ODI RESUME

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

Investigation: EA 02-015
Prompted By: PE02-021
Date Opened: 08/01/2002 Date Closed: 01/12/2004
Principal Investigator: Scott Yon
Subject: Throttle sticking closed

Manufacturer: General Motors Corp.
Products: MY 1999-2002 Silverado/Sierra/Tahoe/Suburban/Avalanche/Yukon
Population: 3,401,467

Problem Description: The throttle valve sticks in the closed position resulting in alleged excessive accelerator pedal opening effort, throttle overshoot and unexpected vehicle movement.

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	159	1,230	1,309
Crashes/Fires:	3	56	59
Injury Incidents:	0	4	4
# Injuries:	0	4	4
Fatality Incidents:	0	0	0
# Fatalities:	0	0	0
Other*:	0	291,746	291,746

*Description of Other: Throttle body related warranty claims

Action: This engineering analysis has been closed.

Engineer: *D. Scott Yon* 1/13/04 Date: *01/12/2004*
Div. Chief: *Jeffrey L. Quandt* Date: *01/12/2004*
Office Dir.: *Kathleen C. DeMeter* Date: *01/12/2004*

Summary: This investigation involves the General Motors Corporation (GM) throttle body (TB) utilized in model year (MY) 1999-2002 Silverado, Sierra, Tahoe, Suburban, Avalanche and Yukon (subject vehicle(s)) with 4.8L, 5.3L, and 6.0L engines. The TB valve may intermittently stick in a closed position. In such a situation, an operator may apply additional accelerator pedal force to increase engine speed. The application of additional accelerator pedal force, to open a stuck throttle valve, may open the throttle valve more than intended and, in turn, accelerate the engine and vehicle more than intended and reasonably expected by the driver. On August 1, 2002, the Office of Defects investigation (ODI), of the National Highway Traffic Safety Administration (NHTSA), opened this engineering analysis. The investigation revealed that two factors may cause the defect: 1) TB manufacturing process problems; and 2) accumulation of deposits (a PCV system by-product) on or around the TB throttle valve and bore.

ODI concludes that the TB performs in a defective manner after analyzing GM's data submissions, and test data collected by the Vehicle Research and Test Center (VRTC). Fifty-nine crashes are alleged to have occurred as a result of GMs TB defect. The majority of the crashes involve a single vehicle, engaging in a close quarter vehicle maneuver (or low speed), and causing only minor property damage. Four out of the fifty-nine crashes involve injury, and those injuries were minor.

Although GM's TB is defective, based on the evidence gathered, ODI has not found that the defect poses an unreasonable risk to safety. The accelerator pedal force required to open a stuck throttle valve is negligible, and the throttle valve does not stick in the open position. Therefore this engineering analysis (EA02-015) will be closed at this time. The closing of this investigation does not constitute a finding by NHTSA that a safety-related defect does not exist.

For a detailed discussion of the TB component and testing, please see the attached report.

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EA02-015 SUMMARY REPORT

SUBJECT: Throttle valve may stick in the closed position affecting MY 1999 – 2002 GM Pickups, SUVs and SU Trucks with 4.8L, 5.3L and 6.0L engines.

BASIS: The investigation was prompted by PE02-021, which was opened in February 2002. Initial Enquiry IE01-067, which formed the basis for PE02-021, referenced GM TSB # 00-06-04-007 (see Technical Service Bulletins section).

ALLEGED DEFECT: Sticking, or stiction,[1] of the throttle valve in the closed position may require additional accelerator pedal force to open the throttle valve. The additional accelerator pedal force may open the throttle valve more than intended and, in turn, accelerate the engine and vehicle more than intended and reasonably expected by the driver.

DESCRIPTION OF VEHICLE SYSTEM: Throttle bodies are used to control the flow of air into the engine, and thus the power the engine produces. GM first installed the subject TB in MY 1999 subject vehicles coincident with the introduction of the GEN III engine family. The TB consists mainly of an alloy housing, a throttle valve, a throttle shaft, a shipping air (or minimum air rate) setscrew, a PCV fresh air tube, a return spring, a throttle position sensor (TPS) and an idle air control valve (IACV). The alloy housing has a horizontal bore that is perpendicular to a horizontal throttle shaft that goes through the bore. The throttle valve is mounted to the shaft within the bore. Rotation of the throttle shaft opens or closes the throttle valve in the bore of the throttle housing, thus controlling the volume of air entering the engine. Crankcase ventilation air from the PCV system enters the TB via the PCV fresh air tube and is mixed with intake airflow that bypasses the throttle valve. A small amount of air bypasses the throttle valve when it is closed. The throttle valve also contains a small diameter hole that allows additional bypass air to enter the engine. This bypass air, in conjunction with air controlled through the IACV, provides the air an idling engine needs during closed valve operation.

A cable connects the TB and the accelerator pedal. This cable linkage rotates the throttle shaft, which, in turn, rotates the throttle valve. The cable operates the TB through a crank on the exposed end of the throttle shaft; the other end of the shaft operates the TPS, which produces an electrical signal proportional to throttle position. The electrical signal is required for engine management system purposes. As an operator's foot depresses the accelerator pedal, the throttle valve opens allowing more air into the engine. As an operator's foot is released, the throttle valve closes and reduces the amount of air entering the engine. A shaft mounted return spring returns the throttle valve to the closed position.

The shipping air setscrew controls the angle of the closed throttle valve position. The setscrew position is a critical adjustment that is set during TB manufacture. Readjustment of the setscrew in service is not expected.

The last five digits of the TB's GM part number and manufacturing date are identified by codes stamped into the TB mounting flange, as depicted in Figure 1 below. The Julian Date code follows the format 'dddy' where 'ddd' represents the day of the year (001 to 365) and 'y' represents the digit value of the year (9 = 1999, 0 = 2000, etc). For example, a date code of '0351' indicates the TB was manufactured on the 35th day of year 01, or February 4th, 2001.

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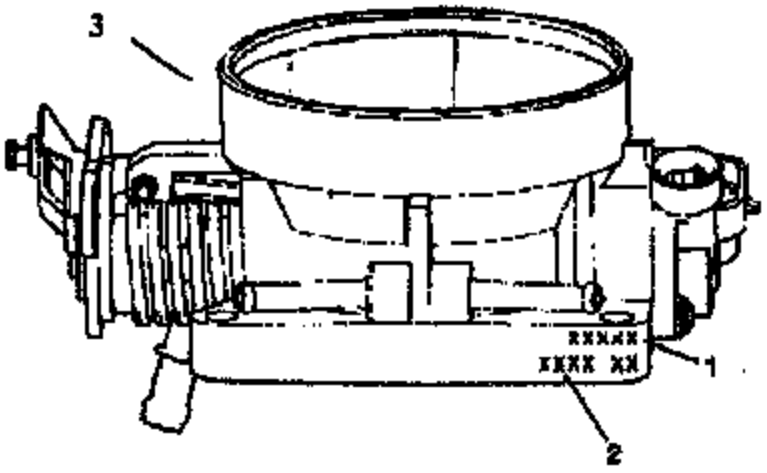
[1] Stiction: from Merriam-Websters Collegiate Dictionary 10th edition 1999 ISBN 0-87779-709-9 - n [static + friction] (1946): the force required to cause one body in contact with another to begin to move.

Figure 1: Throttle Body Identification



1 – Location of last 5 digits of TB part number
2 – Location of 4 digit Julian Date code
3 – Throttle Body

CORRESPONDENCE: In addition to information obtained during the PE02-021 investigation (dated April 29, 2002 and May 10, 2002), ODI also received information from an IR letter submitted to GM on October 7, 2002. GM provided a response dated December 9, 2002 (including a confidential submission of the same date), an initial supplemental response dated February 28, 2003, and a second supplemental response dated April 29, 2003. ODI submitted an additional IR letter to GM on June 20, 2003, which GM responded to on August 6, 2003.

VEHICLE POPULATION: GM provided Vehicle Identification Number (VIN) level detail for each of the subject vehicles, including VIN, model, model year, date of production, date the warranty coverage commenced, and the U.S. State where the vehicle was wholesaled. The following tables summarize subject vehicle populations by model year, model and engine code. The Cadillac Escalade models are removed from these tables (see ODI Analysis section).

Table 1: Populations by Model Year and Model.

	Model			
MY	C/K PU	Suburban Yukon XL Denali XL	Yukon Tahoe Denali Avalanche	Grand Total
1999	509,020			***509,020***
2000	707,156	100,143	81,376	***888,675***
2001	606,196	150,921	188,920	***946,037***
2002	624,109	139,387	294,239	***1,057,735***
Grand Total	***2,446,481***	***390,451***	***564,535***	***3,401,467***

Table 2: Populations by Model Year and Engine Code (8th VIN character).

	Engine Code				
MY	T	U	V	Z	Grand Total
1999	364,405	46,615	97,800		***509,020***
2000	633,677	104,227	150,771		***888,675***
2001	624,058	166,276	155,703		***946,037***
2002	413,707	184,995	182,457	276,576	***1,057,735***
Grand Total	***2,035,847***	***502,313***	***586,731***	***276,576***	***3,401,467***

Table 3: Engine code, displacement and GM Family (for reference).

Engine Code	Displacement (liters)	GM Engine Family
T	5.3	LM7
U	6.0	LQ4
V	4.8	LR4
Z	5.3	L59

PROBLEM EXPERIENCE: Table 4 below summarizes the failure reports at each of ODI's investigation stages.

Table 4: Breakdown of Failure Reports.

	PE02-021 Open	EA02-015 Open	EA02-015 Close
Complaints:	82	940*	1309*
Crashes:	3	50	59
Injury Incidents:	2	3	4
Injuries:	4	3	4
Fatality Incidents:	0	0	0
Fatalities:	0	0	0
Other (Warranty):	-	229,383	291,746
		* - Approximate count due to duplicate records.	

The Table 4 totals above do not contain complaints or crashes that are unrelated to the alleged defect. For example, complaints involving throttle linkage issues (e.g., throttle cable issues, or other outside influence) or driver error related crashes (e.g., pedal misapplication) are not included. The exact number of duplicate complaints between ODI and GM data cannot be determined due to insufficient or missing information.

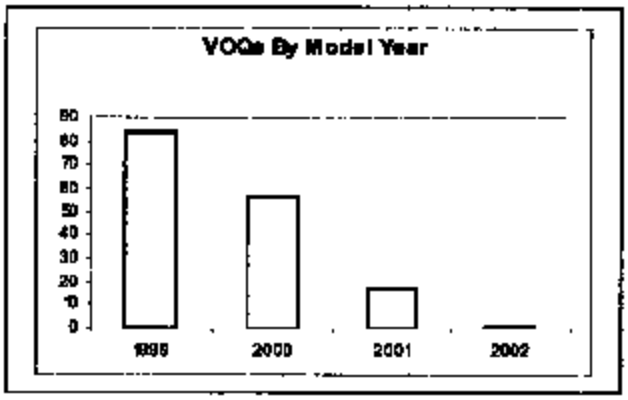
CRASHES AND INJURIES: The 59 crashes referred to in Table 4 generally occurred while operators were attempting to maneuver their vehicle in close quarter situations such as pulling into a parking space, or inching forward in bumper-to-bumper traffic. Fifty-seven of those crashes (97%) involve MY 1999 or MY 2000 vehicles. MY 2001 and 2002 have one reported crash for each MY. Vehicle operators allege that throttle sticking caused them to over apply the accelerator pedal, which led to unexpected vehicle movement. Of these crashes, 54 (92%) resulted in only minor property damage (less than $1500). The crashes are summarized in Table 5 below.

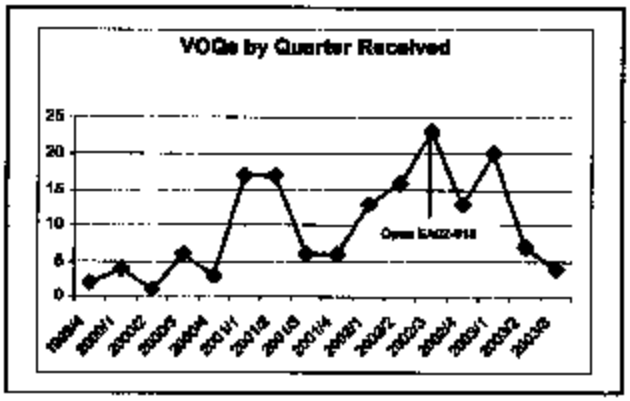
Table 5: EA02-015 Crash Types.

Crashes	Crash Type
38	Minor property damage only, single vehicle
16	Minor property damage only, two vehicles
1	Significant property damage, single vehicle
4	Injury crash
59	

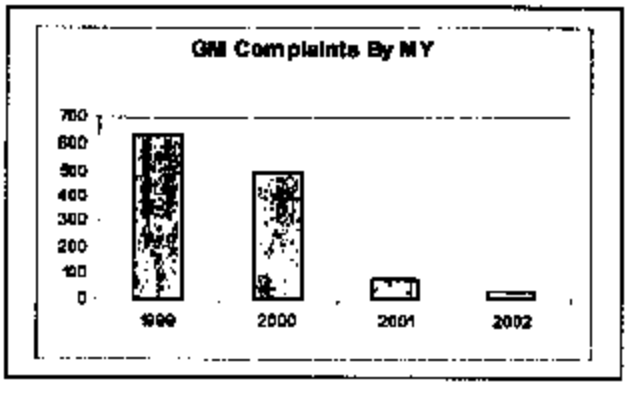
The crashes resulting in injuries referred to in Table 5 involved only MY 1999 and MY 2000 vehicles. The injuries were minor injuries. Three of the injury crashes occurred while the vehicles were being reversed. Specifically, one crash involved a situation where the vehicle allegedly experienced throttle stiction while being directed backwards. The operator pressed the accelerator pedal and the vehicle struck the person directing the vehicle. The person struck was taken to a hospital and released without treatment. The other three injury crashes involved situations where lone vehicle operators struck an inanimate object during close quarter vehicle maneuvers. These three operators have subsequently claimed that bodily injury resulted from their crashes (two drivers complain of back pain, and one complains of ankle soreness).

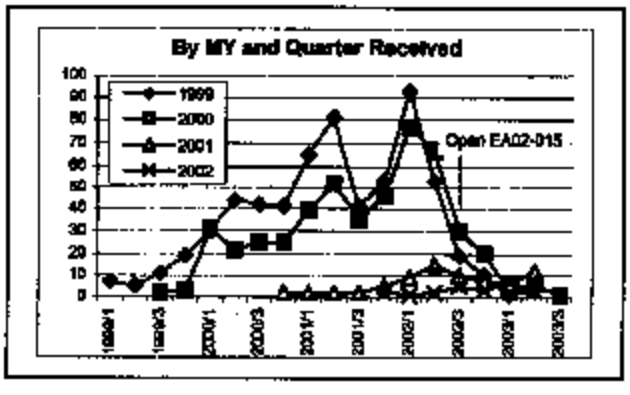
COMPLAINTS: Vehicle Owner Questionnaire (VOQ) trends by MY and quarter received are shown in the following charts.





GM complaint trends by MY and by MY and quarter received are shown in the following charts.





WARRANTY: GM provided warranty claim data once during the PE02-021 investigation, and twice during the EA02-015 investigation. GM's last data submission is current through June 2003. Warranty data for extended warranty coverage was supplied in GM's August 6, 2003 submission. GM offers extended coverage through Motors Insurance Corp (MIC) and Universal Warranty Corp (UWC). Data on GM's extended warranty claims are current through July 2003. GM selected subject vehicle related warranty claims that are coded to labor operations J5485 - Body, Throttle R&R, and J5490 - Body, Throttle Replace (* - UWC data does not contain labor operation detail). Nearly 300,000 claims were collected in total. GM's Warranty data is compiled in Table 6 and 7 below.

Table 6: Warranty claims by labor operation and MY.

LaborOp	1999	2000	2001	2002	Totals:
J5485	52671	35937	17147	3393	*109148*
J5490	107098	65400	9161	797	*182456*
*UWC Clms	73	67	2		*142*
Totals:	*159842*	*101404*	*26310*	*4190*	*291746*

Table 7: Warranty claims by labor operation and GM engine code.

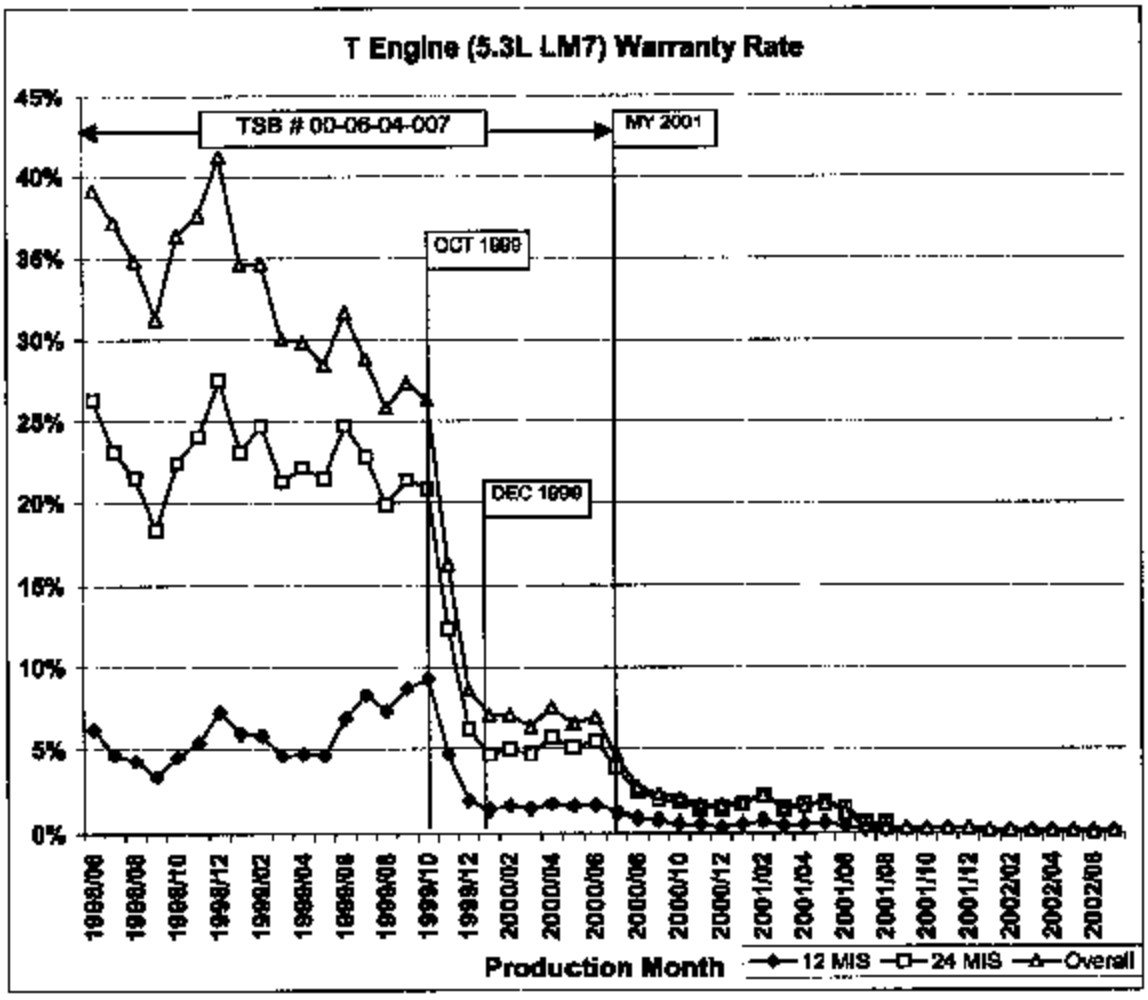
LaborOp	T/5.3L	U/6.0L	V/4.8L	Z/5.3L	Totals:
J5485	82595	8458	17348	747	*109148*
J5490	141582	9625	31055	194	*182456*
*UWC Clms	93	35	14		*142*
Totals:	*224270*	*18118*	*48417*	*194*	*291746*

As part of its analysis of the large volume of data GM supplied, ODI elected to segregate the warranty claim and population data by engine code (family), perform an analysis on each of the four data sets, and then conduct a comparison of the results. At the conclusion of its analysis, ODI did not find any significant differences based on the engine family analysis, and concluded that engine family does not affect the warranty experience of the TB common to all families. Similar comparisons were conducted between engine family and the assembly plant, vehicle body type and geographic location. Again, ODI did not find any significant differences based on the distinguishing variable, and concluded that engine family type does not affect the warranty experience of the common TB.

However, ODI gained notable information from its analysis of Warranty Rate vs. Vehicle Production Month. This analysis compares warranty claim rate (as a percentage of vehicles produced) against month of vehicle production. The analysis also considered service age of the vehicles (months in service, MIS) at 12 and 24 MIS as well as an overall rate, which disregards service age. The chart for the T engine code 5.3L (LM 7) is shown in Figure 2 below (T engine vehicles represented the largest portions of both the production volumes and warranty claims data). Charts for the other engine families show similar or lower warranty rates when compared on a build date basis.

Referring to Figure 2 below, warranty claim rates are significantly higher on vehicles produced from June 1998, the start of production, through October 1999. The overall warranty rate of the TB varies between 25% and 40%, and the two years in service rate varies between 20% and 25%. The warranty rates fall significantly during November 1999, and remain at lower levels through the end of the production period covered by TSB 00-06-04-007 (end of MY 2000). An annotation on Figure 2 identifies the production period covered under TSB #1. At the start of MY 2001 production, the warranty rates drop again and remain relatively low through the end of MY2002 production. Warranty analysis results are discussed further in following sections of this report.

Figure 2: Warranty Rate vs. Vehicle Production Month.



DESIGN CHANGES: GM has made a number of changes in the design and manufacturing processes of the subject TB. Table 8, below, details the date, subject and description of each change. GM's changes, made through November 1999, primarily addressed throttle valve to bore interface issues. The changes focused on eliminating TB housing damage, increasing closed valve clearances, obtaining consistency in setscrew adjustment, and detection of components with improper setscrew adjustment. In November 2001, GM made a change to accommodate the introduction of a fixed orifice PCV valve. This change addressed a condition known to be a causal factor for throttle stiction, i.e., PCV by-products (see Manufacturer's Evaluation and TSB sections in this report). The last two changes effect TBs sold for service replacement use only and both changes occurred after the TB's installation in vehicle production was discontinued. Design changes are discussed further in the ODI Analysis section of this report.

Table 8: TB manufacturing and design changes made by GM.

TB Manufacturing and Design Changes		
Date:	***Subject:***	***Description:***
Feb-99	TB bore deformation	New production tooling introduced in two separate stages to address insertion of the PCV fresh air tube which was determined to be deforming the TB housing and bore.
Jun-99	Throttle valve and bypass hole dimensions, DAG reduction	Changes recommended from GM study, primary objective was to increase closed throttle valve angle. DAG is an air sealant applied to the throttle shaft. Valve and bypass diameter dimensions were decreased.
	Adjustment actuator	The speed of the device that closed the valve for set adjustment was increased. The expected result was an increased closed valve angle.
Sep-99	DAG increase	The application technique was improved (over application no longer a factor), which resulted in better sealing and an increase in the closed valve angle.
Oct-99	Shipping air specification	The target for the shipping air setscrew adjustment process was increased to the high side limit, resulting in an increased closed throttle valve angle.
	Closed throttle angle	The closed throttle angle was checked after assembly to ensure a minimum angle of 2.6 degrees.
	Adjustment actuator	The actuator changed from a pneumatic type to a linear motor type device for improved set consistency.
	Vacuum application	Production tooling change applied to one of three assembly lines, and was subsequently eliminated due to unforeseen problems.
Nov-99	Torque test	100% line check on 4.8L and 5.3L TB assembly to trap defective units before leaving the production facility.
	Adjustment actuator	The actuator speed was decreased to eliminate a 'snap' effect, which resulted in an increased closed valve angle.
Nov-01	Bypass hole dimension	In conjunction with the introduction of a fixed orifice PCV valve, the bypass hole size was decreased, resulting in increased closed throttle valve angle and a reduction in the quantity of engine oil that enters the PCV and TB systems.
Oct-03	Bypass hole elimination	Service TB components only : The bypass hole on 4.8L and 5.3L service TB components has been completely eliminated resulting in an increased closed valve angle.
Oct-03	Bypass hole reduction	Service TB components only: The bypass hole on the 6.0L service TB components was reduced resulting in an increased closed valve angle.

TECHNICAL SERVICE BULLETINS (TSB): GM identifies three existing, and one future TSB relevant to this investigation and the alleged defect.

GM TSB #00-06-04-007 (TSB #1), and its subsequent revisions, addressed the manufacturing process related concerns which could lead to throttle stiction. The initial release of TSB #1 occurred in February 2000 with a subject line of "Increased Accelerator Pedal Effort (Replace Throttle Body)." TSB #1 applied to MY 1999-2000 Chevrolet and GMC C/K Pickup Models (Silverado and Sierra) with 4.8L, 5.3L, or 6.0L V8 engines that exhibited higher than normal accelerator pedal effort from the closed throttle position. TSB #1 instructs technicians to verify that the throttle cable or linkage is not the cause of the condition, and if not, to remove the TB and check the date code stamped in the mounting flange of the TB (see Figure 1). If the date code indicates the TB was manufactured on or before the 297th day of 1999 (October 25, 1999), technicians were instructed to replace it with a new component.

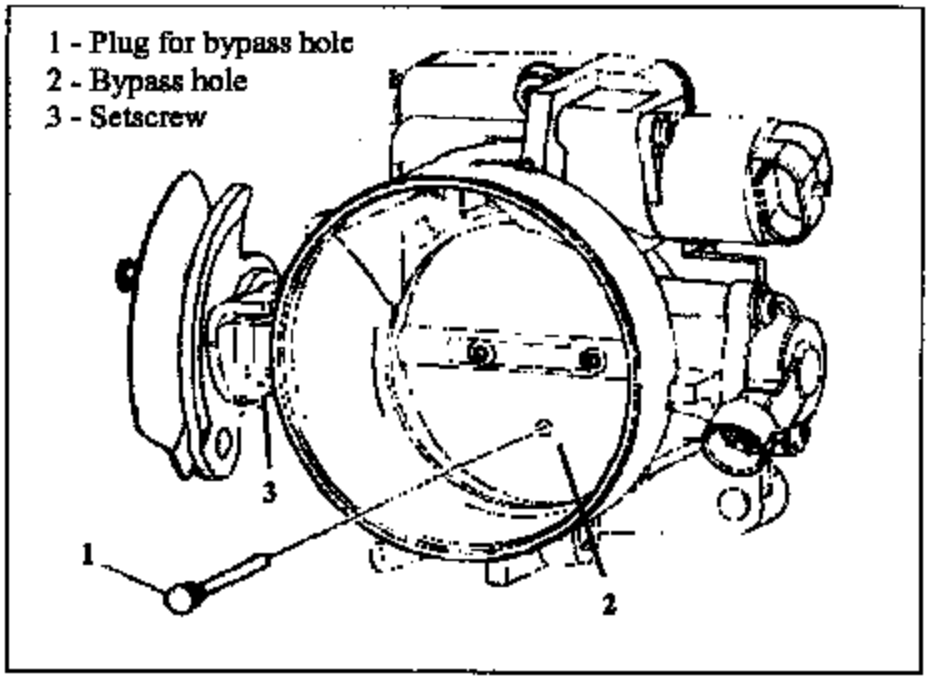
GM TSB #01-06-01-029 (TSB #2), and its subsequent revisions, addressed higher than normal oil consumption rates on MY 1999 to MY 2002 subject vehicles with 4.8L, 5.3L and 6.0L engines. TSB #2 states that the cause of the oil consumption may be due to the PCV valve air flow rate under certain engine operating conditions. TSB #2 has no obvious connection to throttle control concerns; however the document is referenced in TSB #02-06-04-054 which addresses throttle stiction. GM notes that the fixed orifice PCV valve reduces the volume of engine oil entering the PCV system and the TB. Reduced oil entry inhibits the formation of deposits in the TB. GM further advised that the fixed orifice PCV valve was incorporated into subject vehicle engine production commencing in November 2001, coincident with other TB changes (see Design Changes Section).

GM TSB #02-06-04-054 (TSB #3), and its subsequent revisions, is applicable to MY 1999 – 2002 subject vehicles equipped with the 4.8L and 5.3L engines. TSB #3 was issued in November 2002 with the subject lines "Increased Accelerator Pedal Effort (Clean Throttle Body and Adjust Blade);" it was issued to address higher than normal accelerator pedal effort from the idle position. TSB #3 was subsequently revised to include a reference to idle instability.

TSB #3 states that deposits in the TB bore may cause a throttle stiction condition. Technicians were instructed to confirm the vehicle had a fixed orifice PCV valve installed, as described in TSB #2. After confirming a fixed orifice PCV valve was installed, the technician was instructed to first clean the TB bore and then to eliminate the air bypass hole in the throttle valve using a specially developed plug, as shown in Figure 3 below. Using GM service diagnostic tools, the technician then adjusts the shipping air setscrew to increase the closed throttle valve angle, thus compensating for lost bypass air. The setscrew adjustment increases the clearance between the throttle valve and bore, making it more difficult for engine deposits to accumulate and thereby reducing the likelihood of throttle stiction occurring.

GM intends to publish a TSB for subject vehicles equipped with 6.0L engine that will address throttle stiction in a similar manner as described in TSB #3 (TB cleaning, then plugging the bypass hole and adjusting the shipping air screw). The future release of this TSB is set for quarter one 2004.

Figure 3: TSB #02-06-04-054 procedure.



MANUFACTURER'S EVALUATION: GM recognizes two causal factors that contribute to higher than normal accelerator pedal effort: 1) TB manufacturing process problems; and 2) the accumulation of 'gummy coke deposits' in the TB.

GM's first causal factor, manufacturing problems, is the focus of TSB #00-06-04-007 (and revisions). This TSB addresses higher than normal accelerator pedal effort caused by the manner in which TB's, used in MY 1999 and some MY 2000 subject vehicles, were manufactured. The manufacturing methods used in producing those TBs may have resulted in deformed TB housings and bores which may cause the TB valve to become tight in the closed position. Additionally, those TBs may have been manufactured with insufficient closed throttle valve angles, which can also cause throttle stiction. Throttle bodies manufactured since November 1999 apparently are not affected by these manufacturing issues.

The second causal factor GM recognizes involves the formation of a 'gummy coke deposit' on the throttle valve and bore. The buildup of deposits may cause the throttle valve to stick in the closed position and thereby cause higher than normal accelerator opening effort. GM states that the TB deposits are the result of engine oil compounds that enter the intake manifold through the engine PCV system. The engine deposits accumulate gradually with vehicle usage. A service procedure addressing this condition is presented in TSB #02-06-04-054 (and revisions) for the 4.8L and 5.3L engines. A TSB for the 6.0L engine is under development at the time of this writing.

GM alleges that either or both factors may produce a throttle stick condition that is intermittent in nature. GM no longer uses the subject TB in its vehicles. GM utilized an electronic throttle control (ETC) based component that does not utilize a throttle cable commencing with MY 2003 production. GM maintains that the higher than normal accelerator pedal effort, experienced when moving the throttle valve from the closed position, is not a safety related defect.

TESTING: In October 2002, ODI forwarded a request to NHTSA's Vehicle Research and Test Center (VRTC) to perform testing of subject vehicles. The objective of the testing was to determine if the alleged throttle control condition and the resultant effect on vehicle operation represented an unreasonable risk to motor vehicle safety. To assist in their understanding of the condition and the required test work, ODI provided VRTC complaint data, copies of GM documents, electronic data, and warranty return sample TB's (provided by GM). Regular communications between ODI and VRTC occurred as required to facilitate the test work. ODI and VRTC met in August 2003 at VRTC's East Liberty, Ohio facility to review the status of the test work.

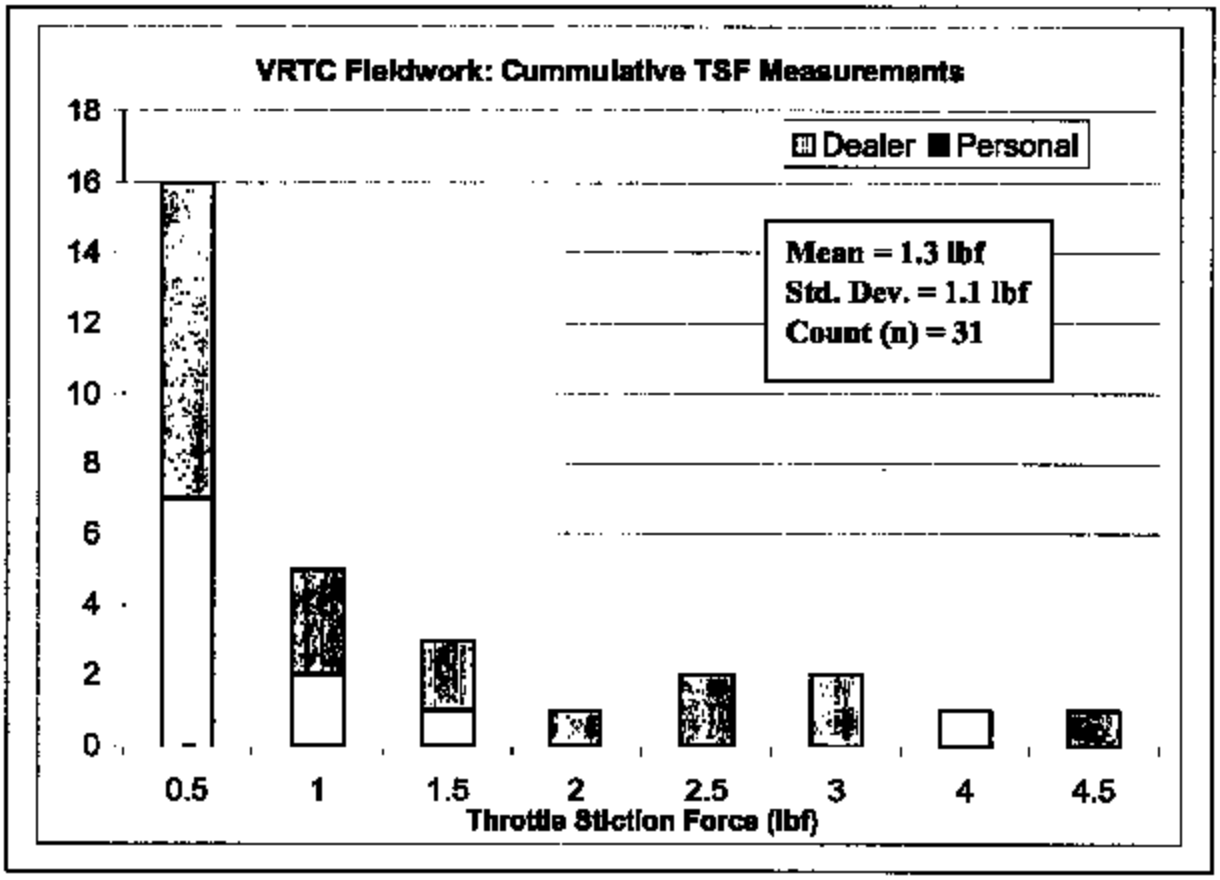
To facilitate their fieldwork, VRTC obtained from the Ohio Bureau of Motor Vehicles a listing of Ohio owners of subject vehicles. The listing was used to mail a questionnaire to subject vehicle owners in the two counties surrounding the VRTC facility. The questionnaire inquired about the presence of the alleged defect in the vehicle. VRTC reviewed questionnaire responses and identified potential participants for subsequent contact. In total, VRTC identified 20 personally owned vehicles (18 MY 1999, 1 MY 2000, 1 MY 2001) and made arrangements to conduct field inspections. VRTC selected 11 additional subject vehicles (6 MY 1999, 3 MY 2000, 2 MY 2001) in an arbitrary manner (they were selected from used vehicle sales lots) and conducted field inspections. A total of 31 vehicle inspections were conducted, 20 personally owned and 11 dealer owned.

Vehicle information (make, model, MY, VIN, mileage, engine, trans, etc) and owner information (name, address, phone) was recorded. TB temperatures, and pedal and body force measurements were also recorded. Pedal force refers to throttle opening force measurements taken at the accelerator pedal. Body force refers to opening force measurements taken directly at the throttle cable crank (TB shaft). A comparison of the pedal and body force measurements confirmed in each inspection that the TB was the source of atypical stiction, i.e., this eliminated the throttle cable and or pedal linkage as atypical stiction sources. VRTC also considered TB temperature effects ('as found' versus 'normal operating') and the effects of engine operation (running versus not running).

The pedal force measurements were used to determine the throttle stiction force of the vehicle. VRTC recognized that some stiction would exist normally in all vehicles, since the TB is mechanical and is operated through a mechanical linkage system. To determine the throttle stiction force, VRTC first measured the maximum pedal force required to open the throttle from the closed position (typically about 5.0 pounds force (lbf). on a 'normal' vehicle). VRTC then measured the force required to maintain the throttle in an open state just off the closed throttle position (typically about 4.5 lbf on a 'normal' vehicle). The difference between these two measurements represents the throttle stiction force. A difference of about one half (.5) lbf is considered typical, anything greater than .5 lbf is considered atypical.

An analysis of the inspection data was performed. A throttle stiction force of about 0.5 pounds was present in 16 of the vehicles tested. This minimum force is considered typical of a normally operating vehicle and results from natural frictional forces that exist in the throttle control system. Fifteen of the vehicles inspected displayed throttle stiction forces higher than 0.5 lbf; 11 of the 20 (55%) personally owned vehicles, and 4 of the 11 (36%) dealer owned vehicles. A maximum throttle stiction force of 4.5 lbf. was measured in one vehicle inspection (the worst-case), a force about twice the typical pedal opening force. For the 31 vehicles inspected, an average throttle stiction force of 1.3 lbf. was found, and a standard deviation of 1.1 lbf was calculated. The results are displayed graphically in figure 4.

Figure 4: VRTC Fieldwork results



Vehicle driving assessments were also conducted during the August 2003 meeting. VRTC engineers temporarily obtained two subject vehicles for use in assessment exercises that were conducted within the East Liberty facility. A 4.8L equipped MY 2001 Chevrolet Silverado with 63,500 miles that was manufactured in November 2000 (VIN 1GCEK14V81Z197105) did not display higher than normal throttle stiction forces and was used as a baseline for assessment exercises. A 6.0L equipped MY 1999 GMC Sierra with 87,500 miles that was manufactured in April 1999 (VIN 2GTEK19TXX1553269) was modified by VRTC to simulate the worst-case throttle stiction observed from fieldwork. Three assessment exercises were conducted: driving on high friction coefficient (dry) road surfaces, driving on very low friction coefficient test surfaces, and maneuvering in close quarters.

Two VRTC engineers and one ODI engineer conducted the driving assessments. The VRTC engineers are recognized by NHTSA as professional test drivers whose regular job responsibilities include driving vehicles for the purposes of assessing safety risks. At the conclusion of the assessment, the VRTC and ODI engineers all stated that the vehicle (worst case atypical throttle stiction) was not hard to control and required no difficult or unusual control inputs even when maneuvering in close quarters.

ODI ANALYSIS: The Cadillac models included at the opening of this investigation were subsequently determined to be manufactured with an ETC based TB design; they are therefore removed from scope and are not included in the population number identified on the closing resume.

ODI reviewed the complaint data that GM had submitted in response to ODI's information requests. In ODI's review of the complaints, especially those where crashes and or injuries were alleged, an attempt was made to discern the cause, or likely cause of the complaint, crash or injury. Complaints where the record identified that the cause of the incident was unrelated to the alleged defect were removed from ODI's final counts. For instance, in two unrelated complaints supplied by GM, operators complained the throttle stuck partially open and resulted in unwanted acceleration of the vehicle; dealership technicians determined the problem was caused by road debris (gravel) that had become lodged between the throttle stop and throttle crank. Accordingly, these complaints were removed from ODI counts. In the absence of any meaningful reason to exclude them, complaints were counted.

In order to better understand incidents which prompted complaints, ODI conducted phone interviews of both ODI and GM complainants. In most of the interviews, owners described a throttle stiction type condition that occurred on an intermittent basis. Interviewed complainants reported varying impacts of the condition on vehicle operation, ranging from minimal to severe. None of those interviewed provided meaningful (objective) information regarding the severity (or force levels) of throttle stiction. Some of those interviewed reported their vehicle had been serviced for the condition but the symptoms returned. However, none of these repair attempts involved application of the TSB #02-06-04-054 process.

Complainants also had varying levels of concern for the occurrence of stiction. In response to a question, a minority number of complainants expressed a safety concern. Complainants sometimes reported driving techniques they had adopted which allowed them to overcome the condition when it occurred. Complainants stated that they felt these techniques allowed them to 'safely' operate the vehicle; however some had concern about an unfamiliar or inexperienced operator driving the vehicle.

As discussed previously, ODI also conducted an analysis of GM's warranty claim data. ODI notes that GM warranty data does not contain sufficient detail to fully discern the exact nature of the condition the owner experienced. For instance, GM warranty data doesn't contain customer problem descriptions or technician repair comments, nor does it reliably identify a relationship to a particular TSB procedure. Some level of warranty claim rate is considered normal for most vehicle systems. However, GM's double-digit warranty claim rate for its throttle body is clearly abnormal and a strong indicator of a systemic concern. Noting the production dates where warranty rate changes occurred, and comparing them to dates where TB manufacturing changes occurred (see Design Changes section) strongly supports the existence of a defect trend.

ODI also reviewed GM's technical and engineering data submissions. This included documentation related to design and manufacturing changes, engineering studies and investigations, component drawings and other documents that discussed the technical aspects of the TB and the throttle stiction concern.

Colloquially GM engineers refer to the subject TB as the "2 degree" TB, and the predecessor design as the "5 degree" TB. The terms are in reference to the closed throttle valve angle. More specifically, the term refers to the angle a centerline that both travels through a closed throttle valve and is perpendicular to the throttle shaft would make with a vertical bore centerline that both travels through and is perpendicular to the throttle shaft, assuming the TB is mounted to a

vertical surface. Due to component tolerances and other design, mechanical and manufacturing limitations, a zero degree angle is considered impractical.

For MY 1999, in conjunction with other GEN III changes, GM changed its throttle body specification to the '2 degree' TB design. In actuality, the design specified valve angle was 2.77 degrees +/- .75 degrees (noting that one of the manufacturing revisions GM implemented was to reject any TB with a closed angle less than 2.6 degrees). Nevertheless, the design change represented a significant reduction compared to the 5-degree TB design that did not display a significant throttle stiction condition.

With the 2-degree design change came reduced clearances between the circumference of the closed valve and the bore of the TB. Beneficially, this reduces the amount of air that bypasses a closed valve. This characteristic may have advantages in engines with low idle air demand, however the reduced air benefit comes at the risk of increased susceptibility to manufacturing/component variation and/or a sensitivity to bore contamination. When either or both are present, there is a high likelihood that a closed valve will stick or bind in the throttle bore at some level of severity.

In review of manufacturing and design changes, ODI finds that GM's objectives focused on eliminating assembly damage and on accurately controlling, and/or increasing, closed valve to bore clearance. The October 1999 changes increased the target throttle valve angle setting to the high end of the specification, which has the effect of increasing closed valve to bore clearances. GM also began identifying TB's with angles below a 2.6-degree angle and prevented them from leaving the production facility in that condition. These changes had a significant effect on the warranty performance of the TB, as can be seen in Figure 2. The strong correlation between the manufacturing revision data and warranty performance change suggests the scope identified for TSB #00-06-04-007 was accurate.

In addition to reducing the volume of PCV born engine oil and related crankcase compounds entering the TB via the PCV fresh air tube, the November 2001 design change incorporating a fixed orifice PCV valve also had a beneficial impact on the closed valve angle; the change reduced the diameter of the bypass hole in the TB valve. The closed throttle valve angle specification thus changed from 2.77 +/- .75 degrees to 3.35 +/- .75 degrees. In addition to this benefit, the formations of deposits in the TB valve are also inhibited by the reduction of oil and other engine compounds entering the PCV system.

According to GM, the October 2003 design change to eliminate the bypass hole in the valve for 4.8L and 5.3L service replacement TB's results in a further increase in the closed valve angle position. The closed valve angle increased from 3.35 +/- .75 degrees to 4.3 +/- .75 degrees. For the 6.0L engine service TBs, the valve bypass hole diameter was reduced (from 3.65 to 2.0 +/- 0.1 mm) resulting in a change in closed valve angle to 4.3 +/- .75 degrees.

In August 2003, ODI visited VRTC to discuss their fieldwork and to take part in vehicle driving assessments. Two vehicles were assessed, and ODI experienced throttle stiction on one; VRTC considered the stiction condition representative of the worst-case seen in fieldwork. Although not a trained professional test driver, the ODI engineer who performed the driving assessment considered the condition to be unspectacular and of no serious consequence to the safe operation of the vehicle.

Finally, ODI reviewed its defect investigation and safety recall databases to identify vehicles with similar alleged defects. The majority of historical investigations and recalls involve conditions of the throttle sticking in an open or partially open position (i.e., failure to close). Historically, defects involving a throttle valve sticking in an open position causing vehicle acceleration after the accelerator pedal is no longer depressed, have traditionally resulted in a safety recall.[2] Investigation EA02-015 deals with a throttle valve stuck in the closed position, and not in the open position. Thus, investigations and/or recalls of stuck open throttle valves were not considered relevant to this investigation (EA02-015).

However, one investigation, and its related recall is relevant to the issues in EA02-015. Investigation EA99-001, with MY 1997 - 1998 Ford Explorer/Mountaineer (equipped with 4.0L SOHC engine) as subject vehicles, involve causal factors similar to those in EA02-015, (i.e., new TB design with reduced valve clearances and accumulation of engine deposits). Complainants in EA99-001 alleged two conditions; a sticking of the throttle in a partially open position causing unintended engine acceleration, and/or a sticking of the throttle in the closed position resulting in higher than expected opening effort and subsequent throttle overshoot. EA99-001 resulted in safety recall 00V-422000 which involved 220,000 subject vehicles not previously remedied by an existing Owner Notification Program (ONP 99M02) that Ford issued in May 1999.

Review of EA99-001 shows that about 80% of the complaints involve throttles sticking in the closed position, with the other 20% involving the throttle sticking in an open, or partially open position. Depending on how the subject population for EA02-015 is defined (all MYs or just MYs 1999 - 2000), the complaint rate in EA99-001 is 5 to 10 times higher, the crash rate is 2 to 5 times higher, and the injury rate is 3 to 9 times higher than EA02-015. Objective comparisons of the severity of the throttle stick condition in each investigation cannot be obtained,[3] however higher complaint and crash rates are generally considered indicative of a more severe condition.

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[2] See Recall 99V-062001, Ford (Cruise control cable can interfere with speed control servo pulley preventing the throttle to return to idle after disengaging the cruise control); Recall 98V-045002, 1997-1998 Chrysler Sebring (Dash panel pad can interfere with throttle cable control causing the throttle plate to not return to the idle position after the accelerator pedal is released); and Recall 97V-04600, 1994-1997 SAAB 900 (Corrosion around the throttle control lever can cause the throttle plate to fail to return to the closed position after accelerator pedal is released).

[3] ODI did not conduct objective measurement of throttle stick force involved in EA99-001 and VRTC did not conduct related testing or fieldwork. Ford provided data under confidentiality, obtained through their own testing conducted in connection with EA99-001, which included objective throttle force measurements. However, due to the differences in the way the Ford testing was performed, the results cannot be compared to those obtained in EA02-015 fieldwork.

CONCLUSIONS AND REASON FOR CLOSING: A new design GM TB, introduced in the MY 1999 subject vehicles, contains a defect that is most likely caused by either of the following two factors: 1) TB manufacturing process issues (which produced damaged TBs, or TBs with insufficient throttle valve to bore clearances); and 2) the accumulation of PCV system related deposits on or around the throttle valve and bore. Either condition, or both conditions working in conjunction with each other, may cause the throttle valve to stick in the closed position. In such a situation, the operator may apply higher than normal accelerator pedal effort to open the stuck throttle. The application of additional accelerator pedal force may open the throttle more than intended and, in turn, accelerate the vehicle more than intended and reasonably expected by the driver.

However, for the following reasons, ODI concludes that there is insufficient evidence to support the finding of a safety-related defect attributable to the throttle stiction condition at this time. First, GM's TB sticks only in the closed position. ODI did not identify cases where the TB stuck in an open position due to the defect. Second, allegations that the throttle stiction forces were excessive were not supported by ODI analysis or VRTC fieldwork. Third, at the conclusion of driving assessments, VRTC and ODI engineers stated that the assessed vehicle (worst case atypical throttle stiction) was not hard to control and required no difficult or unusual control inputs even when maneuvering in close quarters. Finally, the defect has occurred at low speeds in parking maneuvers.

Accordingly, this investigation is closed. The closing of this investigation does not constitute a finding by NHTSA that a safety-related defect does not exist. The agency reserves the right to take further action if warranted by the circumstances.

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Vehicle Control Division — Date: 1/13/04

Kathleen DeMeter, Office Director
Office of Defects Investigation — Date: 1/13/04