U.S. Department
of Transportation

**National Highway
Traffic Safety
Administration**

Memorandum

Vehicle Research and Test Center P.O. Box 937
East Liberty, Ohio 43319
(937) 666-4511

Subject: FINAL REPORT – VRTC-DCD5084 "Unintended Powered Roll-Away In Reverse After Parking – Dodge Ram Pickup Trucks (EA-04-025)"

Date: DEC 19 2005

From: Michael W. Monk
Director, Vehicle Research and Test Center

Reply to Attn. Of: NVS-310

To: Kathleen C. DeMeter
Director, Office of Defects Investigation

NVS-210

Attached are four (4) copies of the subject report. This completes the requirements for this program.

Attachment: Final Report (4)

#

VRTC-DCD5084 (EA04-025)

UNINTENDED POWERED ROLL-AWAY IN REVERSE

AFTER PARKING - DODGE RAM PICKUP TRUCKS

1.0 INTRODUCTION

This program was performed at the Vehicle Research and Test Center (VRTC) at the request of the Office of Defects Investigation (ODI) of the National Highway Traffic Safety Administration (NHTSA). Subject vehicles in this program are 2003 - 2004 Dodge Ram pickup trucks equipped with a Cummins diesel engine or a DaimlerChrylser (D/C) V10 gasoline engine, with the majority of complaints coming from owners of the Cummins diesel engine. Both models use a D/C 48RE transmission. ODI has received complaints from owners of subject vehicles that allege that when the operator stopped the vehicle, attempted to place the transmission shift lever in Park, and exited the vehicle with the engine running, the vehicle at first remained stationary, and then began to move, usually stopping only when it struck something. All claims indicated that the vehicle moved in Reverse. This unintended vehicle movement has resulted in crashes causing property damage, injury, and potentially two deaths. For this report, this phenomenon will be called Unintended Powered Roll-away (UPR). The objective of this program was to assess the vehicle sensitivity to a UPR condition while stationary with the engine idling. Tests were performed to determine the force characteristics on the shift lever that are required to shift between the Neutral and Park positions

Two previous ODI programs (EA96-006: 1991 – 1992 Dodge Dakota, and EA01-017: 1993 - 1999 Jeep Grand Cherokee) have investigated similar claims of UPR in transmissions that used similar design characteristics.

2.0 TERMS USED IN THIS REPORT

Gated Park – The location at which the shift lever is locked in the Park position.
Gated Reverse – The location at which the shift lever is locked in the Reverse position.
Annulus Gear – A gear within the transmission that is mounted on the transmission output shaft into which the park pawl engages to prevent vehicle movement when the transmission is placed in Park.
Park Pawl – A lever within the transmission that engages the annulus gear that prevents vehicle movement when the transmission is placed in Park.
Shift Lever – The gear selector lever operated by the driver.

Transmission Manual Lever – The arm on the outside of the transmission that provides movement of the shift mechanism inside the transmission.
Tick Point – The point at which the parking pawl just touches the annulus gear when shifting from Reverse to Park.
Pawl Engagement – The point at which the parking pawl engages the annulus gear sufficiently to prevent vehicle movement.
Pawl Engaged – The condition where the parking pawl engages and locks the annulus gear.
Pawl Abutted – The condition where the parking pawl rests (perches) on a tooth of the annulus gear rather than engaging the annulus gear.

3.0 PROCEDURE

The following activities were undertaken for this project:

3.1 TEST VEHICLES

Four vehicles (described below) were procured for testing during this program. Each was equipped with a Cummins Diesel engine and automatic transmission. Ram 01 was a complaint vehicle. Ram 02 and Ram 03 were subject vehicles chosen at random. Ram 04 was an exemplar vehicle chosen at random.

Ram 01 – 2003 Dodge Ram 2500
Mileage: 25,804
VIN: 3D7KU28CX3G861893

Ram 02: 2004 Dodge Ram 2500
Mileage: 15,826
VIN: 3D7KA28CX4G[redacted]

Ram 03: 2004 Dodge Ram 2500
Mileage: 23,151
VIN: 3D3KU28C64G[redacted]

Ram 04: 2001 Dodge Ram 2500
Mileage: 112,085
VIN: 3B7KF26641M[redacted]

3.2 INSTRUMENTATION

One instrumentation package was used in turn for all of the test vehicles.

A linear actuator was installed that allowed repeatable accurate positioning of the shift lever. This actuator was capable of speeds between 0.1 and 8.5 in/sec.
Instrumentation was installed that allowed the monitoring of the following parameters:

- Driveshaft torque
- Transmission rear servo hydraulic pressure
- Shift lever position
- Transmission manual lever position
- Shift lever input force
- Transmission control voltage

3.3 TEST PROCEDURES

Test-description logs for each test vehicle are attached on the following pages. All tests were performed in the Pawl Abutted condition unless otherwise noted. Each test used the linear actuator to perform the described test unless otherwise noted. The linear actuator speed was 8.5 in/sec unless otherwise noted.

4.0 RESULTS

Test data are provided on the attached compact disc (CD).

5.0 CONCLUSIONS

Testing showed that the shift lever could be placed at numerous points between Gated Reverse and Gated Park that allowed UPR to occur between 10 and 30 seconds after releasing the shift lever.

Test Log
Test Vehicle #1

1001 - Push from Neutral to Park with Linear Actuator (0.1 in/sec)
1002 - Push from Neutral to Park with Linear Actuator (0.1 in/sec)
1003 - Push from Neutral to Park with Linear Actuator (0.1 in/sec)
1004 - In Gated Park
1005 - In Gated Reverse
1006 - Rapid move to Slow-Build position from Park (8.5 in/sec from here on)
1007 - Stationary at "tick point"
1008 - Move from Neutral to Tick Point
1009 - Move from Reverse to Tick Point
1010 – In Gated Neutral
1011 - Slow-build position at idle
1012 - Slow-build position at 1500 RPM
1013 – False Trigger
1014 - Park to Slow-Build position
1015 - Reverse to Slow-Build position (slowly)
1016 - Neutral to Park with engine off
1017 - Neutral to Park with engine off
1018 - Follow from Park to Reverse with retraction of linear actuator
1019 - Fast push from Neutral to Slow-Build position

The instrumentation was removed and reinstalled between the previous and the following tests. Therefore the position data cannot be directly compared between the two sets of data.
1020 – Instrumentation Check
1021 – Instrumentation Check
1022 – Push & Retract to just short of Gated Park
1023 - Push & Retract
1024 – False Trigger
1025 - Push & Hold Neutral to Gated Park (3.96" on actuator)
1026 - Push & Hold Neutral to Gated Park (3.96" on actuator)
1027 - Push & Retract to 3.78 on actuator
1028 - Push & Retract to 2.70" on actuator
1029 - Push & Retract to 2.90" on actuator
1030 - Push & Retract to 3.10" on actuator
1031 - Push & Retract to 3.30" on actuator
1032 - Push & Retract to 3.50" on actuator
1033 - Push & Retract to 3.70" on actuator
1034 - Push & Retract to 3.90" on actuator
1035 - Push & Retract to 3.96" on actuator
1036 - Manually Push & Release to point of increased force with vehicle free to move (w/ video)
1037 - Manually Push & Release to point of increased force with vehicle free to move (w/ video)
1038 - Manually Push & Release to point of increased force with vehicle free to move (w/ video)

The tests described below were performed by attaching the linear actuator directly to the transmission manual lever. Data cannot be directly compared with previous tests.
1040 – Instrumentation Check
1041 – Neutral to Park – Pawl Abutted
1042 – In Gated Park
1043 – In Gated Reverse
1044 – In Gated Neutral
1045 - Neutral to Park – Pawl Abutted
1046 - Neutral to Park – Pawl Abutted
1047 - Neutral to Park – Pawl Engaged
1048 - Neutral to Park – Pawl Engaged
1049 - Neutral to Park – Pawl Engaged
1050 – At Tick Point

The tests described below were performed by attaching the linear actuator directly to the transmission manual lever. Data **might** be directly compared with tests 1040 – 1050.
1051 - Neutral to Park – Pawl Engaged
1052 - Neutral to Park – Pawl Engaged
1053 - Neutral to Park – Pawl Engaged
1054 - Neutral to Park – Pawl Abutted
1055 - Neutral to Park – Pawl Abutted
1056 - Neutral to Park – Pawl Abutted
1057 – In Gated Park
1058 – In Gated Reverse
1059 – In Gated Neutral
1060 – At point where pawl contacts annulus gear

The tests described below were performed by installing the older, longer manual lever used in 2001 so that the forces could be compared to those in Ram04.
1065 – In Gated Neutral
1066 – In Gated Park
1067 - Neutral to Park – Pawl Engaged
1068 - Neutral to Park – Pawl Engaged
1069 - Neutral to Park – Pawl Engaged
1070 – In Reverse
1071 - Neutral to Park – Pawl Abutted
1072 - Neutral to Park – Pawl Abutted
1073 – Neutral to Park – Pawl Abutted
1074 - At point where pawl contacts annulus gear
1075 – False Trigger

The tests described below repeat the previous group but with the transmission position sensor removed. The two sets can be compared directly.

1076 - Neutral to Park – Pawl Abutted
1077 - Neutral to Park – Pawl Abutted
1078 – Neutral to Park – Pawl Abutted
1079 - Neutral to Park – Pawl Engaged
1080 - Neutral to Park – Pawl Engaged
1081 - Neutral to Park – Pawl Engaged

Test Log
Test Vehicle #2

Note: Distance values reference the shift lever position sensor and do not directly represent the distance traveled by the shift lever

2001 – In Gated Neutral
2002 – In Gated Reverse
2003 – At Tick Point
2004 – Push and hold to location of increased force
2005 – Push and release to location of increased force
2006 – In Gated Park
2007 – In Gated Park
2008 - Push and release to last point before Gated Park engages
2009 – Slow push (0.1 in/sec) and release to last point before Gated Park engages
2010 – Push and hold to Gated Reverse
2011 – Push and release to Gated Reverse
2012 – Push and release to 0.05" beyond Gated Reverse
2013 – Push and release to 0.11" beyond Gated Reverse
2014 – Push/hold/release to 0.21" beyond Gated Neutral
2015 – Push and release to 0.15" beyond Gated Reverse
2016 – Push and release to 0.22" beyond Gated Reverse
2017 – Push and release to 0.28" beyond Gated Reverse
2018 – Push and release to 0.20" beyond Gated Reverse
2019 – Push and release to 0.35" beyond Gated Reverse
2020 – Push and release to 0.39" beyond Gated Reverse
2021 – Push and release to 0.41" beyond Gated Reverse
2022 – Push and release to 0.44" beyond Gated Reverse
2023 – Push and release to 0.47" beyond Gated Reverse
2024 – Push and release to 0.49" beyond Gated Reverse
2025 – Push and release to 0.49" beyond Gated Reverse
2026 – Push and release to 0.51" beyond Gated Reverse
2027 – Push and hold to location of increased force
2028 – Push and hold to 0.30" beyond Gated Reverse
2029 – Push and hold to 0.34" beyond Gated Reverse
2030 – Push and hold to 0.39" beyond Gated Reverse
2031 - Push and hold to 0.43" beyond Gated Reverse
2032 – Point at which Parking Pawl holds vehicle stationary
2033 – Push and release to 0.43" beyond Gated Reverse
2034 – Push and release to 0.45" beyond Gated Reverse
2035 – Push and release to 0.46" beyond Gated Reverse
2036 – Push and release to 0.46" beyond Gated Reverse
2037 – Push and release to 0.47" beyond Gated Reverse
2038 – Push and release to 0.51" beyond Gated Reverse
2039 – Push and release to Gated Park with upper shift gate disabled
2040 – At maximum travel of linear actuator

Test Log
Test Vehicle #3

3001 – Instrumentation Check
3002 – In Gated Neutral
3003 – In Gated Reverse
3004 – At Tick Point
3005 – In Gated Park
3006 – False Trigger
3007 – Push and Release to location of increased force (2.96" on actuator)
3008 – Push and Release to 3.000" on actuator
3009 - Push and release to Gated Park position
3010 – Push and release to last point before gated park engages
3011 – Repeat of 3010 for reference
3012 – Push and hold to last point before gated park engages (2.400" on actuator)
3013 – Push and hold to tick point (same as 3004)
3014 – Push and hold to 2.600" on actuator
3015 – Push and release to 2.600" on actuator
3016 – Push and hold to 2.800" on actuator
3017 – Push and release to 2.800" on actuator
3018 – Push and hold to 3.000" on actuator
3019 – Push and release to 3.000" on actuator (same as test 3008)
3020 – Push manually several times

Test Log
Test Vehicle #4

4001 – Gated Neutral (0.00" on actuator)
4002 – Gated Reverse (1.60" on actuator)
4003 – Tick Point (2.60" on actuator)
4004 – Gated Park (4.02" on actuator)
4005 – Push and Release to location of increased force (2.88" on actuator)
4006 – Push and Hold to location of increased force (2.88" on actuator)
4007 – Push and Release to 3.00" on actuator
4008 - Push and Hold to 3.00" on actuator
4009 – Push and Release to 3.10" on actuator
4010 – Push and Hold to 3.10" on actuator
4011 – Push and Release to 3.20" on actuator
4012 – Push and Hold to 3.20" on actuator
4013 – Push and Release to 3.40" on actuator
4014 – Push and Hold to 3.40" on actuator
4015 – Inst. Check
4016 – Inst. Check
4017 – Point at which the parking pawl will stop the vehicle while moving slowly
4018 - Push and Release to 3.60" on actuator
4019 - Push and Hold to 3.60" on actuator
4020 - Push and Release to 3.80" on actuator
4021 - Push and Hold to 3.80" on actuator
4022 – Inst. Check
4023 – Inst. Check
4024 – Push/Pull on Manual lever Park to Drive
4025 - Push/Pull on Manual lever Park to Drive
4026 - Push/Pull on Manual lever Park to Neutral
4027 - Push/Pull on Manual lever Park to Neutral
4028 - Push/Pull on Manual lever Park to Neutral
4029 - Inst. Check
4030 – Push/Pull on Disconnected Linkage
4031 – Push/Pull on Disconnected Linkage
4032 – Push/Pull on Disconnected Linkage
4033 – Inst. Check

The tests described below are retests with the manual lever tight on the manual lever shaft after discovering that the manual lever had been loose in previous tests.

4034 – Gated Neutral (0.00 on actuator)
4035 – Gated Reverse (1.50 on actuator)
4036 – Gated Park (3.4 on actuator)
4037 – Push and Release to point of increased force (2.20 on actuator)
4038 – Push and Hold to point of increased force (2.20 on actuator)
4039 – Push and Release to 2.30 on actuator
4040 – Push and Hold to 2.30 on actuator
4041 – Push and Release to 2.50 on actuator
4042 – Push and Hold to 2.50 on actuator
4043 – Push and Release to 2.70 on actuator
4044 – Push and Hold to 2.70 on actuator
4045 – Push and Release to 2.90 on actuator
4046 – Push and Hold to 2.90 on actuator
4047 – Push and Release to 3.10 on actuator
4048 – Push and Hold to 3.10 on actuator
4049 – Push and Release to 3.30 on actuator
4050 – Push and Hold to 3.30 on actuator
4051 – Tick Point
4052 - Point at which the parking pawl will stop the vehicle while moving slowly
4053 – False Trigger
4054 – False Trigger
4055 – Push on Manual Lever Park to Drive, pawl engaged
4056 - Push/Pull on Manual lever Park to Neutral, pawl engaged
4057 - Push/Pull on Manual lever Park to Neutral, pawl engaged
4058 - Push/Pull on Manual lever Park to Neutral, pawl engaged
4059 - Push/Pull on Manual lever Park to Neutral, pawl abutted
4060 - Push/Pull on Manual lever Park to Neutral, pawl abutted, engine off
4061 - Push/Pull on Manual lever Park to Neutral, pawl abutted, engine off
4062 - Push/Pull on Manual lever Park to Neutral, pawl engaged, engine off
4063 - Push/Pull on Manual lever Park to Neutral, pawl engaged, engine off
4064 - Push/Pull on Manual lever Park to Neutral, pawl abutted, engine off
4065 - Push/Pull on Manual lever Park to Neutral, pawl abutted, engine off