U.S. Department of Transportation

National Highway Traffic Safety Administration

Memorandum

Subject: Test Request (EA15-006)

Date: NOV 05 2015

From: Otto G. Matheke, III
Acting Director
Office of Defects Investigation

Reply to Attn. of:

To: Tim Johnson, Director
Vehicle Research and Test Center

BACKGROUND: On June 22, 2015, the Office of Defects Investigations (ODI) opened Preliminary Evaluation PE15-026 to investigate incidents of increased brake pedal effort at cold start and extended stopping distance while driving in traffic, resulting from failures of the electric brake vacuum assist pump in model year (MY) 2011-2012 Ford F-150 pickup trucks equipped with 3.5L GTDI engines. In response to ODI's Information Request (IR) for PE15-026, Ford provided ODI with 396 complaints and field reports relating to incidents of increased brake pedal effort or malfunctions in the electric vacuum pump (EVP). ODI's analysis of the data provided by Ford identified 7 crashes and 1,851 warranty claims related to either a hard brake pedal condition or reduced brake effectiveness. Additionally, ODI identified one report in its database alleging an injury to an occupant of a vehicle struck in the rear by a subject F-150 vehicle with a failed EVP, as documented in the police accident report referencing a dealer assessment of the pump.

According to Ford, the subject vehicles utilize a traditional brake vacuum booster to provide power assist for braking and the EVP is intended to operate to maintain consistent brake pedal feel. The engine intake manifold is the primary source of vacuum for the booster and is fully compliant to motor vehicle safety standards without the EVP. Ford described the conditions related to a change in brake pedal feel as limited and temporary and provided component failure analysis showing evidence of water entry into the EVP which caused internal pump corrosion. Ford indicated that the EVP failure mode is progressive and provides warning to operators by way of noise and vibration before an operator is likely to experience any temporary change in brake pedal feel. Damage to the EVP motor bearing may eventually result in a blown EVP fuse and total loss of EVP function.

Ford provided test data showing the brake pedal forces and pedal travel curves over time for 0.3g decelerations to a stop from 80kph (50mph) for: 1) normal system (full engine and EVP vacuum available); 2) Ford's approximation of worst case booster performance with EVP failure (EVP disabled and booster vacuum regulated to 300mbar to simulate cold start, all accessory loads on, and starting at 0 vacuum); and 3) with all source vacuum to the brake booster removed and Hydraulic Boost Compensation (HBC) active to represent complete loss of brake booster

function. The Ford tests showed that the brake pedal forces required for achieving the 0.3g decelerations were relatively low for the normal condition, 35-40 N (8-9 lbf), increased by approximately 2-3 times normal when the EVP is disabled, 75-115 N (17-26 lbf), and increased by about 5-6 times normal for the complete brake booster failure condition, 205-215 N (46-48 lbf). ODI upgraded the investigation to an Engineering Analysis (EA15-006) on October 16, 2015, to test vehicle brake performance with a failed EVP in comparison to normal system operation and to complete loss of brake power assist, as well as evaluating braking performance and human factors considerations during vehicle operating conditions when the EVP is most frequently used (e.g., low-speed driveway braking after cold-start).

REQUESTED WORK: ODI is requesting that the VRTC obtain a subject vehicle and perform testing to:

1. Establish brake performance curves showing vehicle deceleration vs. brake pedal application force under the following conditions:
   a. Normal system - baseline system performance with full engine and EVP vacuum available using exemplar parts;
   b. EVP failure (the alleged defect for EA15-006) - with a disabled EVP and booster vacuum regulated to simulate worst case conditions for brake power assist; and
   c. Brake booster failure - all source vacuum to the brake booster removed and Optimized Hydraulic Braking (OHB) mode active to represent complete loss of brake booster function.
2. Examine changes in braking/stopping performance and pedal feel with a failed EVP in low-speed driveway type maneuvers and other conditions reported in consumer complaints, to evaluate human factors effects such as:
   a. Driver reactions to changes in brake power assist and/or pedal feel;
   b. Driver reaction times;
   c. Brake application rates; and
   d. Resulting changes in stopping distances.

Final details of testing protocol and objectives shall be reviewed with the assigned ODI investigator, division chief and VRTC engineer(s).

ADDITIONAL INFORMATION: Please update the ODI investigator and division chief of test program status whenever there is a significant development or finding, and at least bi-weekly. The ODI investigator is Kareem Habib, kareem.habib@dot.gov, 202-366-8703. The ODI division chief is Jeffrey Quandt, jeff.quandt@dot.gov, 202-366-5207.

FINAL REPORT: It is requested that the test work and draft report be completed to a schedule to be determined in discussion with ODI.