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1.0 Abstract

This report describes testing by EPA of the Vehicle Exhaust Emission Control Device (VEECD) retrofit device under Section 32918 of Title 49 U.S.C. Retrofit Devices (RD). This testing was conducted at the National Vehicle and Fuel Emissions Laboratory (NVFEL) in Ann Arbor, Michigan at the request of the device developer, Hawtal Whiting Environmental Ltd. of the UK. Since submission of the RD application, Hawtal Whiting has established a tradename, EVEC™ for the VEECD.

The VEECD is described by the developer in the international patent application as an embodiment of air bleed principle. It is intended to be retrofitted to vehicles produced without any, or with earlier-technology emission control systems. It is not compatible with newer complex engine management systems or vehicles equipped with closed-loop three-way catalytic systems. The device is designed to be inserted into the hose connecting the inlet manifold to the vacuum brake booster and, as claimed by the developer, acts to optimize the air/fuel mixture during idle and deceleration.

The developer claims (RD Application Appendix A) that the valve significantly reduces CO and HC emissions without substantially increasing CO_2 or NOx emissions. Incidental city fuel economy enhancement was also claimed. Non-FTP test data obtained for 1986/87 European vehicles from two laboratories in the UK was submitted. This data (Appendix B) was analyzed using the t-test for the difference of constant speed data 30/60/85MPH) at 95% confidence level and the following was concluded:

- The device appeared to reduce CO emission at low speed; however, this effect is reduced at higher constant speed.
- HC and NOx emissions did not appear to be affected by the device.
- The device seemed to have negligible effect on CO_2 emissions and fuel economy.

The apparent CO emission reduction warranted EPA to proceed with confirmatory testing of the VEECD device.

The developer provided two vehicles as basis for the test program. Both were 1973 model-year light-duty vehicles. One was a Dodge Dart powered by a 318 cubic inch engine; the other a Ford

Mustang incorporating a base 302 cubic inch engine. Both vehicles were selected by the developer because they appeared to be close to original specification and incorporated the early-technology emission-control systems with which the VEECD is most compatible.

The agreed upon test plan sequence (Appendix C) included a comprehensive inspection and maintenance identical to that performed on in-use vehicles in EPA's Recall Program done by Vehicle Programs and Compliance Division (VPCD). Federal Test Procedures (FTP) were performed to establish the baseline tailpipe emission output of both vehicles. The VEECD was then installed on each vehicle by the developer's representative under the auspices of EPA personnel in accordance with the written instructions provided by the developer. The vehicles were again subjected to FTP testing. The third and final test consisted of a second baseline test without the VEECD.

Complete test data were collected only on the Ford because an undiagnosed engine failure in the Dodge prevented this vehicle from completing the second baseline test.

EPA concludes the following from the testing conducted on these two vehicles:

- Use of the VEECD resulted in a decrease in hydrocarbon (HC) and carbon monoxide (CO) emissions and an increase of oxides of nitrogen (NOx) and carbon dioxide (CO_2) emissions in both cars.

- Use of the VEECD resulted in an increase in city fuel economy in the Ford. Fuel economy in the Dodge remained the same.

2.0 Background

Under Section 32918 of Title 49 U.S.C., EPA is required, in response to requests from certain sources, to evaluate aftermarket retrofit devices and fuel additives (collectively referred to as devices) that are claimed to improve fuel economy and emissions. EPA receives information about many of these devices that are represented by the device developer/manufacturer as offering a potential for reductions in emissions and/or an improvement in the fuel economy of conventional automobiles. EPA's VPCD is interested in evaluating such devices because of the obvious benefits the test results and analyses have for the nation. EPA invites developers of devices to submit information on the principle of operation together with available preliminary

emission test data. In those cases where the developer's/manufacturer's application meets certain established program criteria, and the device shows promise in preliminary screening tests at an independent laboratory, confirmatory tests may be run at EPA's NVFEL in Ann Arbor, Michigan at the expense of the applicant. EPA is also required to evaluate devices at the request of the Federal Trade Commission and may perform such a device evaluation at the discretion of the EPA Administrator.

The conclusions drawn from EPA evaluation tests are necessarily of limited applicability. An all encompassing evaluation of the effectiveness of a device in achieving performance improvements on the many types of vehicles that are in actual use would require a large sample of test vehicles. This is not economically feasible in the evaluation projects conducted by EPA. Therefore, the conclusions from such device evaluation tests can be considered to be quantitatively valid only for the specific test cars used; however, it is reasonable to extrapolate the results from EPA tests to other types of vehicles in a directional manner; i.e., to suggest that similar results are likely to be achieved on other similar types of vehicles.

3.0 Introduction

This report describes EPA's testing of the VEECD air-bleed device under Section 32918 U.S.C. Title 49. The evaluation was conducted to address claims of reduced emissions and incidental improved city fuel economy performance of this device.

4.0 Purpose of the Test Program

The purpose of the EPA RD test program was to conduct a controlled technical evaluation of the VEECD air-bleed device in a manner that would address the developer's specific claims for significant reduction in HC and CO; with incidental reductions in fuel consumption during urban test cycles. Effect of the VEECD on power, octane requirement, cleanliness of the combustion chamber, and driveability were not evaluated. The developer made the following statements with regard to the device:

Purpose:

A mechanical device, which can be easily retrofitted to old vehicles to significantly reduce CO and HC emissions without significantly increasing CO_2 and NOx emissions. Incidental reduction in fuel consumption, particularly during the urban cycle is also achieved.

Applicability:

Effective on four-stroke spark ignition engines and operates with carburetor and fuel-injection systems. VEECD is not compatible with diesel engines.

Not compatible with complex engine management systems or vehicles fitted with three-way, closed loop catalytic converters. Weather and driving conditions do not adversely affect the functionality of the VEECD.

Theory of Operation:

The VEECD enhances the efficiency of the mix between air/ fuel ratio in the combustion chamber and it also reduces overall friction in the non-combustion cylinders.

Construction and Operation:

VEECD is a simple mechanical "T" shaped valve. It is fitted to the vacuum brake servo line and acts to optimize the air/ fuel mixture during idle and deceleration.

Specific Claims:

Significantly reduces CO and HC levels. Incidental reductions in fuel consumption, particularly in the urban cycles have been achieved.

5.0 Test Plan

The test plan developed by EPA and approved by the developer was as follows:

- The developer provided two test vehicles. Both were 1973 model-year light-duty vehicles. One was a Dodge Dart, the other a Ford Mustang.

- Both vehicles were subjected to inspection and maintenance identical to that performed on more recent model vehicles selected for testing in the VPCD Recall Program. Both were tuned as close to manufacturer's specifications as possible given their age and engine wear, replacing parts as necessary. The resultant air fuel ratio (AFR) was rich of stoichiometry in both vehicles.

- Baseline FTP testing was performed to establish the emissions and fuel economy of both vehicles prior to the

installation of the VEECD. The FTP (Federal Register; 40 CFR Part 86; July 1, 1990) is the official EPA test procedure for determining the exhaust emissions and city fuel economy of a vehicle. The vehicles were not tested for evaporative emissions.

- A VEECD was installed in each vehicle and adjusted per developer's procedure by a developer's representative under the auspices of EPA personnel. No adjustments were made to any engine components between tests.

A second set of tests was then performed to evaluate the performance of the VEECD.

The device was removed prior to the second series of baseline tests. Again, no adjustments were made to any engine components between tests. Only the Ford completed this phase of testing. Due to an undiagnosed engine failure, the Dodge did not complete its second baseline test.

Claims other than improved city fuel economy and reduced CO and HC exhaust emissions were not specifically addressed. These other claims are in large part subjective, and procedures for their evaluation are neither well defined nor routinely used by EPA. In addition, to evaluate other claims or vehicle system effects would require extensive vehicle mileage or engine out-of-vehicle operation. It should be noted however, that test technicians noted no driveability problems during the test driving cycles.

The device developer representative was present for all test phases except the first series of baseline tests.

6.0 Results

The results of EPA testing can be found in Table 1. These data have been analyzed and indicate the following:

- Neither vehicle met all emission standards for which they were originally designed even though both had been tuned as close to the manufacturer's specifications as possible and certain parts replaced as necessary. The resultant air fuel ratio for both the Dodge and Ford was rich of stoichiometry at 14.4 and 13.6 respectively. Given the age and engine wear of the vehicle, this is not unusual.

- HC and CO decreased from each vehicle with installation of the VEECD.

- HC and CO were decreased by 21% and 31% respectively in the Dodge; 4% and 20% in the Ford.

- NOx emissions increased from both cars with the installation of the VEECD; 13% for the Dodge and 10% for the Ford.

- CO_2 emissions from both cars increased also; 6% for the Dodge, 4% for the Ford.

- No improvement in city fuel economy was seen in the Dodge; however, city fuel economy did improve by 2% in the Ford.

7.0 Conclusions

EPA concludes the following from the testing reported above (See Table 1).

EPA testing confirmed the trend of data and claims submitted by the developer. The VEECD showed a decrease in HC and CO emissions from two examples of vehicles incorporating older emission control system technology. Volumes of such vehicles are small in the United States so applicability of the VEECD domestically would be quite limited. However, other geographic locations where there are high volumes of vehicles with older emission control systems might benefit from VEECD usage in reducing CO and HC's provided that any NO_x increase does not lead to increase in ozone (O_3) levels. Ozone is formed in ambient air from photochemical reactions of HC's and NO_x. A recent report[1] emphasizes the increased importance of NO_x in O_3 formation. The relative importance of HC and NO_x control varies from one part of a geographic location to another depending on local conditions. EPA regulates vehicle emissions of CO to meet ambient CO levels and HC and NO_x to meet acceptable O_3 levels. Therefore, based upon this very limited amount of test data from one vehicle that completed the test plan, it would seem that the use of VEECD on vehicles containing older technology emission control systems may be environmentally beneficial because of the reduction in HC and CO for areas meeting HC and CO controls. However, any NO_x increase must be considered since in some conditions NO_x emissions are more important than HC in ozone formation. Finally, the fuel economy increase seen in the Ford was not significant for a test sample of this size.

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[1]"Rethinking the Ozone Problem in Urban and Regional Air Pollution", National Research Council, 1992, National Academy Press, 2101 Constitution Ave., NW, Washington, DC 20418.