UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
NATIONAL VEHICLE AND FUEL EMISSIONS LABORATORY
2565 PLYMOUTH ROAD
ANN ARBOR, MICHIGAN 48105-2498

OFFICE OF
AIR AND RADIATION

April 15, 2013

MEMORANDUM

SUBJECT: EPA Response to Comments on the peer review of *Evaluation of the Effectiveness of On-Board Diagnostic (OBD) Systems in Identifying Fuel Vapor Losses from Light-Duty Vehicles*

FROM: Constance Hart, Assessment and Standards Division
Office of Transportation and Air Quality, U.S. Environmental Protection Agency

THRU: Glenn Passavant, Director, Data and Testing Center, Assessment and Standards Division
Office of Transportation and Air Quality, U.S. Environmental Protection Agency

TO: William Charmley, Director, Assessment and Standards Division
Office of Transportation and Air Quality, U.S. Environmental Protection Agency

The three peer reviewers selected by RTI International were Robert Klausmeier (dKC de la Torre Klausmeier Consulting), Stephen Leydon, (Georgia Department of Natural Resources), and Stephen Stewart (BC AirCare Program). EPA would like to extend its appreciation to all three reviewers for their efforts in evaluating this report. The three reviewers brought useful and distinctive views in response to the charge questions.

The peer review process and a summary of the comments can be found in the technical memorandum "Peer Review of LDV/LDT OBD and High Evaporative Emissions Report ", May 2012, from RTI International. EPA in cooperation with the evaporative testing contractor, Eastern Research Group (ERG), has edited the report which has addressed the Peer Reviewer comments. The responses are described below for each group of comments in this report:

Overview of the Reviews (3.1) and Methodology (3.2)

There was confusion regarding the use of RSD as a screening tool to recruit a stratified sample which was weighted more heavily toward higher evaporative emissions but still intended to sample across the range of evaporative emission rates which exist in the fleet. Some of that confusion stems from sentences which were unclear in the charge letter which referred to the RSD and in retrospect

should not have. Regardless of how the vehicles were recruited, the essence of the resulting analysis was that we had some vehicles which were found to have elevated evaporative emissions in the SHED and we also had OBD data available as to whether the evaporative emissions DTCs were set for these vehicles. We agree with Mr. Klausmeier's basic conclusion that "the report can only conclude OBD misses 50-70% of the high evaporative emitters as determined by the RSD evaporative index with the sample size caveat." Unfortunately, there was not data available from the mechanics inspections for each and every high emitting vehicle to clearly identify the source of the vapor emissions. This would have helped to clarify if the vapor source should also have triggered an evaporative emission DTCs or MILs. It is noteworthy that vehicles with low SHED readings generally did not have evaporative-related OBD DTCs set. Thus, the OBD did not identify false positives and did help to identify higher emitters.

Mr. Klausmeier commented that the recruitment with the RSD was screening for Running Losses (instead of traditional evaporative emissions) and that this was somehow skewing the analysis. We examined this concern using laboratory data from the CRC E-77 project with implanted leaks and several of the randomly recruited vehicles which also manifested leaks upon inspection. The information indicated that a leaking vehicle will have higher emissions in all modes – Hot Soak, Diurnal and Running Loss. Depending on the location of the leak, it may be more significant in a Hot Soak versus a Running Loss test or the opposite. Many of the vehicles that were recruited in the "low" emission bins were actually "high" emitters and vice versa due to the location of the leak and also the uncertainty of the instrument measurements at the lower levels. The instrument measurements were generally found to be more predictive in the 1 g/15 minute and higher range SHED reading, but with some margin of error. Thus, there does not appear to be a bias in the sample introduced by Running Losses because vehicles were found to also have high evaporative emissions in the other types of SHED tests when a vehicle has a leak in the fuel system.

The other two reviewers saw shortcomings of the RSD as a recruitment tool but still conceded that the conclusions of the report were valid.

In response to these comments, the report was edited on pages 1, 9 and 10 to clarify references to the RSD screening for recruitment. The details of the Denver study are referenced in two reports on the first page and it is in those reports where detailed information is given for the recruitment methodology and datasets. One of those reports, "Estimated Summer Hot Soak Distributions for the Denver's Ken Caryl IM Station Fleet" has also been peer reviewed. The other report, "Investigations of Techniques for High Evaporative Emissions Vehicle Detection: Denver Summer 2008 Pilot Study at Lipan Street Station" underwent extensive review in the Coordinating Research Council (CRC) Real World Emissions Group.

OBD (3.3)

Most comments in this section were observations that do not require a response. Mr. Klausmeier requests comparison of State I/M OBD data to look at the bigger picture. The report now has in its appendix a memo describing an analysis of evaporative emission system related OBD data for Texas and California.

In response to comment by Mr. Leydon, the early model year OBD equipped vehicles (model years 1996-1999 phase-in years), did not all have enhanced OBD monitoring. This was part of the criteria in the determination on whether the vehicle was expected to set a DTC code or not in going

from the twenty high PSHED values in Table 3-3 to the ten vehicles with high PSHED values in Tables 3-5 and 4-1.

Mr. Leydon also made a comment that it was unclear when the OBD data was downloaded in relation to the SHED test in the Denver 2010 study. To clarify this concern, this information is In the Analysis section, at the bottom of page 3-1, where it states that the OBD data was taken with the last IM240 test just prior to the SHED test.

It is noted, as Dr. Stewart has pointed out that the SHED results indicate a total evaporative emission rate, and does not indicate the source(s) of these emissions on the vehicle. While the OBD system covers most aspects of the vehicle fuel and evaporative control systems, it does not address other possible sources of evaporative emissions such as liquid leaks and canister breakthrough caused by atypical driving.

SHED Results (3.4)

The comments in this section were positive and the questions that were raised on the recruitment are detailed in the referenced reports (listed in last paragraph of responses to Sections 3.1 and 3.2) on the overall study which are given on page 1 of the report.

Dr. Stewart did state that there were certain causes for high evaporative emissions, such as liquid leaks or tailpipe residuals, which would not be detected by OBD. This is discussed in the report on page 3-8. While tailpipe residuals may occur, EPA believes that they are at least an order of magnitude less than the 1 g of HC over 15 minutes (1g/Qhr) in the SHED which we used as a criterion for the 0.020" orifice which we would expect OBD to detect. Out of the twenty vehicles which were above the 1 g/Qhr cut point in Table 3-3 on page 14, only ten vehicles are considered as potentially identifiable by OBD. These are listed in Table 3-5 on page 15. A clarification bullet was added to page 19 of the report to explain why we expect the OBD systems on these ten vehicles to be capable of detecting the problem causing the elevated evaporative emission level : "As OBD requirements developed and phased in, it became common practice for the auto companies, such as those listed in Table 3-5, to certify to the California OBD leak detection standard of 0.020" all of their vehicles sold federally. Laboratory data has shown a 0.020" diameter orifice to be roughly equivalent to an emission rate of 1 g/Qhr. Using the formula for the area of a circle (πr^2), it can be seen that the magnitude of emissions quadruples with the doubling of the diameter size to 0.040", and this has been found to be the case with laboratory testing comparing 0.020" and 0.040" leaks. Consequently, based on the magnitude of emissions, for the vehicles in Table 3-5 with SHED emissions of 6.30 g/Qhr and greater, it is reasonable to assume that they have leaks of diameter 0.040"."

Thus, we acknowledge that there are some sources of evaporative emissions which OBD would not be expected to find. These include liquid leaks as well as those from orifices with a cumulative diameter less than 0.020". These were not included in the analysis.

Modified California Method (MCM) (3.5)

Dr. Stewart and Mr. Klausmeier both thought the study could have done better at determining whether the reason for the high evaporative emission levels in the SHED should have been detectable by OBD. The relationship between in-use evaporative emission rates and OBDs was not a prime objective of the study. It was only when the data came available did it become clear that this

information was important. Clearly, more information on the source of the emissions on the vehicle would have been helpful. Thus, while we are not able to fully address every concern, we still find it valuable to distill what information we can. This point of the commenters is noted and any future studies will be much more aware of whether the emission problem is something that the OBD system has been designed to address.

Mr. Klausmeier again asked for a comparison to other data sources, and therefore we have done an analysis of two States data on OBD codes, particularly evaporative DTC codes. This docket memo is now included as an Appendix to the report "Preliminary Analysis of On-Board Diagnostic (OBD) Evaporative System Information from State Inspection and Maintenance (I/M) Stations – California and Texas", February 22, 2012. He also mentioned the California Roadside Studies. These studies were focused on tailpipe emissions and did not contain any evaporative testing data to compare OBD information, but we are continuing to investigate any additional data sets that might contribute to furthering our understanding of evaporative emissions in the real world.

OBD SHED Pairing (3.6)

Comments on OBD and SHED pairing were in general positive. Mr. Leydon was especially impressed and suggested that future studies be located at I/M stations because the OBD data is so readily available for comparison. He did make a comment that "No specifics are given provided for the high dropout due to no OBD II readings". OBD is advisory only in Colorado, therefore the data is not mandatory but collected for information purposes. This was added to the report in Section 3.1.

Reviewers' Recommendations (3.7)

As noted above, a memo describing State analysis of OBD data collected in I/M programs which is in response to Mr. Klausmeier's recommendations has been added to the report as an appendix.

Mr. Leydon's comment on weighting the older model years more heavily in modeling is easier to understand when looking at it in context of the paragraph on page E-6 of the peer review report. This certainly makes sense and will be recognized in the application of these analysis by model year groups. The early model year OBD equipped vehicles (model years 1996-1999 phase-in years), did not all have enhanced OBD monitoring. This was part of the criteria in the determination on whether the vehicle was expected to set a DTC code or not in going from the twenty high PSHED values in Table 3-3 to the ten vehicles with high PSHED values in Tables 3-5 and 4-1.

Dr. Stewart's recommendation about de-emphasizing the pre-screening with RSD has been taken and the report has been edited on pages 1, 9 and 10 to minimize references to this portion of the project and focus this report on the OBD and SHED comparison.

Overall Conclusions (3.8)

Most of the comments in this section have been addressed above. Dr. Stewart makes a point that in this study it was found that the evaporative OBD did not perform well enough to be a dependable modeling reference for the real world. We generally agree that OBD data taken alone may not be sufficient for modeling purposes. However, OBD systems are of great value in I/M and in ensuring in-use performance and there is potentially a wealth of OBD data that could be used with related information to improve modeling and inform other decisions.

Both Dr. Stewart and Mr. Klausmeier had concern that the sample sizes were not adequate to make strong conclusions. While we agree in principle, the information gathered in this work coupled with the analysis of State OBD data from I/M stations (which is now an appendix to the report) and information on emission rates for leaks of various diameters is very helpful in informing our view of the role of evaporative emission system vapor leaks in hydrocarbon inventories. As mentioned earlier, Mr. Leydon had stated on the first page of his review, E-3 of the peer review report, that he is surprised at how many people actually came to the I/M station with their MILs on, because most people will attempt to correct the problem. However, the data from California and Texas indicate similar trends. If there is a propensity to correct MILs before I/M inspectiom, this suggests that the frequency of problems in non-I/M areas may be higher.