THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV

U.S. Environmental Protection Agency

SOUTHERN RESEARCH INSTITUTE

ETV Joint Verification Statement

TECHNOLOGY TYPE:	**Diesel Fuel Cleaning and Maintenance System**
APPLICATION:	**Diesel-fired, Reciprocating Engines**
TECHNOLOGY NAME:	**JCH Enviro Automated Fuel Cleaning and Maintenance System**
COMPANY:	**JCH Fuel Solutions, Inc.**
ADDRESS:	**4527 Losee Road (T) 702/639-4076** **N. Las Vegas, NV 89031 (F) 702/649-4692**
E-MAIL:	**rsickels@jchfuel.com**

The U.S. Environmental Protection Agency (EPA) has created the Environmental Technology Verification (ETV) program to facilitate the deployment of innovative or improved environmental technologies through performance verification and dissemination of information. The goal of the ETV program is to further environmental protection by substantially accelerating the acceptance and use of improved and cost-effective technologies. ETV seeks to achieve this goal by providing high quality, peer reviewed data on technology performance to those involved in the purchase, design, distribution, financing, permitting, and use of environmental technologies.

ETV works in partnership with recognized standards and testing organizations, stakeholder groups that consist of buyers, vendor organizations, and permitters, and with the full participation of individual technology developers. The program evaluates the performance of technologies by developing test plans that are responsive to the needs of stakeholders, conducting field or laboratory tests, collecting and analyzing data, and preparing peer reviewed reports. All evaluations are conducted in accordance with rigorous quality assurance protocols to ensure that data of known and adequate quality are generated, and that the results are defensible.

The Greenhouse Gas Technology Center (GHG Center), one of six verification organizations under the ETV program, is operated by Southern Research Institute, in cooperation with EPA's National Risk Management Research Laboratory. The GHG Center recently conducted a verification of the Enviro Automated Fuel Cleaning and Maintenance System, Model 4 (Enviro System), which is offered by JCH Fuel Solutions, Inc., of N. Las Vegas, NV.

This verification statement provides a summary of the results obtained during testing of the Enviro System.

TECHNOLOGY DESCRIPTION

Facilities using diesel-fired engines often maintain their own diesel fuel storage tanks at central locations. Stationary engines draw their fuel supply through direct piping to the central storage tanks or they may operate from integral tanks (day tanks) mounted on the engine chassis. Although diesel fuel is best used fresh, or within a few months from when it was manufactured, often times a given inventory of fuel can remain in a storage tank for long periods. For example, a hospital or hotel with a diesel-powered emergency electric generating plant may keep the same tank of fuel for a long time before using it. Some facilities buy fuel months or even years in advance of projected needs to take advantage of favorable pricing. The fuel can become contaminated during long storage periods, even when it is stored in a clean tank.

Contaminants can alter diesel fuel properties and thereby potentially harm the precision mechanisms of a diesel engine, increase wear, clog filters, and reduce combustion quality. Contaminated fuel may therefore increase fuel consumption and emissions. JCH's Enviro System technology treats and cleans contaminated fuel. It also maintains the treated fuel while in storage. The first step of treatment consists of the application of the proper amount of Algae-X AFC-705 fuel catalyst. According to JCH, the AFC-705 solution contains a preservative and dispersant to stabilize fuel in storage by retarding gum formation, a corrosion inhibitor, a demulsifier to drop out entrained water, detergents, and lubricity enhancers. One gallon treats approximately 5,000 gallons of fuel. JCH then installs an Enviro System at or near the storage tank.

JCH manufactures and markets 12 Enviro models in various sizes and capacities. Each system consists of several components. An electric pump moves fuel from the tank through an Algae-X magnetic fuel conditioner, a multistage filter train, and then back to the tank. Most portable Enviro models employ two-stage filtration. The first stage is a cartridge-type coarse particulate screen and bulk water separator. The second stage is a 2-µm particulate filter that also removes emulsified water. The system size and pumping capacity is selected based on the size of the tank to be served. The Enviro System used during this evaluation was based on the size of the fuel tank used for testing.

During treatment and cleaning activities, JCH qualitatively monitors the fuel quality using field test equipment, and applies a rating of 1 to 10 for sediment and water, microorganisms, appearance, clarity/brightness, and debris/contamination. Once a contaminated lot of fuel is satisfactorily treated, its quality must be maintained by regular operation of the Enviro System. JCH recommends that at least one tank volume per week be circulated through the Enviro System.

VERIFICATION DESCRIPTION

The verification strategy was to conduct a set of tests for emissions, fuel quality, and fuel consumption while operating an engine on the contaminated fuel, and then to repeat the tests after treating the same lot of fuel using the Enviro System and running the engine on the treated fuel. During the verification tests, the following fuel and engine performance characteristics were evaluated:

- Mass emission rates of criteria air pollutants and greenhouse gases from the engine while combusting contaminated and treated fuel:
  - Carbon Monoxide (CO)
  - Carbon Dioxide (CO_2)
  - Methane (CH_4)
  - Nitrogen Oxides (NO_X)
  - Sulfur Dioxide (SO_2)
  - Total Hydrocarbons (THCs)
  - Total Particulate Matter (TPM)

- Fuel properties for contaminated and treated fuel:
  - Fuel consumption rate, lb/hr
  - Fuel quality properties as follows:
    - API Gravity, °API
    - Ash, vol %
    - Cetane Number
    - Flash Point, °C
    - Fuel Lower Heating Value (LHV), Btu/lb
    - Gums and Resins, mg/L
    - Lubricity
    - Microbial Contamination
    - Particulate Matter, mg/L
    - Water and Sediment, vol %

- Emissions performance in terms of the percent change in mass emission rates between contaminated and treated fuel. Emission rates were normalized to fuel consumption rates ($lb_{pollutant}/lb_{fuel}$), and to engine heat input ($lb_{pollutant}/10^6$Btu).

During each test period, engine load was maintained at near steady state using a load bank. The emissions tests conformed to well-documented EPA reference methods, and fuel measurements were conducted according to ASTM test specifications and other industry-accepted protocols. The results of these measurements allowed emissions performance comparisons between the two fuel conditions.

This verification was hosted by the Cummins Intermountain (CI) facility located in North Las Vegas, NV. CI is a full-service Cummins engine dealer that maintains a large inventory of diesel-driven generator (genset) rental equipment. The unit selected for testing was an Onan Model 200DGFC 200 kW trailer-mounted test genset, driven by a Cummins Model 6CTAA8.3-G1 6-cylinder, direct-injected, turbocharged engine. JCH provided approximately 300 gallons of contaminated fuel for this test. A series of tests were conducted for each of the verification parameters listed above while combusting the contaminated fuel. The fuel was then treated using the Enviro System, and the tests were repeated while combusting the treated fuel.

VERIFICATION OF PERFORMANCE

A total of at least three valid test runs were conducted for engine emissions while combusting contaminated fuel, each no less than 1 hour in duration. Fuel quality sampling and fuel consumption rate determinations were conducted in conjunction with each test. After completing the contaminated fuel testing, JCH personnel conducted fuel treatment activities on the remaining fuel using the Enviro System. The testing was then repeated the following day while combusting the cleaned fuel. The genset was operated at full load throughout the testing periods. Engine operations were monitored throughout the test periods to document steady operations.

Emissions Rates and Emissions Performance

Emission rates were determined for each of the pollutants in units of pounds per hour (lb/hr) and normalized to fuel consumption rates and reported in units of pounds pollutant per pound of fuel ($lb_{pollutant}/lb_{fuel}$). Normalized emission rates were used to compare changes in emissions that occurred between contaminated and treated fuel. The results are summarized below.

Changes in Emissions for Contaminated and Treated Fuel

Pollutant	Average Emission Rate – Contaminated Fuel, ($lb_{pollutant}/lb_{fuel}$)	Average Emission Rate – Treated Fuel, ($lb_{pollutant}/lb_{fuel}$)	Average Reduction (Increase)[a], (%)
CH_4	0.00003	0.00003	0.0
CO	0.00193	0.00212	(9.6)
CO_2	3.38	3.42	(1.4)
NO_X	0.0490	0.0484	1.3
SO_2	0.000825	0.000851	(3.2)
THCs	0.00123	0.00123	0.1
TPM	0.00155	0.00151	2.4

[a] Average difference = (Contaminated rate – Treated rate) / Contaminated rate * 100

Average changes in emissions varied from a 2.4 percent decrease to a 9.6 percent increase, the difference in emissions between treated and untreated fuel was statistically insignificant for all species, except SO_2 (based on a 95 percent confidence interval). The fuel sulfur content was approximately 3.4 percent higher after treatment of the fuel. Research into the composition of the AFC-705 fuel additive revealed a sulfur content of 1.1 percent in the additive. A total of 9 ounces of AFC-705 was added to the fuel during treatment, corresponding to about 0.005 pound of sulfur. This is the only source of sulfur that might have contributed to the small increase measured in SO_2 emissions. The data also indicate a 9.6 percent increase in CO emissions after treatment, but this increase is statistically significant only at a confidence interval of 86 percent.

Fuel Consumption, Fuel Quality, and Fuel Cleaning Performance

Results of the fuel consumption, fuel quality, and fuel cleaning performance are summarized below:

- At constant load, genset fuel consumption rates averaged 89.5 ± 1.25 lb/hr while combusting contaminated fuel, and 87.8 ± 2.13 lb/hr after fuel treatment. The mass of contaminants collected on the engine filters while burning contaminated fuel may have biased these measurements slightly; i.e., the mass of fuel drawn from the tank is slightly higher than the mass of fuel consumed, especially when high levels of contamination are present which get caught by the engines fuel filters prior to combustion. Given this bias and inherent measurement uncertainties, little or no improvement in fuel consumption rate occurred when burning the cleaned fuel.

- A qualitative analysis of microbial contamination in the fuel indicated that the Enviro System did reduce bacterial and fungal contamination. Cetane number and sulfur content were slightly higher in the treated fuel.

- An evaluation of the Enviro System's fuel cleaning performance was planned but not conducted because all samples were collected downstream of the engine's filters. Visual inspection of the fuel and the engine filters after each test run suggest that significant fuel cleaning was provided by the Enviro System, but changes in fuel quality were apparently masked by the fuel cleaning capability of the existing engine filters. Additionally, the engine could run at full load for only one to two hours on the contaminated fuel before engine filter clogging caused the engine to stall. This operational problem was not evident after treating the fuel with the Enviro System.

Original signed by:

E. Timothy Oppelt
Director
National Risk Management Research Laboratory
Office of Research and Development

Original signed by:

Stephen D. Piccot
Director
Greenhouse Gas Technology Center
Southern Research Institute