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

ODI RESUME

Investigation: EA04-025
Prompted By: PE04-039
Date Opened: 08/26/2004 Date Closed: 12/22/2005
Principal Investigator: Scott Yon
Subject: False Park

Manufacturer: DaimlerChrysler Corporation
Products: 2003-2005 Dodge Ram 2500/3500 Diesel With Auto. Transmission
Population: 250,285

Problem Description: The vehicle may experience a reverse powered rollaway incident after an attempted shift into "Park" with the engine running and the park brake unsecured.

FAILURE REPORT SUMMARY

	ODI	Manufacturer	Total
Complaints:	81	209	250
Crashes/Fires:	69	165	205
Injury Incidents:	14	21	27
# Injuries:	14	21	27
Fatality Incidents:	2	2	2
# Fatalities:	2	2	2

Action: This Engineering Analysis has been closed, Recall 05V-462.

Engineer: *D. Scott Yon* 12/22/05 Date: *12/22/2005*
Div. Chief: *Jeffrey L. Quandt* Date: *12/22/2005*
Office Dir.: *Kathleen C. DeMeter* Date: *12/22/2005*

Summary: The subject vehicles are heavy duty pickup trucks with diesel engines and automatic transmissions commonly used for commercial and work purposes. A column mounted shift lever is used for gear selection and an electronic PRNDL on the instrument panel provides gear position information to the driver. The subject vehicles are also equipped with a brake-transmission shift interlock that prevents the shift lever from being moved from the Park position (when the engine is on) unless the brake pedal is depressed and an ignition-shift interlock that prevents key removal unless the transmission is in the Park position.

Complainants generally report that the vehicle was being operated in a forward gear and brought to a stop through brake application on a flat level surface, at which time the operator moved the shift lever to engage the park position. The operator then opened the driver side door and, without verifying Park engagement (e.g., PRNDL gear indication), securing the park brake, or turning the engine off, exited the vehicle. Initially, no vehicle movement was apparent, however, a short time later, typically reported as 10 to 30 seconds, the vehicle moved rearward under engine power. The incident often ended in a vehicle crash, and sometimes involved serious injury. Two fatalities are alleged.

ODI's analysis of test vehicles and some incident vehicles found no evidence to indicate that a shift lever properly placed in Park could unintentionally (i.e., without driver input) disengage from that position. However, ODI did find that the shift lever could be inadvertently placed, and remain at rest, within an intermediate position between the Park and Reverse gear positions. When placed in such an intermediate position, the vehicle can experience a delayed pressurization of the Reverse hydraulic circuit that is sufficient to cause the vehicle to roll rearward under power. The delay period allows sufficient time for operators to exit the stationary vehicle without perceiving that the shifter is not in Park. The summary report discusses the technical analysis of this issue in greater detail and compares the frequency of these incidents in the subject vehicles to other peer vehicles that ODI examined.

As described in their October 4, 2005 letter to NHTSA, DaimlerChrysler Corporation (DCC) will conduct a Safety Recall (NHTSA Recall No. 05V-462, DCC No. E17) to install an Out-Of-Park alarm system in the subject vehicles. The alarm will provide audible and visual feedback to alert the driver, and others, if the driver attempts to exit the vehicle while the engine is running and the shift lever is not in the Park position. The timing of DCC's action has yet to be determined.

SUMMARY REPORT - ENGINEERING ANALYSIS (EA) 04-025

DATE OPENED: August 25, 2004 **DATE CLOSED:** December 22, 2005

SUBJECT: False Park.

SUBJECT VEHICLES: The scope of the investigation included 250,285 model year (MY) 2003 to 2005 Dodge Ram 2500/3500 pickups with diesel engines and automatic transmissions.

ALLEGED DEFECT: The inadvertent powered rearward movement of the vehicle from a parked position, where the driver alleges the gearshift lever was in Park.

BASIS AND BACKGROUND: Preliminary Evaluation (PE) 04-039 was opened in April 2004 and subsequently upgraded to EA04-025. The basis for investigation was Office of Defects Investigation (ODI) vehicle owner questionnaires (VOQs). Additionally, two prior investigations, EA96-006 and EA01-017, involved powered reverse rollaway incidents in DaimlerChrysler Corporation (DCC) vehicles that utilized transmissions of a similar design and component content.

SYSTEM DESCRIPTION: The subject vehicles (SVs) are equipped with three speed automatic transmissions, which are referred to as the "RE" model, for both two and four wheel drive configurations. A description and explanation of the pertinent internal and external components of the RE transmission follows.

Internally, a valve body within the transmission controls the flow of pressurized transmission fluid, via positioning of a spool valve, which in turn controls gear engagement. The position of the spool valve is controlled by the inner manual lever (rooster comb), which also actuates the park pawl via the park apply rod. When the column mounted shift lever is placed in Park, the park pawl mechanically locks an annulus gear mounted to the output shaft of the transmission, which restricts output shaft rotation and vehicle movement. If the park pawl is unable to engage the annulus gear due to tooth abutment, a lost motion spring on the apply rod is compressed[1]; if subsequent output shaft rotation occurs, the spring force ensures the park pawl engages the annulus immediately, thus preventing further shaft rotation. The inner manual lever has six (6) detent[2] positions (one for Park, Reverse, Neutral, etc.) and the detent force is provided by a spring loaded captive detent ball[3]. The manual lever also actuates a position sensor that controls PRNDL illumination, park/neutral starting, and operation of the reverse lights. The position sensor and shift lever are not internal to the transmission.

Externally, the manual shaft passes through the transmission housing from the inner manual lever such that rotation of the shaft actuates the inner manual lever. One end of the gear shift cable attaches to an outer manual lever, which is indexed and pinch clamped to the exposed end of the manual shaft; the other end of the cable attaches to the shift lever assembly[4] mounted on the steering column. Integral to the shift cable is an electrically actuated blocking device for the brake-transmission shift interlock (BTSI) system and spring loaded devices for accommodating shift cable and BTSI system adjustment. The shift lever moves circumferentially about the steering column for

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[1] The energy stored in the lost motion spring acts to push the manual lever out of the park position towards reverse.

[2] The detent mechanism is intended to provide the operator a sense of feel during shifting and acts to hold the mechanical components in a certain orientation to one another, e.g., in the detent reverse position.

[3] Compared to its non-DCC peers, the RE transmission was unique in its use of the captive ball and spring design approach. GM and Ford peer vehicles use a cantilever spring and roller type design, see Figure 4.

[4] The shift lever assembly is also involved in the ignition-park interlock system, which prevents ignition key removal unless the shift lever is in the Park position.

gear selection[5]. The end of the shift lever situated near the steering column has a tang that interacts with a gating device (which is integral to the assembly, see Figure 5) that influences the movement and positioning of the lever[6]. An electronic PRNDL, located on the instrument panel, indicates information about gear position. With the exception of a portion of the manual shaft, these components are all external to the transmission.

POPULATION: Table 1 shows SV counts by model and MY.

	Model Year			
Model	2003	2004	2005	Totals
Ram 2500	44,016	63,199	56,191	163,406
Ram 3500	24,013	33,461	29,405	86,879
Totals	68,029	96,660	85,596	250,285

Table 1: Subject vehicle production by Model and Model Year

ODI identified peer vehicles for comparative analysis and for use in comparing reverse rollaway incident rates. The peer vehicles were chosen based on component content and/or service use considerations and consisted of MY 1999-2002 Dodge Ram heavy duty (HD) 2500/3500[7], MY 2000-2005 Dodge Ram 1500 light duty (LD) pickup trucks[8], MY 2003 – 2004 Ford F250/F350 Super Duty pickup trucks, and MY 2003 – 2004 General Motors 2500/3500 Sierra and Silverado pickup trucks, all with automatic transmissions. Some of the DCC peer vehicles use the RE transmission, and some use a newer device, referred to as the "RFE" model, a four/five speed transmission with a different internal shift system configuration.

CORRESPONDENCE: ODI produced three information request (IR) letters for DCC response, dated March 17, June 16, and August 4, 2005. DCC provided responses dated May 13, July 1, August 17 (supplemental), and August 30, 2005. Additionally, ODI produced a peer IR letter, one each, to Ford Motor Company and General Motors Corporation[9].

FAILURE MECHANISM: Unintended placement of the shift lever between Park and Reverse that results in a powered rollaway.

PROBLEM EXPERIENCE: The failure report counts, as shown in Table 2, are based on ODI's analysis of VOQ reports and DCC IR data. The numbers shown in the total column reflect unique reports (i.e., duplicate reports to ODI and DCC have been removed) and the complaint counts reflect the number of vehicles involved in rollaway incidents (not the number of incidents)[10]. Some incidents involved driverless vehicles traveling a significant distance in reverse and sometimes crossing public walkways, roadways, parking lots, and railroad tracks. In a few incidents, the vehicles were occupied by passengers. In still other incidents, the operators were able to re-enter

[5] Technically, the lever rotates about a transverse horizontal axis located at the base of the lever although this may not be apparent to the operator.
[6] For instance, when the shifter is in park, the tang engages a gate that prevents lever rotation until the shifter is first moved longitudinally along the steering column toward the steering wheel, which disengages the tang from the gate.
[7] These vehicles have the same transmission as the SVs; earlier MY vehicles have a mechanical linkage shift system.
[8] Portions of these vehicles have the same transmissions as the SVs, some have a different design level transmission; earlier MY vehicles have a mechanical linkage shift system design.
[9] Redacted copies of the non-confidential portions of the IR and response letters are available for public review at ODI's website, http://www-odi.nhtsa.dot.gov, under the Defect Investigations link.
[10] ODI notes that some complainants reported multiple rollaway incidents occurring in the same vehicle.

the vehicle[11] and stop it. In many incidents the vehicle continued and a crash occurred, causing the vehicle to stop. Some injuries were unspecified, and some were minor, however, at least 7 were serious and involved bone fractures and or internal injuries; two fatalities are alleged[12].

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Table 2: Failure Report Summary Table

DESIGN, MATERIAL AND/OR PRODUCTION MODIFICATIONS: According to DCC, the design of the inner manual lever and park apply components have remained unchanged for over 30 years in the RE transmission. However, beginning with MY 2003 SV production, DCC made several changes to the external shift system components. The length of the outer manual lever was shortened. A cable based shift system, which incorporated BTSI, replaced a non-BTSI mechanical linkage (metal rod) based system that utilized a torque shaft assembly[13] and a shift tube integral to the steering column[14]. The cable shift system utilizes a revised shift lever assembly which results in, according to DCC, a change in the rotational characteristics of the shift lever and a longer "throw" to place the shifter in the gated Park position[15]. The PRNDL indicator also changed at MY 2003 from an analog (flag in window) to digital (electronically illuminated letter) display, and this change required the introduction of a revised sensor at the inner manual lever. DCC also made similar changes, including changes to transmission model, to the DCC peer vehicle populations, although at different points in time, as shown in table 3 below.

		MY1999	MY2000	MY2001	MY2002	MY2003	MY2004	MY2005
Peer Gasoline	Trans		RE	RE	RE/RFE	RE/RFE	RFE	RE/RFE
	Shift Sys		LINK	LINK	LNK/CBL	CABLE	CABLE	CABLE
Sub/Peer Diesel	Trans	RE	RE	RE	RE	RE	RE	RE
	Shift Sys	LINK	LINK	LINK	LINK	CABLE	CABLE	CABLE

Table 3: Subject (in red) and DCC Peer Transmission Model and Shift System Type

[11] This is a dangerous practice that was found to result in injury in some incidents. In such circumstances, consideration should be given before attempting to re-enter a reversing vehicle.

[12] The serious injuries occurred when victims were run over by the vehicle's tires, or became trapped under them, or were pinned between the vehicle and an inanimate object such as a gate or building. The two incidents alleging fatality are VOQ reports 10117700 and 10118955, available for review at ODI's website.

[13] This device is mounted between the chassis and engine assembly to counteract the effects of engine torque on the shift system's linkage, which can otherwise influence gear selection and/or shift lever position.

[14] The shift tube transfers shift lever rotation through the firewall to the underhood linkage system.

[15] Gated Park refers to the position where the shifter cannot be rotated towards Reverse unless it is first lifted, along the column axis, towards the steering wheel. See Figure 5 below.

VRTC TESTING: NHTSA's Vehicle Research and Test Center (VRTC) in East Liberty, Ohio performed testing on four SVs. The test work is discussed in VRTC report DCD5084, titled "Unintended Powered Rollaway in Reverse After Parking[16]." The report states that the shift lever can be placed at points between Park and Reverse and that an unintended powered rollaway may result 10 to 30 seconds after the lever is released in this position.

DCC's POSITION: DCC denies the existence of a design or manufacturing defect in the SVs, noting that they have inspected many complaint vehicles and determined that each operated to design intent and met all applicable Federal Motor Vehicle Safety Standards. DCC states that the safety risks presented by rollaway incidents were "universally caused by the same driver error: exiting the vehicle while the engine is still running and leaving the key in the ignition, failing to set the parking brake, and failing to place the shift lever properly in the 'Park' position." DCC's position is described in further detail in their Part 573 Defect and Noncompliance Notice to NHTSA, dated October 4, 2005, available at ODI's website under Recall 05V-462.

ODI DISCUSSION: Figure 1 shows the cumulative hazard rate[17] for powered rollaway incidents against vehicle age for the subject and DCC peer vehicles as of July 20, 2005. The Ford and GM peer vehicles are not shown on the chart because ODI did not identify any reports of rollaway incidents for these vehicles[18]. As noted in the chart, the SVs experience a higher incidence of powered reverse rollaway at a given vehicle age as compared to DCC vehicles.

DCC provided Figure 2, which shows the state of the PRNDL, reverse gear hydraulic circuit, and park pawl versus manual shaft position when rotation from Reverse to Park occurs[19]. For example, starting from the detent Park position[20], the chart shows that the "P" indicator of the PRNDL will be illuminated through 2.1 degrees of manual shaft rotation, followed by a blank PRNDL for the next 0.7 degrees, then "R" display for the next 9.7 degrees, etc. Notably, the chart shows that hydraulic reverse[21] pressurization occurs at approximately 6.3 degrees of rotation (area highlighted by red circle); at this position the park pawl is neither engaged, nor unlocked. When an operator places the manual shaft at or near this position, a hydraulic valve bleed condition occurs at the spool valve within the valve body. The valve bleed results in a transient charging of the reverse hydraulic circuit (due to restricted fluid flow) and a coincident delay in hydraulic reverse engagement. At this position, the park pawl is not engaged and the output shaft is not locked, thus vehicle movement is possible[22]. When the vehicle is stopped on a flat and level surface, the delay period the valve bleed condition produces, if sufficiently long, present a false sense of Park to the operator and may allow the operator to exit the vehicle prior to vehicle movement becoming apparent[23]. Therefore, the susceptibility of the shift system to be inadvertently placed in an intermediate or incomplete shift

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[16] The report will be posted to ODI's website as soon as possible.

[17] Hazard rate is calculated as the number of failures (incidents) occurring within a given age increment divided by the number of vehicles with an opportunity to fail (i.e., units that have reached of achieved that age) within that age increment. Cumulative hazard is the sum of the incremental rates (from start of service to that age increment). There were 235 incidents known to ODI at the time this chart was produced.

[18] The hazard rate and failure rate would therefore be zero.

[19] The values are approximate and based on a small sample empirical assessment. Zero degrees represents detent Park.

[20] The detent Park position is defined as the inner manual lever position where the detent ball is in the Park detent valley on the inner manual lever. Other positions are defined similarly; at detent reverse the ball is in the reverse valley.

[21] Hydraulic reverse means the reverse gear of the transmission is energized and that engine power can move the vehicle rearward. ODI notes that an R can be displayed on the PRNDL when the transmission is both in hydraulic reverse (~6.3 to 12.5 degrees), and when it is out of hydraulic reverse (~2.8 to 6.3 degrees).

[22] ODI notes that the instrument panel PRNDL indicates reverse gear in this state.

[23] This assumes that the operator does not notice that the PRNDL indicates R, and does not set the park brake or turn off the engine, before exiting the vehicle.

state between Park and Reverse exists and is a critical factor in whether rollaway incidents, such as those experienced by the SVs, are likely to occur.

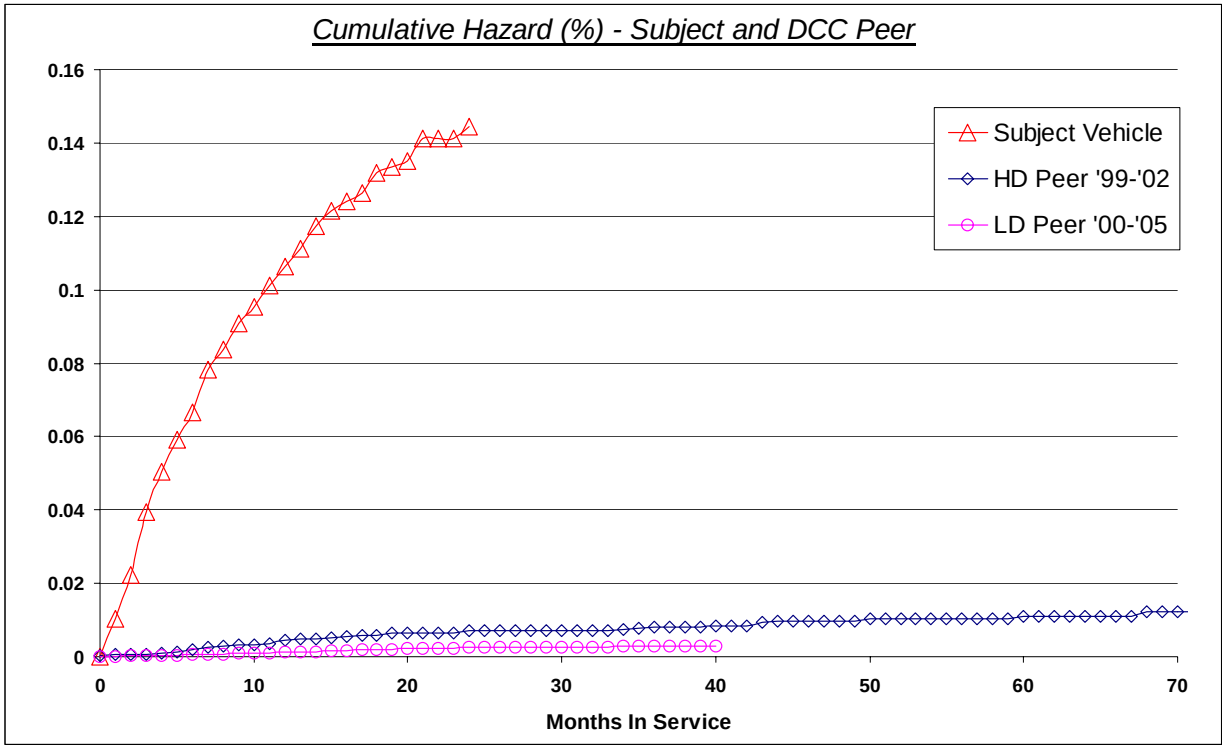

Figure 1: Subject and DCC Peer Cumulative Hazard Rates for Powered Reverse Rollaway Incidents as of July 20, 2005

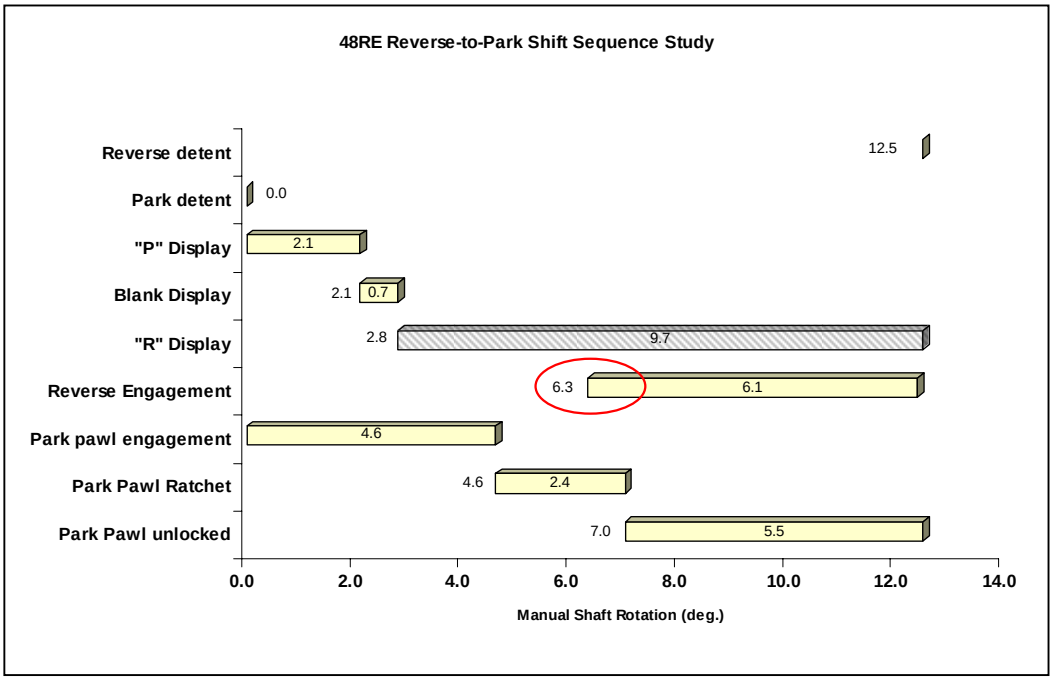

Figure 2: Subject Vehicle Shift Sequence – State versus Manual Shaft Position

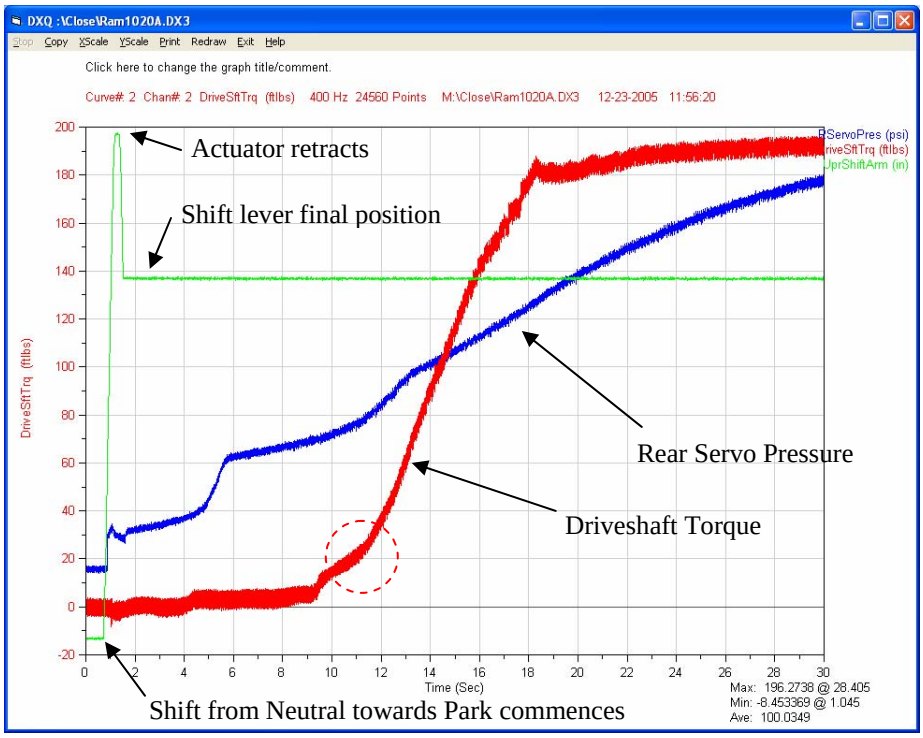

Figure 3: Subject Vehicle Shift Parameter data from VRTC testing

Figure 3, produced from data collected during VRTC testing, shows graphically how a valve bleed condition, due to an incomplete shift, effects engagement of hydraulic reverse. The green trace represents movement of the shift lever from the Neutral position towards Park; at time zero the shifter is in detent neutral. In the VRTC test, the shift lever tang was disabled and an electro-mechanical actuator moved the shift lever to a position between gated park and reverse and then retracted[24]. The shift lever settles back to a stable position and remains there from approximately 2 seconds onward[25]; this position results in a valve bleed condition within the valve body[26]. At this time, the torque on the drive shaft (red trace) is zero and the pressure in the reverse servo (blue trace) shows an increasing trend due to the effects of the valve bleed condition[27]. At approximately 9 seconds rearward torque begins to develop on the drive shaft as the rear servo pressure continues to increase. If the vehicle is on a flat and level surface (e.g., concrete), sufficient drive shaft torque (~ 20 – 25 ft. lbs.) exists to cause the vehicle to move rearward within approximately 11 or 12 seconds of the shift event. Torque continues to increase over the next 7 to 8 seconds as rear servo pressure increases and the transmission achieves full rearward torque (i.e., full hydraulic reverse) about 20 seconds after the shift; the vehicle is now fully powered in reverse.

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[24] If the shift lever tang was enabled and the shifter was pushed further towards Park, it would engage gated Park.

[25] ODI notes that the park pawl was in an abutted state when this test was performed. The settling back of the shifter may be caused by relaxation of the lost motion spring on the park apply rod within the transmission. The shift lever does not exhibit this settle back movement when the park pawl is not abutted (engages the annulus gear tooth).

[26] VRTC testing showed that there was a range of positions between gated Park and Reverse where the shifter could be released and result in a valve bleed condition.

[27] In a typical shift directly to detent/gated Reverse, the rear servo pressure and the torque on the drive shaft reach their maximum values within a 1 to 2 second period.

During the investigation, ODI reviewed the SV shift system in connection with the issue of incomplete shifting to Park and reviewed peer vehicles in a similar fashion. ODI's review included discussions with DCC, Ford and GM engineers responsible for designing these systems, as well as, a review of IR responses related to this issue. A notable difference between the SV and peer systems is the profile of the inner manual lever in the area between the detent Park and detent Reverse positions. The SV and peer inner manual levers are shown in Figure 4 and the park to reverse profiles are highlighted with a red circle. As seen in the figures, the SV park to reverse profile is nearly flat in comparison to peers. Both Ford and GM advised ODI that the peaked park to reverse detent profile of their levers, in conjunction with the cantilever detent spring and roller, is specifically designed to minimize the likelihood of an incomplete shift to Park. This design minimizes the occurrence of an incomplete shift by producing a torque onto the manual lever which acts to force the shift system into either the detent Park or detent Reverse position in the event the shift lever is inadvertently released between Park and Reverse[28]. In contrast to the peer vehicles, the SV park to reverse profile is nearly flat rather than peaked. As a result, the SV inner manual lever is incapable of producing a torque of sufficient magnitude to influence shift system position. Therefore, when compared to peers, the SV's detent profile is inferior at preventing the occurrence of an incomplete shift to Park[29].

In explaining the higher rollaway rates experienced by the SVs, DCC notes that, according to their research and analysis, the owners who experience SV rollaway incidents are older males[30] who are likely to have previously owned an automatic transmission pickup truck equipped with column mounted shift lever. DCC further states that the slightly fore-aft motion of the SV shift assembly is physically different from the radial type shift pattern of the prior DCC design, and many peer designs, resulting in a slightly different shift lever movement. DCC hypothesizes that this older male demographic may have developed learned behaviors, with respect to shift patterns, that are based on a radial type lever motion. DCC asserts that this learned behavior is what causes these operators to achieve an incomplete shift that results in a rollaway incident in the SV that have the different shift lever movement[31]. To support this assertion, DCC highlights the lower rate of rollaway incidence experienced by younger, mixed gender users of MY 2002 gasoline engine, LD Ram 1500 pickups equipped with the same transmission, shift system, and shift ergonomics.

ODI conducted 45 complainant interviews and many of these were male. Those interviewed reported their vehicles were used for work[32] and that their engine would often remain running throughout the entire day[33]. Some interviewees were ranchers or oil field workers who entered and exited the vehicle multiple times throughout the day, for example, to open and close cattle gates or take readings from field equipment. ODI suggests that an alternative explanation as to why the LD vehicles do not experience the same incidence of rollaway is that their usage pattern differs from the SVs; they do not experience the same number of opportunities for an incident to occur[34,35]. ODI

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[28] For further information, see GM's response to Request 8 of the February 8, 2005 IR response regarding the GM design approach and a discussion of the concepts of detent centering torque and external shift system force and displacement, or drag, characteristics as pertains to incomplete shifting.

[29] DCC has used this component and detent profile for over 30 years.

[30] DCC did not collect demographic data for peer MY 1999 – 2002 HD Ram diesel owners.

[31] See DCC's comments in the October 4, 2005 Part 573 notice submitted in connection with Recall 05V-462.

[32] Additionally, many owners advised they had previously owned an earlier MY HD diesel Ram truck, used in a similar fashion, but had never experienced a rollaway incident in the earlier vehicle.

[33] Many of these owners reported that they did not prefer to stop and start their diesel engines any more than necessary due to the effects of wear and tear on the battery, starter, and turbo charger.

[34] ODI notes that some rollaway incidents do occur in the LD vehicles although at a lower rate of incidence.

does not believe that owner demographics, or 'learned behaviors,' represent an explanation for the disparity in rollaway rates which exist between the SV and peer vehicles, as shown in Figure 1.

DCC has maintained that a vehicle which is properly placed in the gated Park position will stay in this position and will not experience a powered rollaway. ODI agrees with this analysis and notes that it can be confirmed though a visual inspection of the shift lever assembly gate system, as shown in Figure 5 (left side picture), however, ODI also notes that the shift lever can rest on the land that separates gated Park from gated Reverse, as also shown in Figure 5 (right side picture).

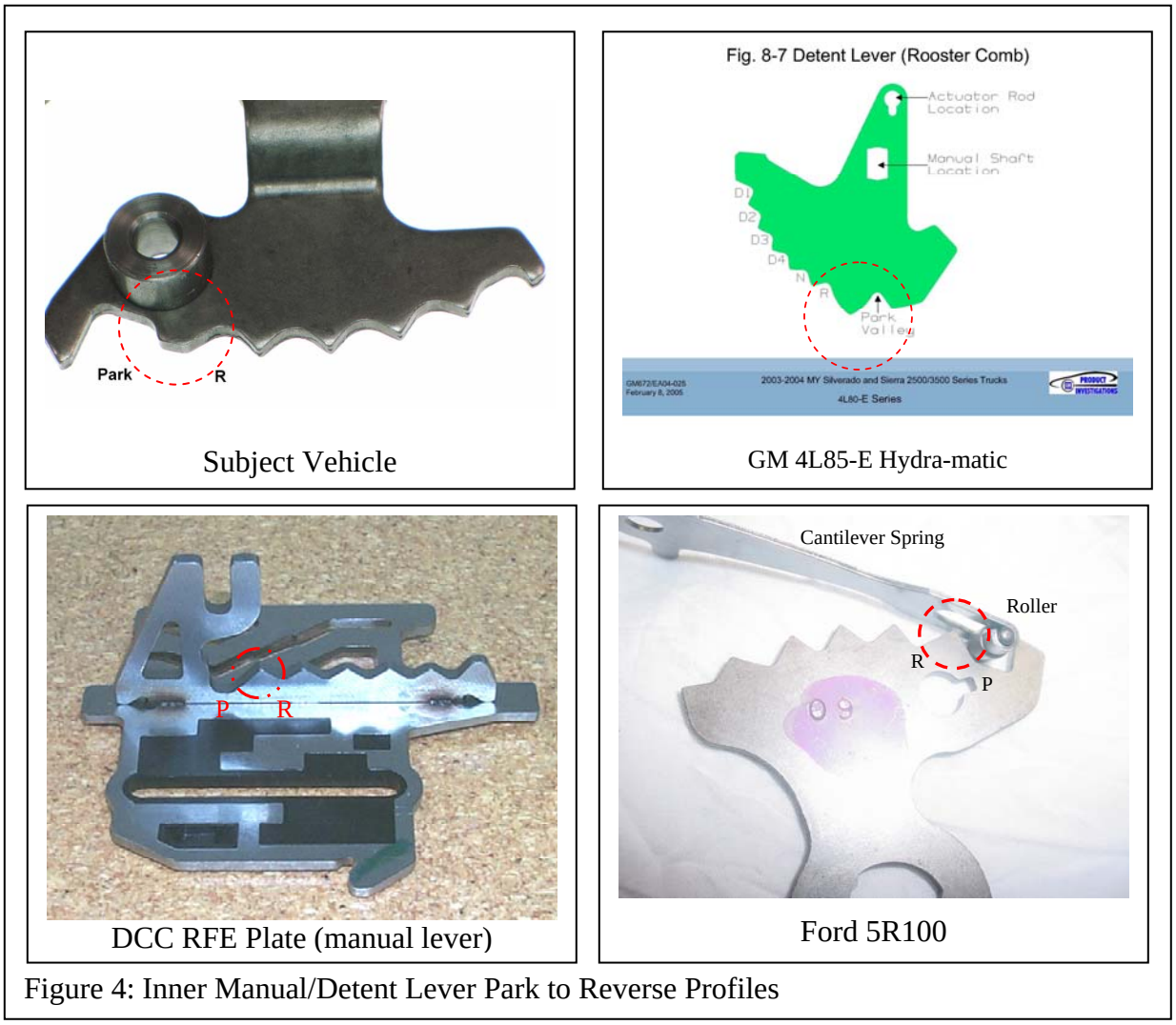

Figure 4: Inner Manual/Detent Lever Park to Reverse Profiles

ODI considered whether the higher SV rollaway incidence rates were attributable to the cable based external shift system that was introduced coincident with MY 2003 SV production. Data from VRTC's testing suggested that the force and displacement (F/D), or drag, characteristics of the cable based system differ from the linkage based system it replaced. GM provided information indicating that the F/D characteristics of the external shift system are a primary consideration in the design of the overall shift system that may influence the occurrence of an incomplete shift[31]. DCC

[35] Additionally, ODI notes that, in its opinion, the service usage and owner demographics of the HD peer vehicles, which did not experience rollaway at high rates of incidence, are similar to those of the SV.

advised that their development process did not consider shift system F/D characteristics during the implementation of the cable based shift system[36].

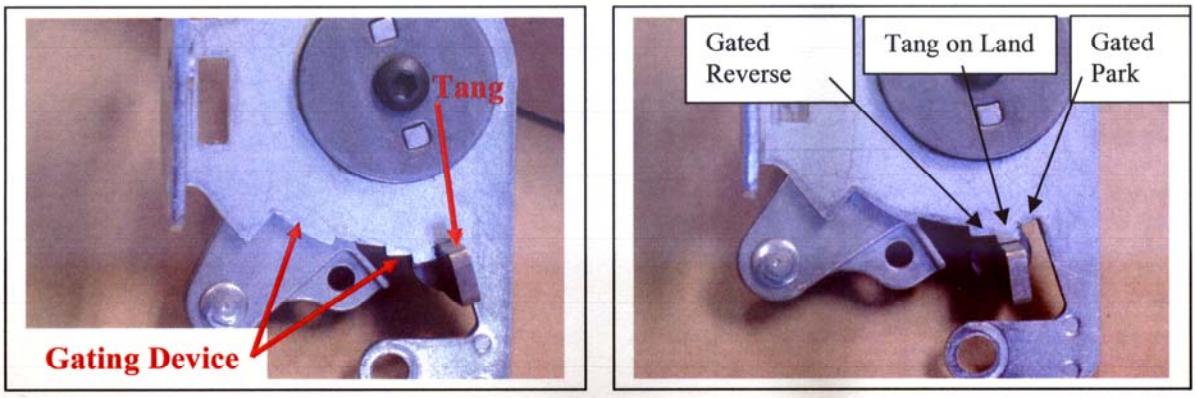

Figure 5: Shift lever tang in gated Park (left) and resting on the Land (right)

A variant of the alarm system DCC is installing in the SVs as part of Recall 05V-462 was introduced at the start of MY 2006 HD Ram diesel truck production for vehicles that are equipped with the RE transmission. According to DCC, the RE model transmission is scheduled to cease production at the end of CY 2006 and will no longer be installed in DCC products after that time.

When exiting any automatic transmission equipped vehicle, ODI strongly advises all drivers to verify the shifter has been fully placed in the gated park position, to turn off the engine, to fully set the park brake, and to remove the key from the ignition and from the vehicle. ODI notes that following these simple, common sense, procedures would have prevented the SV rollaway incidents and the injuries and damages that resulted.

REASON FOR CLOSING: The recall action that DCC has announced is sufficient to address NHTSA's current concerns for this issue and therefore the investigation is closed. Further action will be considered if warranted by future circumstances.

Safety Defects Engineer — Date: 12/22/2005

I Concur:

Chief, Vehicle Control Division — Date: 12/22/2005

Director, Office of Defects Investigation — Date: 12-22-05

[36] According to DCC, the cable based system was evaluated 1) through subjective assessment by DCC personnel familiar with the Ram product line and 2) for compliance with applicable Federal Motor Vehicle Safety Standards.