



US Department
Of Transportation

National Highway
Traffic Safety
Administration

Memorandum

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Subject: FINAL REPORT - VRTC-DCD4080 "Investigation of Alleged Parking Brake Failures in 1999-2003 General Motors Trucks Based on the GMT-800 Platform (EA04-011)" Date: **APR 29 2005**

From: *[Signature]* Michael W. Monk Director, Vehicle Research & 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.

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Attachments: Final Report (4)

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Technical Report Documentation Page

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16. Abstract <p>The objectives of this program were to measure the holding power of the subject parking brake system under different wear conditions and to identify conditions that may lead to undesired vehicle motion. Four sets of brake shoes were supplied by ODI that had been removed from vehicles for which the owner had submitted a complaint. Testing was performed using the Parking Brake Test Procedure (S7.12) of FMVSS 135.</p> <p>Tests of the "complaint" shoes were performed on a 20% grade under the following conditions:</p> <ol style="list-style-type: none"> 1. With the test vehicle at curb weight, each set of shoes was tested with the shoe/drum clearance specified for new shoes. 2. With the test vehicle at curb weight, each set of shoes was tested with the shoe/drum clearance adjusted for the worn condition of the set of shoes being tested. 3. With the test vehicle at GVWR, each set of shoes that held the vehicle stationary in the preceding step was tested again with the shoe/drum clearance adjusted for the worn condition of the set of shoes being tested. 4. With the test vehicle at GVWR, each set of shoes that did not hold the vehicle stationary in the preceding step was tested on 15%, 12%, and 5% grades to determine if the shoes would hold the vehicle stationary on a reduced grade. <p>The test results showed that none of the "complaint" shoes held the test vehicle stationary on the 20% grade at curb weight when the test shoes were adjusted to "new" shoe clearance; three of the four sets of shoes held the test vehicle stationary on the 20% grade at curb weight when the shoes were adjusted for wear; and only one set of shoes held the test vehicle stationary on the 20% grade at GVWR when the shoes were adjusted for wear.</p> <p>It was concluded that adjusting the parking brake shoes appears to extend the satisfactory performance of the shoes until wear becomes excessive. However, adjusting the shoes for wear requires removal of the brake calipers and rotors since the parking brakes were not equipped with automatic brake adjusters.</p>					
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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). ODI opened an Engineering Analysis (EA04-011) on 1999 - 2003 General Motors (GM) GMT-800 platform vehicles (Silverado, Sierra, Avalanche, and Escalade EXT) as a result of alleged failures of the parking brake.

2.0 Background

The parking brake on the subject vehicles consists of a small, cable-operated, single-shoe drum brake contained within the "hat" portion of each rear disc brake rotor. The design contains no provision for actively self-centering the brake shoe within the parking brake drum. This condition may allow the parking brake linings to sustain prolonged contact with the drum while driving, thus contributing to premature lining wear. The design also contains no provisions for automatic adjustment of the parking brake shoe to compensate for wear. This condition contributes to the ineffectiveness of the brake as it becomes worn. Figure 1 shows a new parking brake shoe. Figure 2 shows the "hat" portion of a new brake rotor where the parking brake shoe is installed.

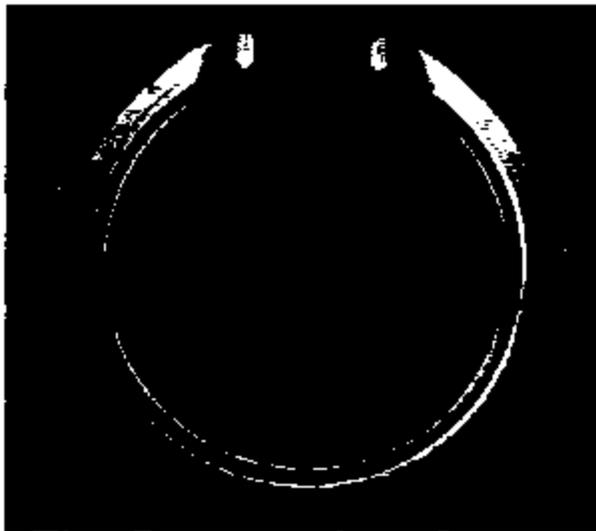


Figure 1
New Parking Brake Shoe

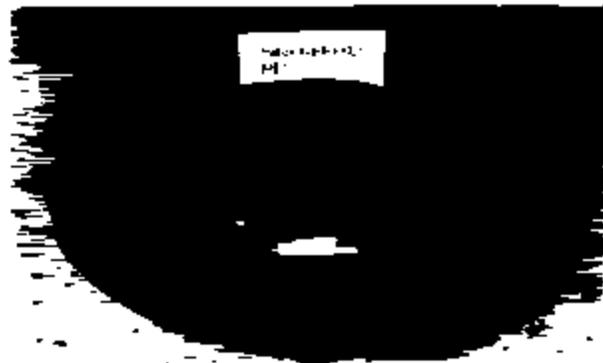


Figure 2
"Hat" Portion of Rear Brake Rotor

3.0 Objective

The objectives of this program were to measure the holding power of the subject parking brake system under different wear conditions and to identify conditions that may lead to undesired vehicle motion.

4.0 Testing

Testing performed for this program is described in the following sections.

4.1 Test Vehicle

A 2001 Chevrolet Silverado 1500 (VIN 1GCEC14W91Z [REDACTED]) subject vehicle was leased for this program. The GVWR was 6,400 lb and the odometer reading was 59,010 miles at the beginning of these tests.

4.2 Test Items

Four sets of brake shoes were supplied by ODI for testing. The test shoes had been removed from vehicles for which the owner had submitted a complaint to ODI. Each pair of test shoes was assigned an identification number that was based on the order in which the shoes were tested. The maximum and minimum thicknesses of the lining on each "complaint" shoe, of a pair of new shoes, and of the shoes that were original equipment on the test vehicle were measured prior to testing. Table 1 shows the measured thicknesses described above.

Table 1
Brake Shoe Thicknesses

Minimum lining thickness (in)		Test Item	Maximum lining thickness (in)	
Left Shoe	Right Shoe		Left Shoe	Right Shoe
0.08	0.00	1	0.12	0.13
0.01	0.05	2	0.13	0.13
0.08	0.08	3	0.12	0.11
0.01	0.07	4	0.13	0.12
0.12	0.12	New	0.14	0.14
0.11	0.05	Orig. Equip.	0.12	0.13

4.3 Test Procedure

Testing was based on the Parking Brake Test Procedure (S7.12) of FMVSS 135, "Light Vehicle Brake Systems." The performance requirements of FMVSS 135 require that "The parking brake system shall hold the vehicle stationary for 5 minutes in both a forward and reverse direction on the grade." The grade specified in FMVSS 135 for a truck with a GVWR of 7,716 lb or less is 20%. The initial two series of tests were performed with the test vehicle at curb weight rather than at the Gross Vehicle Weight Rating (GVWR) specified in FMVSS 135. The final two

series of tests were performed at GVWR, as specified in FMVSS 135. The test procedure for this program additionally required that the driver shift his body weight within the vehicle and open and slam the driver's door five times in an attempt to induce vehicle movement if the parking brake initially prevented movement of the vehicle. Vehicles that failed to meet the requirements of the test procedure at GVWR were retested on reduced grades (5%, 10% & 12%) to determine the maximum grade at which the parking brake was capable of holding the test vehicle stationary.

4.4 Test Conditions

A preliminary test was performed with the test vehicle at curb weight on the 20% grade in the as-received condition.

Following the "as-received" test, the original rear brakes were removed and new rotors/drums, parking brake shoes, and parking brake cables were installed and adjusted following the instructions that were supplied with the parking brake shoes.

Each set of complaint shoes was tested under four conditions:

1. Because the design of the parking brake assembly did not include a self-adjusting mechanism, each set of complaint shoes was tested, in turn, without readjusting the brake clearance that had been previously determined with the new shoes. These tests were performed on a 20% grade with the test vehicle at curb weight plus the weight of the driver.
2. Because the design of the parking brake assembly did include a manual parking brake adjuster within the brake drum, each set of shoes was next tested on a 20% grade with the shoe/drum clearance adjusted for the worn condition of the set of shoes being tested.
3. The sets of shoes that held the vehicle stationary in Step 2 above were retested on a 20% grade with the vehicle loaded to the GVWR.
4. The sets of shoes that did not hold the test vehicle stationary in Step 3 above were tested on 15%, 12%, and 5% grades to determine if the shoes would prevent vehicle movement on a reduced grade.

5.0 Results

Test results are discussed in the following sections.

5.1 Tests in the As-Received Condition

During the preliminary tests in the as-received condition at curb weight, the non-complaint (but worn) parking brake shoes held the vehicle stationary in the uphill direction on the 20% grade but not in the downhill direction. No brake adjustments or additional testing was performed on the "as received" brake shoes.

5.2 Tests at Curb Weight with Clearance Adjusted for New Shoes

The results of the tests on a 20% grade with the vehicle at curb weight and each parking brake shoe clearance adjusted to the specification for new brake shoes are shown in Table 2.

Table 2
Test Results at Curb Weight for "New" Shoe Clearance

Vehicle Direction		Load	Test Item
Uphill	Downhill		
Fail	Fail	Curb	1
Fail	Fail	Curb	2
Fail	Fail	Curb	3
Fail	Fail	Curb	4

5.3 Tests at Curb Weight with Clearance Adjusted for Wear

The results of the tests on a 20% grade with the vehicle at curb weight and each parking brake shoe clearance adjusted for wear are shown in Table 3.

Table 3
Test Results at Curb Weight for "Adjusted for Wear" Clearance

Vehicle Direction		Load	Test Item
Uphill	Downhill		
Pass	Pass	Curb	1
Fail	Fail	Curb	2
Pass	Pass	Curb	3
Pass	Pass	Curb	4

5.4 Tests at GVWR with Clearance Adjusted for Wear

The results of the tests with the vehicle loaded to GVWR and each parking brake shoe clearance adjusted for wear are discussed in the following sections.

5.4.1 Tests on 20% Grade

The results of the tests performed on a 20% grade are shown in Table 4. Because of the failure to hold the vehicle stationary in either direction in the Curb Weight test condition, the "Snare" shoes were not included in this series of tests.

Table 4
Test Results at GVWR for "Adjusted for Wear" Clearance

Vehicle Direction		Load	Test Item
Uphill	Downhill		
Fail	Pass	GVWR	1
Not Tested			2
Pass	Pass	GVWR	3
Pass	Fail	GVWR	4

5.4.2 Tests on Reduced Grades

The maximum grades on which each set of "complaint" shoes held the test vehicle stationary at GVWR are shown in Table 5.

Table 5
Maximum Grade on Which Parking Brake Held Vehicle Stationary

Uphill (%)	Downhill (%)	Test Item
12	20	1
15	5	2
20	20	3
20	15	4

6.0 Results

The as-received parking brake held the test vehicle stationary at curb weight on the 20% grade in the uphill direction but not in the downhill direction.

None of the four sets of "complaint" shoes held the test vehicle stationary on the 20% grade at curb weight when the test shoes were adjusted to "new" shoe clearance.

Three of the four sets of "complaint" shoes held the test vehicle stationary on the 20% grade at curb weight when the shoes were adjusted for wear.

Only one set of "complaint" shoes held the test vehicle stationary in both the uphill and downhill directions on the 20% grade at GVWR when the shoes were adjusted for wear.

7.0 Conclusions

Adjusting the parking brake shoes appears to extend the satisfactory performance of the shoes until wear becomes excessive. However, adjusting the shoes for wear requires removal of the brake calipers and rotors since the parking brakes were not equipped with automatic brake adjusters.