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UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR, MICHIGAN 48105

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OFFICE OF
AIR AND RADIATION

MEMORANDUM

SUBJECT: Effect of Test Fuel Differences on NMHC + NO_x Emissions

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THRU: Tad Wysor, Senior Project Manager
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TO: The Record

The purpose of this memo is to discuss the effects of using California fuel rather than federal fuel when testing heavy-duty engines. California has set a medium-duty LEV standard of 3.5 g/BHp-hr NMHC + NO_x. In proposing a federal standard, it is important to understand the difference in emissions for an engine tested on federal rather than California fuel.

The analysis for diesel engines was based on a fuel effects study performed on a 1991 prototype DDC Series 60 engine[1]. For comparing federal and California diesel fuels, aromatic percent and cetane number were examined. Since California does not have a cetane requirement separate from the federal value, the fuel effects on NMHC + NO_x are likely to result from differences in test fuel aromatic content. This analysis uses the specified aromatic levels of 10 percent for California test fuel and 35 percent for federal test fuel. Because California does not have a separate cetane number requirement, the same minimum cetane number as federal fuel (i.e., 40) was used for California fuel. The following regression equations were developed for total hydrocarbon (THC) and NOx using the fuel effects data on the DDC engine. The fuel effects data were determined by performing two to three Federal Test Procedures on 13 different fuels of varying aromatic content and cetane number.

Regression Curves of Fuel Effects Data

(1) THC [g/BHp-hr] = EXP(1.015 - (0.9539 * ln(Total Cetane - 35)))

(2) NO_x [g/BHp-hr] = EXP(1.587 + (0.00296 * (FIA Aromatics %))
- (0.04276 * ln(Total Cetane - 35)))

Using the regression equations and the fuel quality assumptions above, the following table was generated.

Table 1:

Emission Differences Between Federal and California Diesel Fuel

Fuel (aromatic, cetane)	THC (g/Bhp-hr)	NO_x (g/Bhp-hr)	THC + NO_x (g/Bhp-hr)
Federal (35%, 40)	0.59	5.06	5.66
California (10%, 40)	0.59	4.70	5.30
Difference	0.00	0.36	**0.36**

- Numbers in table may not add up due to rounding.

As shown in Table 1, this analysis indicates that for the engine tested federal fuel results in approximately seven percent greater THC + NO_x emissions than California fuel. THC emissions were not affected by the varying aromatic levels, and it is reasonable to assume that NMHC emissions from the two fuels would be similar. Therefore, the difference in NMHC + NOx emissions between the two fuels should be the same as the difference in THC + NOx emissions. If a diesel engine emitting at a level of 3.5 g/BHp-hr NMHC + NO_x with California fuel experiences a similar difference with federal fuel, a seven percent increase in emissions due to using federal fuel would result in an emission level of about 3.75 g/BHp-hr NMHC + NO_x.

References

1. T. Ullman, R. Mason, D. Montalvo, "Effects of Fuel Aromatics, Cetane Number, and Cetane Improver on Emissions from a 1991 Prototype Heavy-Duty Diesel Engine," Southwest Research Institute, 1990, SAE Paper 902171.