require lubricant, while the potentiometer tracks do not. According to Ford documents, the sensor supplier was aware that lubricant migration would lead to premature failure of the sensor but chose a lubricant known by its manufacturer to be unsuitable. The documents also indicate that the sensor supplier's manufacturing process resulted in improper application of the lubricant (in both volume and placement). A combined effort between Ford and the component supplier apparently resolved

the sensor issues prior to FSA 03B03. After an internal review, Ford concluded that failure of the AP sensor did not pose a threat to safety and conducted FSA 03B03 in lieu of a recall. ODI continued its investigation in order to review the matter further.

ODI analyzed the complaint and warranty information Ford provided in its PE and EA IR responses. In response to IR requests, Ford provides data from several internal data sources, each designed to fulfill a specific Ford business purpose (see Appendix B of Ford's June29, 2004 IR Response for complete details of the various data sources). Ford searches each data source using specific criteria based on the particular investigation ODI is conducting (see Appendix B). The search process is not perfect[7], and some submitted data was determined to be unrelated. Likewise, the data is imperfect and some records were ambiguous. Ford categorized the data, and ODI conducted its own assessment and analysis. ODI focused primarily on data taken from the MORS3, CQIS and AWS databases.

The MORS3 database contains consumer data from phone and written correspondence to Ford (i.e., voice of the customer data). Ford submitted 181 MORS3 reports involving the subject vehicles. ODI determined that 19% involved a failure of the sensor (i.e., failure to respond to throttle application), 27% involved intermittent operation (failed to respond intermittently, or required reapplication), and 54% were ambiguous or unrelated. About 5% of the complaints expressed a concern for safety, and 10% indicated that a vehicle tow was involved. Most owners who experienced a problem advised that the check engine light (CEL) had been observed; in some cases normal throttle operation was reestablished by releasing and reapplying the pedal. Many consumers complained because the problem occurred several times.

The CQIS database contains data from field staff and dealership technicians (i.e., technical contacts). Ford submitted 621 subject vehicle CQIS reports[8]. About 9% of the reports involved a failure, while 40% involved intermittent operation; these reports also involved CEL illumination. Forty seven percent of the reports were unrelated or ambiguous. In 4% of the reports, an ETC related CEL was noted without a drivability symptom; 0.5% indicated a tow was required. ODI notes that technicians appeared to understand the problem and how to repair it, but provided field reports to advise Ford of frequent or multiple failures. Additionally, technicians sought insight regarding Ford changes (improved component availability) and or future actions (FSA or recall).

Ford's IR responses contained 58,000 subject vehicle warranty claim records, of which approximately 46,000 records were related to FSA 03B03 repairs. ODI analyzed the remaining 12,000 claims to assess AP warranty performance, noting that average time to failure was about 10 months at about 20,000 miles. Chart 3 below shows warranty rate versus month of vehicle production at one year in service, and identifies the month Ford began implementing sensor countermeasures for the GEN 2 AP[9]. Warranty data for the GEN 3 AP sensor was used by ODI for peer comparison, as shown in chart 3[10]. Ford warranty claims

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7 ODI recognizes that some responsive data may not have been uncovered by Ford's search methods, however it appears a diligent effort was made.

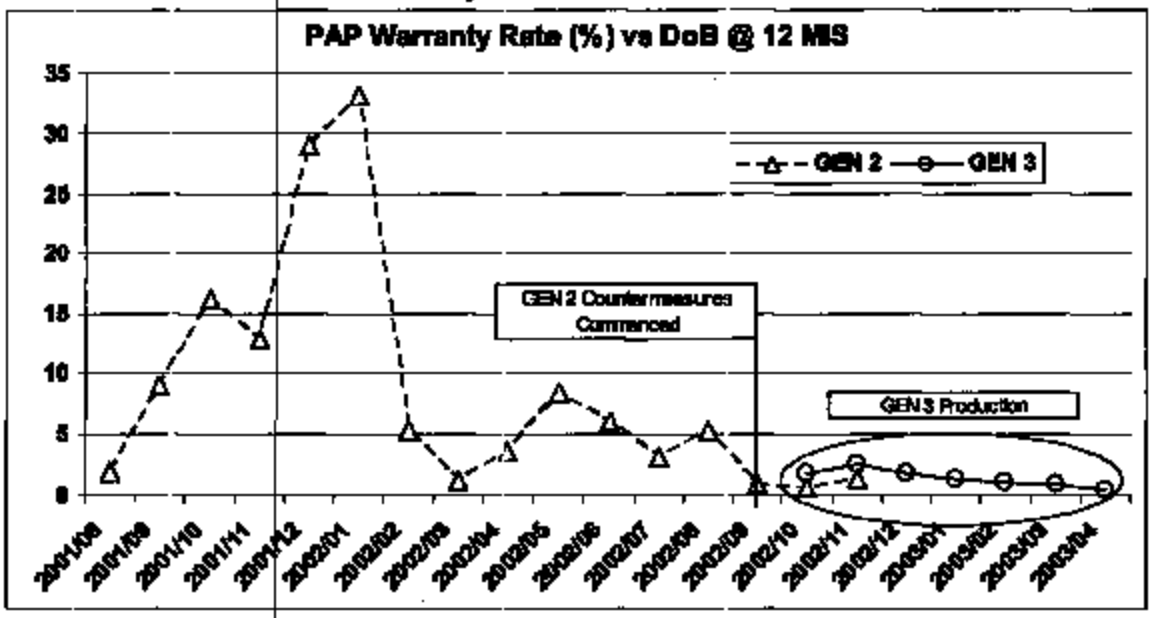
8 Duplicate reports exist between the MORS3 and CQIS data.

9 Ford launched FSA 03B03 in March 2003. Vehicles which received this action prior to significant mileage accumulation or time in service were unlikely to ever experience a sensor failure.

10 The GEN 3 AP sensor is not known or suspected to contain a quality concern or defect as was present in the GEN 2 PAP sensor.

contain customer and technician comments also. ODI assessed this information through random sample and keyword analysis to determine that approximately 22% of the claims indicated a sensor failure, 63% indicated intermittent operation, 9% indicated CEL (w/o other symptom) and 6% were ambiguous or unrelated. About 1.5% of the claims involved a vehicle tow.

Chart 3: GEN 2 and GEN 3 Warranty Rates



Based on the foregoing analysis, ODI believes that the following sequence of events (stages) are most likely to occur as the sensor fails; 1) illumination of the CEL; 2) intermittent throttle operation (the engine stays/returns to idle, pedal reapplication is needed); 3) no throttle operation (the engine remains at idle). ODI is unable to precisely predict how much time is required to get from one stage to the next. However, if taken to a dealer, a technician, through a stored DTC, can identify the sensor as the cause of a consumer complaint, even an intermittent one. The availability of improved service parts indicates that the repair would likely be successful. ODI found no evidence of engine stalling but remains concerned that accelerator control problems that lead to an uncommanded return to idle or induce operators to use the throttle inappropriately could present a risk to safety. In September 2004, when FSA 03B03 had been closed for several months, Ford's records indicated that approximately 50% of the eligible vehicles had been repaired. ODI requested that Ford re-open the program to improve the overall completion rate. On December 1, 2004, Ford agreed to a 6 month extension of the FSA.

ODI DISCUSSION – FIXED PEDALS: During EA04-006, ODI became aware of a safety allegation involving the standard equipment AP used in approximately 520,000 MY 2001 to 2003 SUVs and F Super Duty trucks equipped with the 7.3L diesel engine. Standard equipment for these vehicles is a non-adjustable fixed throttle pedal of GEN 2 design type (with different hardware and supplier than GEN 1). The rest of the ETC system (ECU, wiring, servo motors) is similar to that of the subject vehicles. The fixed pedal did not suffer the lubricant migration issue suffered in PAP sensors.

Five VOQ reports (ODI numbers 568019, 890604, 8004883, 10016862, 10017262) alleged that the throttle operated normally up to wide open throttle (WOT), at which point the engine returned to an idle state. If the throttle was released from WOT, normal operation returned. One report alleged a failure caused a collision resulting in a fatality and serious injuries. In this report, the driver of a Ford truck stopped in a lane to wait for a clearing in oncoming traffic. The driver, who was young and may have been unfamilar with the vehicle, attempted to make a left turn across opposing traffic lanes when the throttle allegedly failed to respond. The truck subsequently drifted into the path of an oncoming mini van and was struck on the passenger side. The driver of the van was killed and two occupants were injured. However, this incident resulted in litigation and ODI was unable to inspect the components or conduct interviews.

Ford's IR responses indicated that the GEN 2 fixed pedal did not fully meet an internal Ford engineering specification for throttle pedal overload[11]. High throttle pedal force can cause the linear potentiometer signal to go out of range on the high end of its output signal. When this occurs, the diagnostic system of the ECU interprets the out of range signal as a failure of the sensor and returns the engine to the idle state. To resolve this issue, Ford introduced design changes to the WOT stop and produced a new AP component for both production and service use. The revised design and its effect on overload performance are discussed in a report produced by NHTSA's Vehicle Research and Test Center (VRTC), as discussed below.

Review of Ford data revealed 46 complaints related to throttle overload failures. There were additional indications that some warranty claims involved overload failures. Some of the Ford reports indicated that very high pedal forces resulted in technicians reporting the AP assembly was visibly damaged or distorted. Some technicians, who claimed to have witnessed a demonstration of the condition, described the operator's behavior as abnormal or abusive.

ODI requested that VRTC evaluate the nature and extent of the throttle overload failures. The results of VRTC's test and field work are discussed in report number VRTC-DCD4072 (available from web site). VRTC's test work determined; 1) about 12 pounds force (lbf) was required to press the throttle to WOT; 2) potentiometer voltages above 4.5 volts DC cause the CEL to illuminate and the engine to return to idle; and 3) that forces nearing 150 lbf were required to induce a return to idle condition on a VRTC test vehicle[12]. A VRTC's field study using a 100 lbf pedal application, did not identify the concern in any of the 30 vehicles

11 FMVSS 124 does not address the subject of throttle pedal overload.

12 VRTC notes that the maximum force gradually reduced to about 90 lbf. as the testing continued, surmising that the reduction in force was due to deformation of the AP assembly due to high force cyclic loading.

inspected but did show that the improved design dual WOT stop AP assembly performed significantly better than its single stop predecessor.

Although Ford had issued an improved part, ODI was concerned that Ford had not provided any notice describing the potential overload concern or the existence of the new part. ODI communicated this concern to Ford and the company published Technical Service Bulletin 04-24-11 in November 2004.

REASON FOR CLOSING: Analysis of available data indicates that the throttle sensor in the subject vehicles failed at an unacceptably high rate, and ODI was concerned that the failures could result in safety consequences. Ford initially identified and implemented a countermeasure to correct the failures through a field service action (FSA 03B03). During the course of its investigation, ODI requested that Ford re-open the program for a 6 month period in an effort to improve the 50% completion rate, and Ford did so. A review of available data indicates that Ford's countermeasure has remedied the sensor problem. ODI's investigation also revealed that some non-subject vehicles with fixed pedal assemblies suffered uncommanded return to idle due to deformation of the pedal assembly. This deformation resulted from the application of very high forces to the pedal. Ford issued a technical service bulletin advising that severe pedal forces could damage the accelerator controls and that a new service part would resolve the issue. In light of Ford's field service action and other steps to address accelerator control concerns, ODI has determined that further investigation or action would not represent an efficient use of limited agency resources or significantly improve vehicle safety. Accordingly, ODI will close the investigation. The closing of the investigation does not constitute a finding by NHTSA that a safety-related defect does not exist, and should not be considered as having any precedential value or effect binding the agency in future defect investigations. NHTSA will take further action if warranted by future circumstances.

Safety Defects Engineer — Date: 2/10/2005

I Concur:

Chief, Vehicle Control Division — Date: 2/10/2005

Director, Office of Defects Investigation — Date: 2/10/05