THE ENVIRONMENTAL TECHNOLOGY VERIFICATION PROGRAM

ETV Joint Verification Statement

TECHNOLOGY TYPE:	Vehicle Fuel Additive
APPLICATION:	Gasoline Passenger Vehicles
TECHNOLOGY NAME:	TEA Fuel Additive
COMPANY:	Taconic Energy, Inc.
LOCATION:	Saratoga Springs, NY
WEB ADDRESS:	http://www.taconicenergy.com

The U.S. Environmental Protection Agency's Office of Research and Development (EPA-ORD) operates the Environmental Technology Verification (ETV) program to facilitate the deployment of innovative technologies through performance verification and information dissemination. The goal of ETV is to further environmental protection by accelerating the acceptance and use of improved and innovative environmental 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), operated by Southern Research Institute (Southern), is one of six verification organizations operating under the ETV program. One sector of significant interest to GHG Center stakeholders is transportation - particularly technologies that result in

fuel economy improvements. Taconic Energy (Taconic) has developed the TEA fuel additive for gasoline passenger vehicles and requested that the GHG Center independently verify its performance. The GHG Center verified the fuel economy performance attributable to the TEA additive at the Transportation Research Center (TRC) in East Liberty Ohio in October 2010.

TECHNOLOGY DESCRIPTION

Taconic Energy has registered with the EPA three products within the TEA additive technology family in accordance with the regulations found in 40 Code of Federal Regulations (CFR) Part 79 of the Federal Register. Gasoline containing any of these registered materials retains their EPA baseline fuel designation. The additive family TEA-037, 037E, and 037M differ in the types and amounts of solvent systems. The active ingredient of this technology serves primarily as a friction modifier ameliorating the in-cylinder friction losses in a gasoline engine.

The following technology information is provided by Taconic and does not represent verified information. Taconic Energy has completed development and rigorous testing of this active ingredient in a variety of vehicles. According to Taconic, the additive typically improves fuel economy in passenger vehicles by 1-5% and provides associated emission reductions. Taconic claims that the additive has been shown to have an almost immediate effect on fuel economy with no required break-in period, a slight increase in improvement over time, and impacts of the additive are not immediately eliminated when the additive is removed. There is a carryover effect that requires accumulation of significant mileage to return to the original equipment condition. The physical properties of the three products within the TEA additive technology family are governed by the amount and type of solvent used in formulation.

VERIFICATION DESCRIPTION

Details on the verification test design, measurement test procedures, and quality assurance/quality control (QA/QC) procedures are contained in two related documents. Technology and site specific information can be found in the document titled *Test and Quality Assurance Plan (TQAP) – Taconic Energy, Inc. TEA Fuel Additive.* The TQAP describes the system under test, project participants, site specific instrumentation and measurements, and verification specific QA/QC goals. The TQAP was reviewed and revised based on comments received from peer and stakeholder reviews, and the EPA Quality Assurance Team. The TQAP meets the requirements of the GHG Center's Quality Management Plan (QMP) and satisfies ETV QMP requirements.

The primary performance parameter for this technology was the fuel economy change (Δ or "delta") due to TEA additive use. The GHG Center performed a series of controlled dynamometer tests on a representative vehicle (2008 Chrysler Town and Country passenger van). Once the fuel economy change was established, a percentage fuel savings was determined relative to the reference fuel. The test plan was designed to evaluate the immediate effect of the additive by comparing a set of baseline and candidate test runs occurring over a very short test period. Each fuel economy test run conformed to the widely accepted Highway Fuel Economy Test (HwFET) and the New York City Cycle Test (NYCC).

All tests were conducted on a chassis dynamometer at the laboratories of TRC. GHG Center personnel ensured that the test facility equipment specification and calibrations conformed to the method criteria during all tests. Emissions and fuel consumption were measured over the duty cycle gravimetrically and also by monitoring the tailpipe exhaust emissions. The vehicle tests also quantified pollutant and greenhouse gas emissions (CO, CO_2, NO_X, and THC) as secondary verification parameters. Testing was conducted during the period of October 26 through 28, 2010 with six replicate test runs conducted at each test condition.

Quality assurance (QA) oversight of the verification testing was provided following specifications in the ETV QMP. The GHG Center's QA manager conducted an internal technical systems audit (an audit of the testing and measurement systems used by TRC) and an audit of data quality on the data generated during this verification and a review of this report. Data review and validation was conducted at three levels including the field team leader, the project manager, and the QA manager.

VERIFICATION OF PERFORMANCE

Results of the verification testing for fuel economy using baseline and additized fuels and the HwFET vehicle duty cycle are summarized in Table S-1. The table summarizes test results obtained using both the carbon balance and gravimetric analyses for each fuel, and summarizes the statistical delta analysis comparing results from the baseline and additized fuels tests. Due to unfavorable results of the first set of additized fuel tests on the HwFET cycle, the verification testing was modified to deviate from the planned sequence. Specifically, the vendor requested that the analysts run the same sequence of HwFET tests on a second lot of additized fuel before moving on with further NYCC duty cycle testing. When results of the second lot of additized fuel confirmed results of the first, further testing of additized fuel (on the NYCC duty cycle) was cancelled. The rationale for this decision was that demonstrating a statistically significant delta would be even more difficult on the NYCC duty cycle where baseline fuel economy was 8.5 mpg less than it was on the HwFET cycle. Therefore the testing was aborted to minimize unnecessary vendor testing costs and no further testing was conducted.

Table S-1. Statistical Analysis of Test Results (Delta)

Statistical Parameter	Additized Fuel - Lot 1		Additized Fuel - Lot 2	
	Carbon Balance	Gravimetric	Carbon Balance	Gravimetric
Average Fuel Economy (mpg)	32.03	31.06	31.88	31.14
Difference from Baseline (mpg)	0.20	0.09	0.05	-0.03
Difference from Baseline (%)	0.62	0.29	0.26	-0.09
F_{test}	4.00	4.61	1.66	1.25
F, 0.05, DF	5.05	5.05	5.05	5.05
Equal Variance?	**Yes**	**Yes**	**Yes**	**Yes**
Pooled Standard Deviation - S_p	0.16	0.15	0.18	0.18
t_{test}	2.12	1.04	0.47	-0.27
DF	10.0	10.0	10.0	10.0
T, 0.05, DF	2.23	2.23	2.23	2.23
Statistical Significance?	**No**	**No**	**No**	**No**
$\pm$ Confidence Interval	0.21	0.20	0.24	0.24
Confidence Interval of Mean Fuel Economy Change (%)	105.0	214.7	475.6	-815.3

Results of the analysis show that there was no statistically significant change in vehicle fuel economy between the baseline and additized fuels on the HwFET duty cycle. As a secondary verification parameter, engine emissions of pollutant and greenhouse gases (CO, CO_2, NO_X, and THC) were also determined during each test. Table S-2 summarizes the average emission rates for each pollutant under each HwFET test series. Emissions of NOx, THC, and NMHC were very low for all test periods. Although

statistical analyses were not performed on the CO and CO_2 emissions, the additive did not appear to have a measureable impact on engine emissions.

Table S-2. Summary of Engine Emissions

Pollutant	Average Measured Emission Rate (grams/mile)		
	Baseline Fuel	Additized Fuel - Lot 1	Additized Fuel - Lot 2
NOx	0.018	0.021	0.023
THC	0.004	0.007	0.008
NMHC	0.001	0.005	0.005
CO	0.207	0.188	0.227
CO_2	276	275	276

Signed by Cynthia Sonich-Mullin (6/10/2013)

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