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**US FOODS**  
Livermore, CA

**Emissions Test Report**

5 International Diesel Trucks Model 8600 with Cummins Engines  
NO<sub>x</sub>, CO, SO<sub>2</sub> & THC Emissions Results with ACES Fuel additive

**Performed and Reported by:**

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REVIEW AND CERTIFICATION

Team Leader:

The work performed herein was conducted under my supervision, and I certify that the details and results contained within this report are to the best of my knowledge an authentic and accurate representation of the test program. If this report is submitted for compliance purposes it should only be reproduced in its entirety. If there are any questions concerning this report, please contact the reviewer or myself at (925) 455-9474.

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Jim McCormack  
Project Manager

Reviewer:

I have reviewed this report for presentation and accuracy of content, and hereby certify that to the best of my knowledge the information is complete and correct.

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Regan Best  
Source Test Manager

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## SECTION 1. INTRODUCTION

**1.1. Test Purpose**

Best Environmental was contracted by ACES Fuel Systems to perform NO<sub>x</sub>, CO, SO<sub>2</sub> & THC emissions testing on 5 International Diesel trucks Model 8600 with Cummins engines while burning the ACES fuel additive.

**1.2. Test Location**

The emission sources were located at US Foods, 300 Lawrence Drive, Livermore, California. Emission sampling was performed at the engine exhaust stack. See the stack digital image in the appendix.

**1.3. Test Date(s)**

Testing was conducted on May 5

**1.4. Pollutants Tested**

The following emission parameters were measured:

Parameter	Monitoring & Analytical Protocols
Volumetric Flow Rate	CARB Methods 1-4
THC, NO <sub>x</sub> , CO, CO <sub>2</sub> & O <sub>2</sub>	CARB Method 100

**1.5. Sampling and Observing Personnel**

Sampling was performed by Jim McCormack and Suhail Asfour of BEST ENVIRONMENTAL (BE).

Russ Chiasson with ACES Fuel Systems was present to assist with testing.

**1.6. Important Background Information**

Baseline testing was performed using an ECOM A+ Portable Combustion Analyzer on August 8, 2008. The baseline testing was not preformed by Best Environmental and was included for comparison purposes only.

## SECTION 2. SUMMARY OF RESULTS

## 2.1. Emission Results

Table 2.1  
EMISSIONS SUMMARY TABLE

<b>Emission Test VIN #6J330436</b>							
1000 RMP No Load Test	O <sub>2</sub> %	CO ppm	NO ppm	NO <sub>2</sub> ppm	NO <sub>x</sub> ppm	SO <sub>2</sub> ppm	CO <sub>2</sub> %
Average Baseline Test (8/13/08)	17.6	75	316	41	357	1	2.5
Average Final Test (5/5/09)	18.1	131	228	20	248	0.19	2.3
% of Reduction	0	0	27.85	51.22	30.53	81	8

<b>Emission Test VIN #6J330477</b>							
1000 RMP No Load Test	O <sub>2</sub> %	CO ppm	NO ppm	NO <sub>2</sub> ppm	NO <sub>x</sub> ppm	SO <sub>2</sub> ppm	CO <sub>2</sub> %
Average Baseline Test (8/13/08)	17.7	84	267	36	303	0	2.4
Average Final Test (5/5/09)	18.4	61	201	18	219	0.17	2.1
% of Reduction	0	27.38	24.72	20.00	27.72	0	12.5

<b>Emission Test VIN #6J330484</b>							
1000 RMP No Load Test	O <sub>2</sub> %	CO ppm	NO ppm	NO <sub>2</sub> ppm	NO <sub>x</sub> ppm	SO <sub>2</sub> ppm	CO <sub>2</sub> %
Average Baseline Test (8/13/08)	17.6	113	301	45	346	0	2.5
Average Final Test (5/5/09)	18.2	156	221	43	264	0.23	2.1
% of Reduction	0	0	26.58	4.44	23.70	0	16

<b>Emission Test VIN #6J330478</b>							
1000 RMP No Load Test	O <sub>2</sub> %	CO ppm	NO ppm	NO <sub>2</sub> ppm	NO <sub>x</sub> ppm	SO <sub>2</sub> ppm	CO <sub>2</sub> %
Average Baseline Test (8/13/08)	17.6	84	254	40	294	0	2.5
Average Final Test (5/5/09)	18.2	74	198	48	246	0.20	2.1
% of Reduction	0	11.90	22.05	0	16.33	0	16

<b>Emission Test VIN #8J568710</b>							
1500 RMP No Load Test C. Converter problem @ 1000	O <sub>2</sub> %	CO ppm	NO ppm	NO <sub>2</sub> ppm	NO <sub>x</sub> ppm	SO <sub>2</sub> ppm	CO <sub>2</sub> %
Average Baseline Test (8/13/08)	18.0	0.33	264	25	288	4	2.1
Average Final Test (5/5/09)	18.0	<3.00	172	21	192	0.23	2.3
% of Reduction	0	0	34.85	16.00	33.33	94.25	0

A more extensive summary of the final test emissions is presented in Table 1 following the text.

**2.2. Allowable Emission Limits**

See Table 2.1 above. Emission limits have not been disclosed.

**2.3. Description of Collected Samples**

A Chain of Custody (COC) was filled out for all samples to ensure proper handling and analysis.

**2.4. Comments: Discussion of Quality Assurance and Errors**

Quality assurance procedures listed in the above referenced test methods and referenced in the Source Test plan were performed and documented. The QA/QC procedures are described in Section 4.3 of the report. Documentation of the QA/QC is provided in Appendices A, B, E & F.

The baseline testing was not performed by Best Environmental and was included for comparison purposes only.

The one diesel truck with a catalytic converter VIN # 8J568710 could not maintain stable emissions at 1000 RPM. The RPM was raised to 1500 RPM where stable emissions could be recorded.

## SECTION 3. SOURCE OPERATION

### 3.1. Process Description

The five diesel fired I.C Engines are used to move storage trailers

### 3.2. Process Diagram

A digital image of the exhaust stack is contained in Appendix G.

### 3.3. Process and control operating parameters during testing

The engines were to be operated at 1000 RPM for the duration of the tests. The engine was operated with no load.

### 3.4. Fuel Products and Characterization of the exhaust gas stream

The engine is operated on California low sulfur #2 fuel oil (Diesel Fuel).

### 3.5. Testing or Process interruptions and changes

Testing was performed at no load condition. A Dyno was not used. The one diesel truck with a catalytic converter VIN # 8J568710 could not maintain stable emissions at 1000 RPM. The RPM was raised to 1500 RPM where stable emissions could be recorded.



## SECTION 4. SAMPLING AND ANALYSIS PROCEDURES

### 4.1. Port location

Emissions from each engine were sampled through exhaust stack of each truck

The dimensional cross-section of the engine stack is 5-inches (Area SQFT=0.136).

### 4.2. Point description/Labeling-port/stack

The sample ports were not labeled

### 4.3. Sampling Train Description

Reference 4.5

### 4.4. Brief Description of Sampling Procedures

Stack temp, moisture and flow rate (EPA 1-4) were used to determine an emission rate and emission factor.

One 15-minute test run was performed at the engine outlet for THC, NO<sub>x</sub>, CO, O<sub>2</sub> & CO<sub>2</sub> using CARB Method 100.

All calculations can be found in Table 1 and in Appendix A.

All sampling was performed within the method specifications.

### 4.5. Method description, equipment, sampling, analysis and QA/QC

Sampling and analytical procedures of the EPA Methods are followed as published in the "Quality Assurance Handbook for Air Pollution Measurement Systems" Volume III, US EPA 600/4-77-027b.

#### The following is an overview of the Testing Performed

Parameter	Location	Method(s)	Duration	#of Runs
Flow Rate, DSCFM	Exhaust	CARB Methods 1-4	15 mins	5
THC, NO <sub>x</sub> , CO, O <sub>2</sub> & CO <sub>2</sub>	Exhaust	CARB Method 100	15 mins	5

**CARB Method 1.** These methods are used to determine the duct stack area and appropriate traverse points that represent equal areas of the duct for sampling and velocity measurements. The point selection is made based on the type of test (particulate or velocity), the stack diameter and port location distance from flow disturbance.

**CARB Method 2** is used to determine stack gas velocity using a standard or S-type pitot tube and inclined manometer or magnahelic gauge. Temperature is monitored using a K-type thermocouple and calibrated Omega temperature meter. Leak checks are performed before and after each traverse to validate the results. Thermometer calibrations are performed using an Omega Model CL-300 calibrator. Geometric calibrations of S-type pitot tubes are performed and records are submitted with the report.

**CARB Method 3** is used to measure O<sub>2</sub> and CO<sub>2</sub> concentrations to determine the molecular weight of the stack gas. The %O<sub>2</sub> and %CO<sub>2</sub> concentrations were measured by CEM.

**CARB Method 4** is used to determine the moisture content in the gas stream by extracting a sample and condensing the moisture in the impingers and the silica gel trap of the Method 4 sample

trains. The moisture gained is determined volumetrically and gravimetrically. Results are recorded on the field data sheet. A sample is pulled using a leak tight pump. Volume is measured with a calibrated dry gas meter. Pre-and post-test leak checks are performed for each run.

**Sampling QA/QC:** consists of pitot leak checks per EPA Method 2. Sampling system leak checks are performed before and after each test run. The sampling system leak checks are performed per EPA Method 4. The impingers are kept in ice to maintain the temperature of the gas exiting the last impinger to below 68°F. No silicone grease is used in the components of the sampling train. The dry gas meter, pitot, thermocouples, gauges and nozzles are all calibrated according to the methods and with a frequency of between 6 to 12 months as specified in EPA QA/QC Volume VI, Table 3. Nozzles are calibrated to within 0.001" diameter and are inspected for damage prior to each test. Reagent blanks are collected using the same lot reagents, same proportions and techniques as the test samples. Analytical QA/QC consisted of a reagent blank. All gravimetric work is performed on calibrated analytical balances.

**CARB Method 100 (NO<sub>x</sub>, CO, O<sub>2</sub> & CO<sub>2</sub>)** are all continuous monitoring techniques using instrumental analyzers. Sampling is performed by extracting exhaust flue gas from the stack, conditioning the sample and analyzing the flue gas using continuous monitoring gas analyzers in a CEM test van. The sampling system consists of a stainless steel sample probe, Teflon sample line, glass-fiber particulate filter, glass moisture-knockout condensers in ice, Teflon sample transfer tubing, diaphragm pump and a stainless steel/Teflon manifold and flow control/delivery system. A constant sample and calibration gas supply pressure of 5 PSI was provided to each analyzer to avoid pressure variable response differences. The entire sampling system was leak checked prior to and at the end of the sampling program.

The BE sampling and analytical system was checked for linearity with zero, mid and high level span calibration gases, and was checked for system bias at the beginning of the test day. System bias was determined by pulling calibration gas through the entire sampling system. Individual test run calibrations used the calibration gas, which most closely matches the stack gas effluent. The calibration gases were selected to fall approximately within the following instrument ranges; 80 to 100 percent for the high calibration, 40 to 60 percent for the mid range and zero. Zero and calibration drift values were determined for each test.

**THC as methane by FID (CARB Method 100)** is an accepted method for the determination of Total Hydrocarbons (THC). A flame ionization detector (FID) total hydrocarbon continuous monitor is used for the sampling. The sampling and calibrations are performed through an all heated sample line connected directly to the THC analyzer without the removal of moisture. The FID in the analyzer is heated to 160 °C. The calibration gases are selected to fall within the following instrument ranges; 80 to 100 percent for the high calibration, 40 to 60 percent for the mid range calibration and zero can be collected through activated carbon and measured through the THC analyzer during each run to determine methane. Methane can be measured and used to subtract from the THC concentration to determine VOC. This is not applicable for diesel emission sources as methane is not a byproduct of diesel combustion.

All BE calibration gases are EPA Protocol # 1. The analyzer data recording system consists of strip chart recorders, which can be supported by BE's Data Acquisition System (DAS). The NO<sub>2</sub> converter was checked and confirmed to be > 90% efficient.

**System Criteria**

Instrument Linearity	≤2% Full Scale
Instrument Bias	≤5% Full Scale

**Test Criteria**

Instrument Zero Drift	≤3% Full Scale
Instrument Span Drift	≤3% Full Scale
NO <sub>2</sub> Converter Efficiency	≥90%

**Instrumentation:** The following continuous emission monitors were used:

Instrument	Analyte	Principle
CAI Model 600CLD	NO <sub>x</sub>	Chemiluminescence
TECO Model 48C	CO	GFC/IR
CAI Model 100	CO <sub>2</sub>	NDIR
CAI Model 110P	O <sub>2</sub>	Paramagnetic
CAI Model 300	THC	HFID

TABLE #1

**US Foods**  
**NO<sub>x</sub>, CO, SO<sub>2</sub> & THC Test Results**

Truck VIN#	6J330486	6J330477	6J330484	6J330478	8J568710
Engine RPM	1000	1000	1000	1000	1500
TEST	1	2	3	5	6
Test Location	Outlet	Outlet	Outlet	Outlet	Outlet
Test Date	5/5/09	5/5/09	5/5/09	5/5/09	5/5/09
Test Start Time	13:02	13:44	14:11	15:00	15:25
Standard Temp., °F	68	68	68	68	68
Flow Rate, DSCFM (Method 2)	259	233	232	202	218
O <sub>2</sub> , %	18.05	18.36	18.23	18.21	17.97
CO <sub>2</sub> , %	2.33	2.05	2.12	2.13	2.31
NO <sub>x</sub> , ppm	248.34	219.21	264.00	246.23	192.27
NO, ppm	228.45	200.77	220.62	198.28	171.72
NO <sub>2</sub> , ppm	19.89	18.44	43.39	47.94	20.55
NO <sub>x</sub> , ppm corr. to 15% O <sub>2</sub>	513.96	509.72	584.05	540.93	386.50
NO <sub>x</sub> , lbs/hr	0.46	0.37	0.44	0.36	0.30
CO, ppm	130.92	60.97	156.00	74.23	<3.00
CO, ppm corr. to 15% O <sub>2</sub>	270.96	141.78	345.11	163.07	<6.03
CO, lbs/hr	0.148	0.062	0.158	0.065	<0.00
THC, ppm	52.1	40.1	44.3	32.5	20.2
THC, ppm corr. to 15% O <sub>2</sub>	107.75	93.20	98.00	71.46	40.65
THC, lbs/hr	0.034	0.023	0.026	0.016	0.011
SO <sub>2</sub> , ppm	0.19	0.17	0.23	0.20	0.23
SO <sub>2</sub> , ppm corr. to 15% O <sub>2</sub>	0.39	0.40	0.50	0.44	0.46
SO <sub>2</sub> , lbs/hr	0.0005	0.0004	0.0005	0.0004	0.0005

Note: Test #4 was not included due to problems with the catalytic converter at 1000 RPM.

**WHERE:**

MW = Molecular Weight

DSCFM = Dry Standard Cubic Feet Per Minute

ppm = Parts Per Million Concentration

lbs/hr = Pound Per Hour Emission Rate

CO = Carbon Monoxide (MW = 28)

NO<sub>x</sub> = Oxides of Nitrogen as NO<sub>2</sub> (MW = 46)

THC = Total Hydrocarbons as Methane (MW = 16)

SO<sub>2</sub> = Sulfur Dioxide (MW = 64.1)

**CALCULATIONS:**

lbs/hr = ppm \* DSCFM \* MW \* 60 / 385 x 10<sup>6</sup> @ 68°F

ppm @ 15% O<sub>2</sub> = ppm \* 5.9 / (20.9 - stack O<sub>2</sub>)

Oil Fd-Factor @ 68°F 9190