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ARMY EVALUATION OF JP-8 AND DIESEL FUEL EXPOSED TO ANTI-DETONATION MATERIAL FILLER (ADMF) FOR FUEL TANK EFFECTS

INTERIM REPORT
TFLRF No. 378

by
Bernard R. Wright
Edwin A. Frame

U.S. Army TARDEC Fuels and Lubricants Research Facility
(SwRI®) Southwest Research Institute®
San Antonio, TX

Under Contract to
U.S. Army TARDEC
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Edwin C. Owens, Director
U.S. Army TARDEC Fuels and Lubricants
Research Facility (SwRI®)

REPORT DOCUMENTATION PAGE			Form Approved OMB No. 0704-0188

1. AGENCY USE ONLY	2. REPORT DATE September 2005	3. REPORT TYPE AND DATES COVERED Interim, February 2003 – September 2005

4. TITLE AND SUBTITLE Army Evaluation of JP-8 and Diesel Fuel Exposed to Anti-Detonation Material Filler (ADMF) for Fuel Tank Effects	5. FUNDING NUMBERS DAAE-07-99-C-L-053 WD 19
6. AUTHOR(S) Wright, B.R. and Frame, E.A.	
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) U.S. Army TARDEC Fuels and Lubricants Research Facility (SwRI) Southwest Research Institute P.O. Drawer 28510 San Antonio, Texas 78228-0510	8. PERFORMING ORGANIZATION REPORT NUMBER TFLRF No. 378
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES) U.S. Army TACOM U.S. Army TARDEC Petroleum and Water Business Area Warren, MI 48397-5000	10. SPONSORING/MONITORING AGENCY REPORT NUMBER
11. SUPPLEMENTARY NOTES	
12a. DISTRIBUTION/AVAILABILITY STATEMENT Approved for public release; distribution unlimited	12b. DISTRIBUTION CODE

13. ABSTRACT (Maximum 200 words)

Extensive laboratory research was conducted on metal mesh and organic foam products to determine their effects on fuels when placed in fuel tanks and the resulting effects to operating fuel systems. Tests done with and without mesh materials included fuel particulates, fuel elements, fuel color, fuel gum, Karl Fisher water, total acid number, jet fuel thermal oxidation test, conductivity, lubricity (SLBOCLE, BOCLE, etc.). Two interestingly negative results were in the areas of lubrication and particle contaminants. All metallic mesh material had “chaff” or particles in the matrix of the material. All mesh materials, metal mesh and organic foam products produced a significant change in the measured lubricity of the output fuel. Results of these extensive investigations did not identify any problems, which could not be overcome (with additional resources), for the HMMWV and M915 FOV series military vehicles.

14. SUBJECT TERMS

Antidetonation	Fuel	Tank on HD	Materials	Additive	Metallic
Compatibility	Chaff	Wear	Testing	JP-8	Diesel Fuel
Mesh Filler Liner					

15. NUMBER OF PAGES: 108

16. PRICE CODE

17. SECURITY CLASSIFICATION OF REPORT	18. SECURITY CLASSIFICATION OF THIS PAGE	19. SECURITY CLASSIFICATION OF ABSTRACT	20. LIMITATION OF ABSTRACT
Unclassified	Unclassified	Unclassified	

NSN 7540-01-280-5500

Standard Form 298 (Rev. 2-89)
Prescribed by ANSI Std. Z39-18
298-102

EXECUTIVE SUMMARY

The objective of this project was to determine the effects of anti-detonation material filler (ADMF) on the properties of fuel and the effects of fuels on ADMF. The investigations included a literature review, in-vehicle evaluations, and laboratory environmental testing. Six materials were evaluated and listed below. Four of the materials were aluminum mesh, one stainless steel mesh and organic foam. The material code (see below) was used to identify the product throughout the testing that was conducted.

Materials

Anti-Detonation Material Filler

Material Code	Material Identity
B	Suppress X-S
C	Deto-Stop
D	FireXX
E	ADI XNET
F	Safetypacs
G	Foamex

Test Fuels

The primary fuel used today by the U.S. Army is JP-8 (MIL-T-83133 specification) that is basically a kerosene fuel such as Jet-A-1. Sufficient volume of this base fuel was procured and stored in an enclosed tank. To address the concern that, due to foreign procurement in the combat theatre, a non-JP-8 fuel was procured, a high-sulfur (1.07%) fuel was procured for testing under conditions discussed later. The concern was the possible reaction of the sulfur with the ADMF products.

In-Vehicle Evaluations

The in-vehicle evaluations were conducted in the fuel tanks from a High Mobility Multi Multi-Wheeled (HMMWV) and a M915/6 truck that have been mounted on a rack positioned on a drive vehicle. This approach will still provide the vehicular motion to conduct the evaluations without the necessity of actually using a HUMMWV or M915/6.

Seven aluminum fuel tanks for the M-915/6 vehicle and seven plastic HMMWV fuel tanks were obtained.

Fuel tank evaluations were conducted using neat JP-8 and the ADMF materials. The following parameters were determined:

- Weight of ADMF in fuel tank
- Reduction of fuel tank liquid capacity caused by ADMF
- Fuel tank fill time
- Fuel tank drain time

- Fuel holdup by ADMF
- Filterable solids of drained fuel, both before and after vehicle fuel filter.

The weight of ADMF placed in each fuel tank was determined. ADMF material F added the most weight to the fuel tank, while material G added the least weight.

The experiments were repeated in the M916 tanks to generate JP-8 fuel samples for particle size distribution analyses. Particle size distribution tests were completed on fuel taken directly from the tank with ADMF, and also on fuel filtered through an M916 fuel filter. Both fuel samples were tested for lubricity using the High Frequency Reciprocating Rig (HFRR) test (ASTM D6079) and the Scuffing Load Ball on Cylinder Lubricity Evaluator (SLBOCLE) (ASTM D6078) to determine if the particle content had any impact on expected fuel system wear. The reduced particle count did not decrease the observed wear scar in the HFRR test. Considering the relatively large test repeatability of SLBOCLE testing (± 725g) no consistent effect on SLBOCLE load was observed.

Particle size distribution tests were completed on fuel taken directly from the tank with ADMF, and also on fuel filtered through a HMMWV fuel filter. Both fuel samples tested for lubricity using the HFRR to determine if the particle content had any impact on HFRR wear scar.

The data show that the HMMWV filter did an excellent job of removing particles. No substantial effects in HFRR wear scar were observed after fuel filtration. No effect was observed in the SLBOCLE test.

Laboratory Environmental Evaluations

Storage and analytical analyses were conducted for JP-8 and high sulfur fuel in the presence of ADMF.

JP-8 Samples

The following fuel tests were conducted to determine fuel stability and condition of JP-8.

Test	Method
Particulates	D4628
Elements	D5185
Color	JT100
Gum	D381
Karl Fischer Water	D6304
Total Acid Number	D3242
Jet Fuel Thermal Oxidation Test	D3241
Conductivity	D2624
Lubricity (selected samples)	D5001, D6078 (SLBOCLE)

In addition, photographic documentation of the samples was made.

Insolubles, Total Acid, Metals, Gum, Water Content, Conductivity, and Lubricity test results showed no adverse effects by ADMF on the fuel.

ASTM D1500 Color – Increase in color for ADMF E with and without water. Increase in color for ADMF F without water.

High Sulfur Fuel Samples

The following fuel tests were conducted to determine fuel stability and condition of the high sulfur fuel:

Test	Method
Particulates	D4628
Elements	D5185
Color	D1500
Gum	D381
Karl Fischer Water	D6304
Total Acid Number	D3242
Conductivity	D2624

Overall the ADMF materials had very minimal effects on HSF properties, as shown in Appendix A.

ADMF Chaff Investigations

ADMF chaff investigations were initiated for materials B, C, D, E and F. Six pieces of a given ADMF material were washed in 500 ml of JP-8. The results showed the following chaff weights recovered on a filter:

Material	Initial mg/L	At 12 Weeks (mg/L)
B	3.2	1.2
C	2.6	4.0
D	17.8	11.4
E	2.0	1.4
F	36.4	4.8

Material "G" was not tested, as it is not metallic and not suspected to contain cutting scraps

Investigations were conducted to determine the particle size of chaff material that was washed from metallic ADMF materials. The results indicate the following trends: more particles were removed with the shaking technique than with the ultra-sonic technique; in most cases the number of particles decreased with successive washings for particles <6 microns. Particle counts/mL greater than 1000 were observed for all ADMF metallic samples.

Additive Effects

The effect of ADMF on jet fuel additives was determined.

FSII

The effect of ADMF on diethylene glycol monomethyl ether fuel system icing inhibitor (FSII) was tested and after 3 weeks the investigations showed no effect of other materials.

Corrosion Inhibitor

Corrosion inhibitor presence can be monitored by the standard BOCLE test (ASTM D5001). All ADMF materials were stored and periodically tested for up to 1824 hours and major changes in BOCLE wear scar were observed.

Static Dissipater Additive (SDA)

The effect of ADMF on static dissipater additive was determined by measuring fuel conductivity. The static dissipater tests were conducted for all ADMF materials and all materials had essentially no effect on fuel conductivity.

Microbiological Growth Effects

JP-8

The effects of ADMF on microbiological growth were determined using JP-8 and diesel fuels. Two different sources of active microbiological cultures (inoculates) were prepared. Inoculated JP-8 fuel, neat and with all ADMF materials completed 16 weeks of storage. Overall, the ADMF did not appear to impact microbiological growth in JP-8 fuel.

High-Sulfur Fuel

Inoculated high sulfur fuel (HSF), neat and with ADMF materials completed 16 weeks of storage. Overall the ADMF did not appear to impact microbiological growth in high sulfur fuel.

Low Temperature Effects

A low temperature filterability test was used to determine the effect of ADMF on fuel at low temperatures. The test is based on ASTM D4539, "Filterability of Diesel Fuels by Low-Temperature Flow Test (LTFT)." The tests were conducted using the HSF (AL-26971), neat and with each ADMF material. The ADMF material did not affect flow time.

FOREWORD/ACKNOWLEDGMENTS

The U.S. Army Tank-Automotive RD&E Center (TARDEC) Fuels and Lubricants Research Facility (TFLRF) located at Southwest Research Institute (SwRI), San Antonio, Texas, performed this work during the period May 2002 through September 2005 under Contract No. DAAE-07-99-C-L053. The U.S. Army Tank-Automotive RD&E Center, Petroleum and Water Business Area, Warren, Michigan administered the project. Mr. Luis Villahermosa (AMSTA-RBFF) served as the TARDEC contracting officer's technical representative. Mr. Steve McCormick and Mr. Mike Clauson, U.S. Army TARDEC, Survivability provided technical advice and program direction.

Special acknowledgement is given to the entire staff of U.S. Army Fuels and Lubricants Facility (SwRI) for dedication and support in conducting this extensive program. Special thanks for their technical support and dedication goes to Steven Westbrook, George R. Wilson, III, Rosemary Ward, Marilyn Voigt, Mindy Villalba, J.R. Johnson, Jr., Chad Vollmer, Linda De Salme, and Rebecca Emmot.

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SYMBOLS AND ABBREVIATIONS

ADMF	Antidetonation Material Filler
ARL	U.S. Army Research Laboratory
ASTM	American Society for Testing and Materials
F	Fahrenheit
HEMMT	Heavy Expanded Mobility Tactical Truck
HMMWV	High-Mobility Multipurpose Wheeled Vehicle
HSDF	High Sulfur Diesel Fuel
l	Liter
LTFT	Low-Temperature Flow Test
mg	Milligram
mm	Millimeter
SDA	Static Dissipater Additive
SwRI®	Southwest Research Institute®
TARDEC	U.S. Army Tank-Automotive RD&E Center
TFLRF	U.S. Army TARDEC Fuels and Lubricants Research Facility
µ	Micron
U.S.	United States

1.0 OBJECTIVE

Essentially all of the research programs conducted in recent years on metal mesh were designed for fuel tank vulnerability reduction. In reality, the effect of the mesh on the vehicle fuel and fuel system and the effect of the fuel on the mesh have not been addressed and could become a showstopper if the fuel chemical composition was changed. An example is the fuel-foam solubility problems encountered by the U.S. Air Force during the early days of developing fuel tank foam fillers. With the complexity of today's engine systems and fuel-additive blends to allow the engine to operate properly, any changes such as additive depletion could result in catastrophic results in the vehicle fuel handling/injection system.

2.0 INTRODUCTION AND BACKGROUND

Metallic mesh fuel tank filler material was first developed 20 to 30 years ago consisting of mesh type pillows of aluminum. Early products were developed in Canada and were identified as Explosafe aluminum mesh fuel tank filler to control fuel tank explosions. It was revealed in testing that, even if the material was effective in reducing fuel tank explosions, the major market would be retrofit systems since new vehicular development could be many years apart. Therefore, a physical redesign to allow filling existing fuel tank systems would be required, thus the emergence of the mesh balls and tubular designs.

The primary application of the metal mesh was the reduction of fuel tank explosions and to that end, a number of vulnerability testing programs have been conducted during the last several years. The Department of Defense, office of the Director, Operational Test and Evaluation has supported several series of evaluations using aluminum, stainless, and organic foam materials. These tests were conducted at the 46th Aerospace Survivability and safety Flight Center at Wright-Patterson Air Force Base, Ohio, Naval Air Warfare Center, Survivability Division at China Lake, California and U.S. Army Research Laboratory (ARL) at Aberdeen Proving Ground, Maryland. The current program was Congressionally allocated and was conducted in two separate phases: Vulnerability Reduction at Army Research Laboratory (ARL) at Aberdeen Proving Ground, Maryland and Fuel System Compatibility Studies at TFLRF, Southwest Research Institute, San Antonio, Texas.

The TFLRF research program was divided into two separate phases: laboratory evaluations to determine changes in the fuel when exposed to the mesh fuel tank filler materials, and the effect of the fuel/mesh on vehicle operation.

3.0 PHASE I: LABORATORY EVALUATIONS

Six tank filler materials were evaluated:

Material Code	Material Identity	Description
B	Suppress X-S	This product was an expanded aluminum mesh alloy material.
C	Deto-Stop	The product tested was anti-corroding aluminum alloy spheres.
D	FireXX	This product was expanded aluminum alloy spheres.
E	ADI XNET	This product was evaluated in the ellipsoid configuration formed of stainless steel.
F	Safetypacs	This product was aluminum foil, slit and expanded to form a cylindrical shape.
G	Foamex	This product was a fully reticulated, three-dimensional cellular polymeric foam.

Figures 1–6 are photographs of each ADMF material.

Figure 1. ADI Stainless Steel

Figure 2. Deto-Stop

Figure 3. FireXX

Figure 4. Foamex

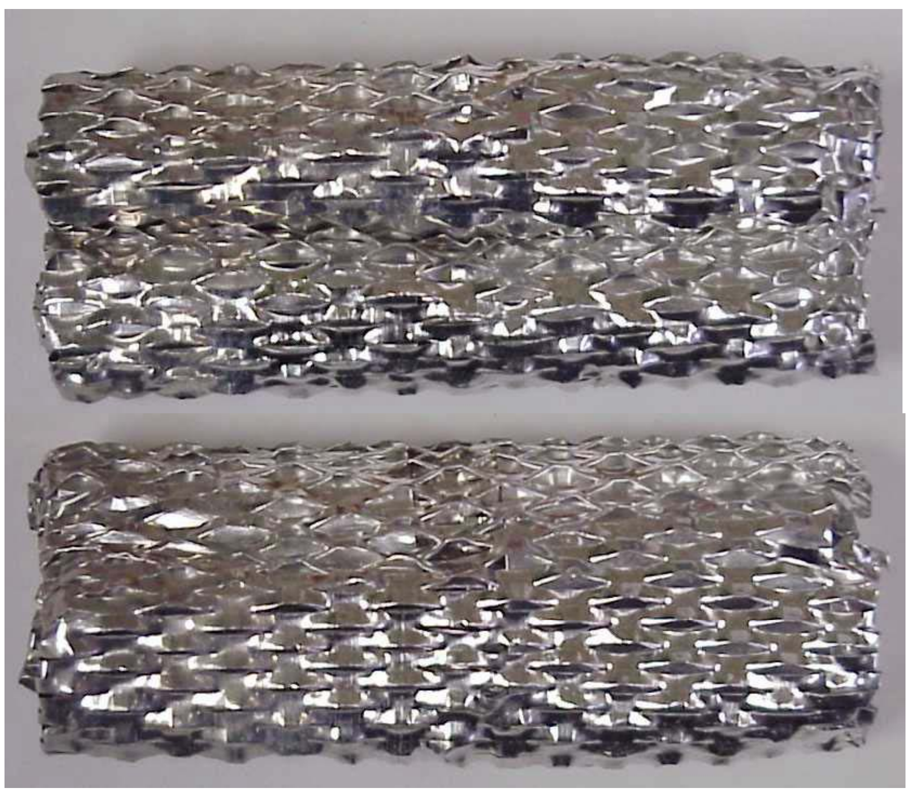

Figure 5. Safetypacs

Figure 6. Suppress S-X

3.1 Fuel Tanks

Two fuel tanks were evaluated for the in-vehicle fuel studies.

1. M915 truck, aluminum with a capacity of approximately 100 gallons.
2. HMMWV, plastic tank with a capacity of approximately 25 gallons.

The HEMMT fuel tank was not tested due to its close dimensions to the M915 fuel tank.

3.2 Fuels Tested

Two fuels were utilized for this series of testing. The primary fuel used today by the U.S. Army and U.S. Air Force is JP-8, which is basically Jet A-1 with three additives to enhance performance. These additives are:

1. Diethyleneglycol monomethyl ether, which is added in 1000-1500 ppm and reacts with water present in the fuel to prevent water crystallization. Most fuels contain a low percentage of water in the form of dispersed droplets that will freeze when the fuel is exposed to low temperature. The frozen water crystals can be filtered and, thus, will plug the fuel filter.

2. Conductivity additives are added to increase the discharge of electrical charge build-up and reduce the possibility of static discharge acting as an ignition source for fuel vapor present in the fuel tank.

For ignition to occur, it is necessary to have an ignition source of sufficient energy and a mixture of fuel and air in the flammable range. The lean and the rich limits define the boundaries of the flammable range. Below the lean limit there is not enough hydrocarbon vapor to sustain combustion, whereas above the rich limit there is not enough oxygen. The mixture temperature and pressure and the fuel characteristics, including boiling range and vapor pressure, determine the amount of a given fuel that is vaporized and therefore establish the flammability of the mixture. However, ignitions have occurred below the lean ignition limit when the fuel was in the form of a foam or spray. Also, systems are not normally in equilibrium when there is sufficient fuel flow to generate electrostatic charges. Turbulence in the vapor space can lead to unexpected flammable air-vapor mixtures in localized areas. Equilibrium flammability limits can therefore be used only as rough guidelines of flammability.

The second requirement for ignition is a static discharge of sufficient energy and duration. Discharges occur when the voltage across a gap exceeds the breakdown strength of the fluid or air in the gap. Minimum energy requirements vary widely depending on the nature of the spark, the configuration of the spark gap and electrodes, nature of materials, and other factors. There is no doubt that sparks due to static electricity in petroleum systems can have sufficient energy to ignite flammable mixtures when they occur in the vapor space. Discharges from highly charged fluids are known to penetrate plastic tubing.

Whenever a hydrocarbon liquid flows with respect to another surface, a charge is generated in the liquid and an equal but opposite charge is imposed on that surface. This charge is attributed to ionic impurities present in parts per million or parts per billion quantities. At rest the impurities are adsorbed at the interface between the fuel and the container walls, with one part of the ionic material having a strong attachment for the fuel or the container. Under these conditions, there is no net charge on the fuel. However, when the fuel flows, one set of charges is swept along with the fuel while the opposite charges that accumulate along the wall surfaces usually leak to ground. This charge separation results in a rise in voltage in the moving fuel.

When charged fuel enters a tank, a substantial voltage difference may be produced between the surface of the liquid and the tank walls and this may result in a static discharge. The voltage difference is limited by charge dissipation/relaxation processes that occur both in the pipework downstream of strong charge generating elements and in the tank itself. Relaxation in the pipework reduces the amount of charge that reaches the tank while relaxation in the tank reduces the voltage produced by a given amount of inlet charge. Under most practical loading conditions, the voltage generated by a given inlet charge density is proportional to the relaxation time of the fuel. This relaxation time is inversely proportional to the conductivity and is approximately 20 seconds when the conductivity is one pS/m. The conductivity of hydrocarbon fuels is highly variable as a result of natural product differences, commingling, or the use of additives. Products not containing additives, including diesel fuels, may have conductivities of less than one pS/m but many modern additive packages (not just static dissipater additives) provide considerably increased conductivity, possibly up to several hundred pS/m or more. The relaxation time produced by increasing the conductivity more than compensates for any increase in charge generation that may occur.

The highest voltages and electrostatic ignition risks are therefore associated with low conductivities. Unless conductivities are controlled, the possibility of encountering low conductivity product should be allowed for when defining safe loading procedures.

To address these concerns of static build-up and discharge, a fuel additive such as Stadis 450 may be added at approximately three mg/l.

3. Corrosion Inhibitors/Lubricity Improvers. Corrosion inhibitors (MIL-PRF-25017F) are added to the fuel to protect metals from corrosion in fuel handling systems. Typical additives are organic acids. Polar materials in the fuel become surface active by adhering to the surface and providing increased wear protection. Laboratory testing has confirmed the requirement for this additive since high-speed rotary fuel injection systems are prone to increased wear if used in Jet-A1 fuel systems. Therefore, this additive is extremely important by reducing metal wear over extended operational environments.

JP-8 fuel is the product of the "One Fuel Forward" concept developed in the 1990's. Prior to that, the U.S. Air Force used JP-4, which is wide cut blend of gasoline and jet fuel. Since the fuel contained approximately 30 to 40 percent gasoline, the flash point was very low and, thus, prone to fuel explosions and fires. Also, at the same time, the U.S. Army used diesel fuel with a flash point minimum of approximately 150°F and, thus, was a less flammable fuel. The problem with diesel fuel is its low freeze point (freezing at low ambient temperatures). Also, diesel fuel is not as stable in storage as jet fuel and, therefore, JP-8 addressed and improved the deficiencies of each type of fuel. It was also considered desirable to have only one fuel on the battlefield as an improvement in logistics.

3.3 Laboratory Environmental Evaluations

The main objective for laboratory analyses was to determine the long-term effects that the ADMF may have on fuel, fuel systems and components. Long-term storage was performed under the guidelines set by ASTM D4625. Additional testing was included for the samples obtained from the long-term storage (such as elements, conductivity, water, acid number, and color). Each fuel was tested according to the appropriate method (which is listed in Tables 1–4). Independent studies were selected based on the probability of affects the ADMF may have on the fuel or components, which included JP-8 lubricity study, additive, thermal stability and microbiological growth (Table 1). The diesel fuel independent study included microbiological growth and low temperature effects. Discussion of each test procedure, results obtained, and discussions of results are presented in Appendix A.

Table 1. Baseline Properties of High Sulfur Diesel Fuel, AL-26971		
Property	**ASTM Method**	**HSDF Results**
Flash Point, °C	D93	79
Water & Sediment	D2709	0.0
Distillation, °C, IBP	D86	187.4
Distillation, °C, 10%	D86	226.4
Distillation, °C, 20%	D86	246.2
Distillation, °C, 30%	D86	260.3
Distillation, °C, 40%	D86	271.6
Distillation, °C, 50%	D86	282.0
Distillation, °C, 60%	D86	292.4
Distillation, °C, 70%	D86	304.1
Distillation, °C, 80%	D86	318.0
Distillation, °C, 90%	D86	337.0
Distillation, °C, 95%	D86	353.0
Distillation, °C, FBP	D86	257.1
Distillation, °C, % Rec	D86	97.5
Distillation, °C, % Loss	D86	1.0
Distillation, °C, % Residue	D86	1.5
Viscosity @ 40°C	D445	3.18
Ash %, Mass	D482	<0.001
Sulfur, % Mass	D2622	1.0689
Copper Strip 3 hrs. @ 50°C	D130	1A
Cetane Number	D613	53.6
Cetane Index	D976	52.1
Cetane Index	D4737	52.8
Cloud Point, °C	D5773	-6.2
Low Temperature Flow Test (LTFT), °C	D4539	-7.0
Rambottom Carbon Residue 10%, wt%	D524	0.13
Color	D1500	<1.0
Aromatics, mass %, PNA	D5186	8.6
Aromatics, mass %, MONO	D5186	18.5
Aromatics, mass %, TOTAL	D5186	27.2
Density	D4052	0.8442
Thermal Stability, % Reflectance, 90 min.	D6468	87.7, 76.8
Thermal Stability, % Reflectance, 180 min.	D6468	64.9, 74.2

Table 2. Baseline Properties of the JP-8, AL-26936			
Property	**ASTM Method**	**Results**	**ASTM D1655**
Acidity, mg/KOH/g	D3242	0.11	0.10 max
Aromatics, vol. %	D1319	16.8	25 max
Saturates, vol. %	D1319	82.2	—
Olefins, vol. %	D1319	1.0	—
Sulfur, Mercapan, wt%	D3227	0.001	0.003 max
Distillation, °F, 10%	D86	160.0	205 max
Distillation, °F, 20%	D86	166.2	—
Distillation, °F, 50%	D86	189.6	Report
Distillation, °F, 90%	D86	235.1	Report
Distillation, °F, FBP	D86	255.9	300 max
Distillation, °F, Residue	D86	1.2	1.5 max
Distillation, °F, Loss	D86	0.4	1.5 max
Flash Point, °C	D93	41.39	35 min
Density, 15°C, kg/l	D4052	0.7930	0.0775-0.0840
Vapor Pressure, PSI	D5191	0.33	—
Freezing Point, °C	D5972	-48.1	-47 max
Viscosity @ -20°C	D445	3.48	8.0 max
Net heat of Combustion, mJ/Kg	D4809	43.57	42.8 min
Elemental Analysis, Carbon wt%	D5291	85.63	—
Elemental Analysis, Hydrogen, wt%	D5291	13.15	—
Sulfur content, ppm	D5453	87.3	300 max
Naphthalene, vol. %	D1840	1.62	3.0 max
Copper Strip 2 hrs. @ 100°C	D130	1A	No: 1 max
JFTOT 2.5 hrs. @ 260°C, mmHg	D3241	1	25 max
JFTOT 2.5 hrs. @ 260°C, code	D3241	<2	>3
Existent gum, mg/100 ml	D381	0	7 max
Water reactions/Interface rating	D1094	0 (1,2 rating)	1b max
Particulate Matter, mg/L	D5452	0.38	—
Electrical Conductivity, pS/m	D2624	10	—
BOCLE, mm	D5001	0.51	—
SLBOCLE, grams	D6078	2150	—
HFRR, µm	D6079	720	—

Table 3. Elemental Analysis JP-8, AL-26936	
ASTM D5185 Elements	**Results (ppm)**
Aluminum (Al)	<1
Antimony (Sb)	<1
Barium (Ba)	<1
Boron (B)	18
Calcium (Ca)	<1
Chromium (Cr)	<1
Iron (Fe)	<1
Lead (Pb)	<1
Magnesium (Mg)	<1
Manganese (Mn)	<1
Molybdenum (Mo)	<1
Nickel (Ni)	<1
Phosphorus (P)	1
Silicon (Si)	<1
Sodium (Na)	<5
Tin (Sn)	<1
Zinc (Zn)	<1
Potassium (K)	<5
Strontium (Sr)	<1
Titanium (Ti)	<1
Cadmium (Cd)	<1

Table 4. Non-Specification Tests		
Properties	**High Sulfur Diesel Fuel**	**Aviation Fuel (JP8)**
Baseline Condition	ASTM D975	ASTM D1655
Long Term Study ASTM D4625		
Particulates	ASTM D4625	ASTM D4625
Existent Gum	ASTM D381	ASTM D381
Acid Number	ASTM D974	ASTM D3242
Conductivity	ASTM D2624	ASTM D2624
Elements	ASTM D5185	ASTM D5182
Color	ASTM D1500	JT100
Waste Content	ASTM D6304	ASTM D6304
Independent Studies		
Lubricity, BOCLE		ASTM D5001
Lubricity, SLBOCLE		ASTM D6079
Corrosion Inhibitor		SWRI/ASTM D5001
Icing Inhibitor		SWRI/ASTM D5006
Static Dissapitor		SWRI/ASTM D2624
Microbiological Growth	SwRI	SwRI
Low Temperature Effect	ASTM D4635	
Thermal Stability		ASTM D3241

3.4 Phase II - In-Vehicle Fuel Testing

Full-scale fuel tank testing was conducted to determine the feasibility of adding tank filler material from the standpoint of fuel handling and engine fuel consumption. The in-vehicle evaluations were conducted in the fuel tanks from a HMMWV and an M915/6 that were mounted on a rack positioned on a drive vehicle. This approach provides the vehiclular motion to conduct the evaluations without the necessity of actually using a HMMWV or M915/6 vehicle.

3.5 Tank Filler Materials

Table 5 lists the tank filler materials according to supplier and the same order of testing is consistent throughout this series of tests.

Table 5. Phase II Tank Filler Materials	
Test Material Code	**Material Supplier**
None	Base Fuel only/ No Mesh
B	Suppress X-S – Aluminum eXess
C	Deto-Stop-Aluminum
D	FireXX – Aluminum
E	ADI XNET-Stainless
F	Safetypacs – Aluminum
G	Foamex (organic foam)

4.0 IN-VEHICLE EVALUATIONS

The following data was recorded in order to evaluate the concerns of in-vehicle utilization:

- Weight of filler material in fuel tank
- Reduction of fuel tank capacity
- Fuel tank fill time
- Fuel tank drain time
- Fuel hold-up in fuel tank
- Filterable solids of drained fuel, before and after vehicle fuel filter
- Particle contamination
- wear testing
- unfilterable solids

4.1 ADMF Test Preparation

In order to establish consistency throughout the extensive testing, the procedure shown below was followed:

1. Bulk Fuel Tank Set-up and Test Preparation

   A. Move or remove the fuel in the SIXCON tanks on the LVS.

   B. Rinse the tank and the tank walls with Jet-A fuel.

   C. Flush lines with test fuel (use approximately 60 gallons).

   D. Draw a sample of the test fuel, approximately one gallon (acquire samples before and after transfer of fuel to the SIXCON).

   E. Transfer approximately 700 gallons of test fuel to the SIXCON tank.

   F. Use a linear valve to set flow rate.

   G. Establish instrumentation to consistently measure and reproduce filling rates of the two types of test tanks.

   H. Establish filtering apparatus for fuel drained from tanks, using appropriate filters.

4.2 ADMF Vehicle Fuel Tank Testing Procedures

1. Install fuel tanks to be tested.

2. Attempt to index fuel tanks exactly the same as the baseline set-up.

3. Connect the high flow loop to the LVS pump station.

4. Set butterfly flow control valve for filling either tank.

5. Be sure that the totalizer on the flowmeter has been re-set before actually filling the fuel tank.

6. The idle tab is set on the LVS pump station for approximately 11-12 gpm. (maximum fill rate for the HMMWV tank). Check flow rate by dispersing into a slop drum long enough to get a stable reading on the flowmeter. When filling the fuel tank, adjust the rate only if back-splash or auto-shutoff occurs. The maximum flow rate is recorded on the run sheet regardless of adjustment.

7. The wide open throttle tab is set on the LVS pump station for approximately 25-26 gpm flow rate (maximum fill rate for the M915/6). Check flow-rate by dispensing into a slop drum long enough to get a stable reading on the flow meter. When filling the fuel tank, adjust the rate only if back-splash or auto-shutoff occurs. The maximum flow rate is recorded on the run sheet regardless of adjustment.

8. Record conductivity measurements of neat fuel and again after introduction of ADMF to fuel tank.

9. Measure and record fuel level, volume, rate and total filling time without ADMF.

10. Measure and record fuel level, volume, rate and total filling time with ADMF for verification of fuel capacity reduction.

11. The fill level on the HMMWV tank is marked on the vent tube and is filled to this level each time. Record gallons of fuel dispensed.

12. The fill level on the M915/6 tank is the bottom of the lowest hole in the filler neck and is filled to this level each time. Record gallons of fuel dispensed.

13. Disconnect from LVS pump station.

14. Measure and record volume, rate, and total drain time without ADMF. Retain drained fuel in a clean container for baseline measurement.

15. Retain ten gallons of fuel (from prior step) to filter through vehicle equivalent filter.

16. Measure and record volume, rate, and total drain time with ADMF for verification of fuel hold up in tank.

17. Retain ten gallons of fuel (from prior step) to run through vehicle equivalent filter.

18. The testing procedure was conducted twice with each fuel tank system and are reported as HMMWV test 1 or 2, Run 1-7. The procedure was similar for the M915/6 and reported as test 1 or 2 run 1-7. Note: the prior listing of material test code is followed throughout.

Table 6 shows the weight of ADMF that was placed in each fuel tank. ADMF material F added the most weight to the fuel tank.

Table 6. ADMF Weight in Each Fuel Tank

					Weights before Fuel			
M915/6	**Tank Serial Number**	**ADMF Code**	**Manufacturer**	**Fuel AL#**	**Empty (lb)**	**Full (lb)**	**ADMF (lb)**	**% Increase**
M916.1	M.916.1	None	None	AL-26936-F	61.6	N/A	N/A	N/A
M916.2	M.916.2	B	Suppress X-S	AL-26936-F	61.6	140.00	78.4	127%
M916.3	M.916.3	C	Deto-Stop	AL-26936-F	61.6	87.00	25.4	41%
M916.4	M.916.4	G	Foamex	AL-26936-F	61.6	72.60	11	18%
M916.5	M.916.5	D	FireXX	AL-26936-F	61.6	89.60	28.0	45%
M916.6	M.916.6	E	ADI XNET	AL-26936-F	61.6	145.00	83.4	135%
M916.7	M.916.7	F	Safetypacs	AL-26936-F	61.6	220.80	159.2	258%
					Weights before Fuel			
HMMWV	**Tank Serial Number**	**ADMF Code**	**Manufacturer**		**Empty (lb)**	**Full (lb)**	**ADMF (lb)**	**% Increase**
H-1	41662-2 (H-1)	None	None	AL-26936-F	23.2	N/A	N/A	N/A
H-2	41672-2 (H-2)	B	Suppress X-S	AL-26936-F	23.2	37.0	13.8	59%
H-3	41675-2 (H-3)	C	Deto-Stop	AL-26936-F	23.2	30.0	6.8	29%
H-4	42138-3 (H-4)	G	Foamex	AL-26936-F	23.2	26.4	3.2	14%
H-5	42142-3 (H-5)	D	FireXX	AL-26936-F	23.2	32.6	9.4	41%
H-6	42143 (H-6)	E	ADI XNET	AL-26936-F	23.2	42.2	19.0	82%
H-7	42146-3 (H-7)	F	Safetypacs	AL-26936-F	23.2	60.6	37.4	161%

The experiments were repeated in the M916 tanks to generate JP-8 fuel samples for particle size distribution analyses. Particle size distribution tests were completed on fuel taken directly from the tank with ADMF, and also on fuel filtered through an M916 fuel filter. Both fuel samples were tested for lubricity using the HFRR (ASTM D6079) and the SLBOCLE (ASTM D6078) to determine if the particle content had any impact on expected fuel system wear (see results in Table 7). The reduced particle count has not decreased the observed wear scar in the HFRR test. Considering the relatively large test repeatability for the SLBOCLE test (± 900 g), no consistent effect on SLBOCLE was observed.

Table 7. Fuel Particle Counts and Wear Scars, M916 Filter				
Sample ID	**Description**	**ASTM D6079, HFRR Wear Scar (µm)**	**ASTM D6078, SLBOCLE (g)**	**Particle count/ml 6 micron**
M-916.1	Before Filter, No Mesh	700	2500	772
M-916.1	After Filter, No Mesh	690	1800	266
M-916.2	Before Filter, Suppress X-S	695	2550	1043
M-916.2	After Filter, Suppress X-S	755	2150	201
M-916.3	Before Filter, Deto-Stop	525	2650	3389
M-916.3	After Filter, Deto-Stop	740	2950	165
M-916.5	Before Filter, FireXX	720	2150	3013
M-916.5	After Filter, FireXX	720	1500	145
M-916.6	Before Filter, ADI XNET	695	2550	5485
M-916.6	After Filter, ADI XNET	705	2900	539
M-916.7	Before Filter, Safetypacs	695	2550	2266
M-916.7	After Filter, Safetypacs	725		239

Particle size distribution tests were completed on fuel taken directly from the tank with ADMF, and also on fuel filtered through a HMMWV fuel filter. Both fuel samples were tested for lubricity using the HFRR to determine if the particle content had any impact on HFRR wear scar. The results are shown in Table 8.

Table 8. Fuel Particle Counts and Wear Scars, HMMWV Filter				
Sample ID	**Description**	**ASTM D6079, HFRR Wear Scar (µm)**	**ASTM D6078, SLBOCLE (g)**	**Particle count/ml 6 micron**
M-916.1	Before Filter, No Mesh	700	2500	772
M-916.1	After Filter, No Mesh	650	2650	45
M-916.2	Before Filter, Suppress X-S	695	2550	1043
M-916.2	After Filter, Suppress X-S	675	2750	31
M-916.3	Before Filter, Deto-Stop	525	2650	3389
M-916.3	After Filter, Deto-Stop	485	2550	32
M-916.5	Before Filter, FireXX	720	2150	3013
M-916.5	After Filter, FireXX	695	2600	34
M-916.6	Before Filter, ADI XNET	695	2550	5485
M-916.6	After Filter, ADI XNET	725	2050	49
M-916.7	Before Filter, Safetypacs	695	2550	2266
M-916.7	After Filter, Safetypacs	570	2600	114

The data show that the HMMWV filter did an excellent job of removing particles. No substantial effects in HFRR wear scar were observed after fuel filtration. No effect was observed in the SLBOCLE test. All testing results are presented in Appendix B.

5.0 LABORATORY ENVIRONMENTAL EVALUATIONS

The details for the laboratory environmental evaluations are presented in Appendix A.

5.1 Storage and Thermal Stability

Plans were developed for storage and thermal stability investigations of JP-8 and high sulfur fuel in the presence of ADMF. Fuel storage and thermal stability were determined after exposure to ADMF.

5.1.1 JP-8 Samples

Samples were stored with and without 5% water present for 4, 8, and 12 weeks at 43°C in an oven. The following fuel tests were conducted to determine fuel stability and condition of JP-8:

Test	Method
Particulates	D4628
Elements	D5185
Color	JT100
Gum	D381
Karl Fischer Water	D6304
Total Acid Number	D3242
JFTOT	D3241
Conductivity	D2624
Lubricity (selected samples)	D5001, D6078 (SLBOCLE)

In addition, photographic documentation of the samples was made.

Insolubles, Total Acid, Metals, Gum, Water Content, Conductivity, and Lubricity had no adverse effects by ADMF on the fuel.

ASTM D1500 Color was included in the testing because the Army uses color to denote fuel grade and type. There was an increase in color for ADMF E with and without water. There was an increase in color for ADMF F without water.

5.1.2 High Sulfur Fuel Samples

Samples were stored with and without 5% water present for 4, 8, and 12 weeks at 43°C in an oven.

The following fuel tests were conducted to determine fuel stability and condition of the high sulfur diesel fuel:

Test	Method
Particulates	D4628
Elements	D5185
Color	D1500
Gum	D381
Karl Fischer Water	D6304
Total Acid Number	D3242
Conductivity	D2624

5.2 ADMF Chaff Investigations

During filtration of the samples stored with material "B", particulate material was discovered on the filter paper. The material was examined and found to be aluminum particles that ranged in size from 3 to 90 microns. The particles appear to be "chaff" from the ADMF. Figure 7 shows a 250X optical magnification of the particles. Because of this, washing experiments were conducted on the as-received ADMF samples to better define chaff occurrence.

ADMF chaff investigations were initiated for materials, B, C, D, E and F. Six pieces of a given ADMF material were washed in 500 ml of JP-8. The results showed the following chaff weights recovered on a filter:

Material	Initial mg/L	At 12 Weeks (mg/L)
B	3.2	1.2
C	2.6	4.0
D	17.8	11.4
E	2.0	1.4
F	36.4	4.8

Material "G" (Foamex) was not tested.

Figure 7. 250X Optical Magnification of the Particle

Investigations were conducted to determine the particle size of chaff material that was washed from metallic ADMF materials. A given ADMF material was placed in a jar with the baseline fluid (MIL-H-5606) that is used for particle counting. Two different methods were used to loosen the particles. One set of samples was physically shaken, while a second set of samples was sonicated in a bath. Triplicate particle counts were made after the agitation using a Met One particle counter. The same ADMF piece was re-agitated in a fresh fluid sample, and particle counts were made. The procedure was repeated a third time in fresh fluid for each ADMF piece.

The results indicate the following trends: more particles were removed with the shaking technique than with the sonic technique; in most cases the number of particles decreased with successive washings; for particles <6 microns, particle counts/ml greater than 1000 were observed for all ADMF samples.

5.3 Additive Effects

The effect of ADMF on jet fuel additives was determined.

5.3.1 FSII

The effect of ADMF on diethylene glycol monomethyl ether fuel system icing inhibitor (FSII) was determined by ASTM D5006, which is an extraction method. At 3 weeks the investigations showed no effect of materials "B" and "C" on FSII, and testing was stopped.

5.3.2 Corrosion Inhibitor

Corrosion inhibitor presence can be monitored by the standard BOCLE test (ASTM D5001). A calibration curve for corrosion inhibitor content based on the BOCLE test was prepared. All ADMF materials were stored and periodically tested for up to 1824 hours. No major changes in BOCLE wear scar were observed, thus the ADMFs were judged to have no effect on corrosion inhibitor content.

5.3.3 Static Dissipater Additive (SDA)

The effect of ADMF on static dissipater additive was determined by measuring fuel conductivity. The test plan for determining SDA retention in the fuel was developed. The static dissipater tests were conducted for all ADMF materials at the same time. The effect of ADMF materials E & F were retested. All materials had essentially no effect on fuel conductivity.

5.4 Microbiological Growth Effects

The effects of ADMF on microbiological growth were determined using JP-8 and diesel fuels. Two different sources of active microbiological cultures (inoculates) were prepared.

5.4.1 JP-8

Inoculated JP-8 fuel, neat and with all ADMF materials completed 16 weeks of storage. Qualitative observations were made of the water/fuel/mesh interface after storage at room temperature. At 6 weeks slight growth first appeared for both inoculates in the JP-8/mesh samples. Photographs were taken to document the microbiological activity. Overall the ADMF did not appear to impact microbiological growth in JP-8 fuel.

5.4.2 High-Sulfur Fuel

Inoculated high sulfur diesel fuel (HSF), neat and with ADMF materials completed 16 weeks of storage. Inoculate A showed an immediate growth only in neat HSF. At 4 weeks, microbiological growth was observed at the water/fuel interface for the neat fuel and the fuel with mesh “C”. At four weeks, the water layer of the mesh “B” samples turned pale yellow, and no growth was observed for inoculate B at 8 weeks. Overall the ADMF did not appear to impact microbiological growth in high sulfur fuel.

5.5 Low Temperature Effects

A low temperature filterability test was used to determine the effect of ADMF on fuel at low temperatures. The test is based on ASTM D4539, “Filterability of Diesel Fuels by Low-Temperature Flow Test (LTFT).” The apparatus was set up and baseline evaluations were completed. The tests were conducted using the HSF (AL-26971), neat and with each ADMF material. For all samples, the flow time increased dramatically between −6.9 and −7°C. The ADMF material did not affect flow time.

6.0 SUMMARY AND RECOMMENDATIONS

Results of extensive laboratory and vehicular testing failed to indicate any particular problems that would preclude the use of the ADMF materials in the fuel systems under inspection. Probably the greatest concern at the onset of testing was the possibility that the material would extract some of the fuel additives that are required for proper functioning of JP-8 fuels. This concern was based on the greatly increased surface area of the ADMF, both metallic and organic foam. Results of extensive testing indicated that additive extraction would not occur.

A second major concern developed when laboratory testing indicated that some aluminum chaff was extracted during laboratory fuel filtration testing. The question that needed an answer was “if the chaff material was not removed by the vehicle fuel filtration system, would damage occur to the fuel injection system?” This question could have been easily addressed if the actual vehicles to be provided by the U.S. Army TACOM would have been available. However, since vehicles were not available due to the war effort, the next best method to evaluate this concern was to conduct the standard laboratory fuel wear tests

These test results, presented earlier, indicated that the HMMWV fuel filter was more successful in removing the chaff; however, results of wear tests did not indicate or predict a fuel system problem. It is believed that actual vehicle testing using the full-up fuel system on the vehicles should be conducted in order to establish a high level of confidence concerning this issue of fuel-system performance if fielding of AMDF in ground tactical vehicles is considered.

Insolubles, Total Acid, Metals, Gum, Water Content, Conductivity, and Lubricity showed no adverse effects by ADMF on the fuel.

ASTM D1500 Color (HSDF) increased for ADMF E with and without water. Additionally, there was an increase in color for ADMF F without water.

Corrosion Inhibitor Jet Fuel Additive results were that there was no change in lubricity with prolonged exposure to ADMF.

Icing Inhibitor JP-8 Additive (DiEGME) Diethylene Glycol Monomethyl Ether results were that there was no significant effect on ADMF with exposure to DiEGME and water.

Stadis 450 JP-8 Static Dissipater Additive results on ADMF types B, C, D, & G showed no significant change in fuel conductivity.

Microbiological Growth results indicated normal rates of microbiological growth (compared with control) and slight tarnishing of ADMF. Microbiological growth entrained in several ADMF (as expected). ADMF-Foamex (22 week) water turned cloudy and fuel became darker in color.

7.0 REFERENCES

1. ASTM D1655-02, "Standard Specification for Aviation Turbine Fuels."

2. ASTM D975-02, "Standard Specification for Diesel Fuel Oils."

3. Chevron Products Company, "Technical Review of Aviation Fuels (FTR-3)." 2000.

4. Wright, B.R., "Ballistic Evaluation of Deto-Stop using 22 mm HEIT Ammunition." SwRI Report No. 1209, June 1998.

APPENDIX A

Laboratory Analyses

ASTM D4625 Standard Test Method for Middle Distillate Fuel Storage Stability at 43°C (100°F)

The long-term storage test is to determine the changes occurring in the fuel when stored for long periods. Changes that can occur with an unstable fuel are due to oxidation, resulting in the formation of sediments and gums. These changes in the fuel can cause serious problems due to blocked filters or deposits forming on injectors or combustion chambers. The ASTM 4625 is useful in predicting these changes.

Objective and Plan: The Storage Stability of fuels at 43°C was used to evaluate the exposure of ADMF specimens to JP8 and High Sulfur Diesel Fuel. The storage stability was used to determine the effects over long periods. The sample was aged by using a borosilicate glass and tested at 0, 4, 8, and 12-week intervals. A battery of testing was performed at each interval such as: Particulates (Insolubles according to ASTM D4625), Steam Jet Gums (ASTM D381), Elements (ASTM D5185), Conductivity (ASTM D2624), Acidity (ASTM D974/D3242), Color (ASTM D1500/JT100) and Water Content (ASTM D6304). Each test specimen was tested with water (15%) and without water. The addition of water to samples was to represent the effects of fuel tank water bottoms present in a fuel system.

Particulates Results (Insolubles) according to ASTM D4625

For this study, a modification of volume was made to expose a maximum amount of ADMF specimens with the fuel. A 1-gallon glass jar was used for the storage testing. Storage sample jars were made up of approximately 3 liters of ADMF with 3 liters of fuel (see figure below). The determinations of the filterable particulates (insolubles) are determined by filtering 100 ml increments of fuel through a filtering system.

Figure A-1. Storage Sample Jar with ADMF and Fuel

The filterable and adherent insolubles are two different results obtained from the storage test. The Filterable insolubles are solids formed during storage, which can be removed from the fuel by filtration, and the adherent insolubles are based on solvent washings adhering to the container. The adherent insolubles washings are collected and analyzed by air jet gums procedure. The adherent gum is reported with the filterable insolubles.

Visible Notes

A noticeable occurrence of the ADMF specimens is debris found in the test jars. ADMF B (in JP8) had a large accumulation of aluminum particles that were seen on the filterable insolubles (see below). ADMF C had small silver particles on the filterable insolubles. ADMF D contained dirt and debris (possibly fiberboard material-samples D33-D40). ADMF G (poly spheres) at week 4, no color was seen on filters. The ADMF seem to absorb the staining material from the fuel. Black particles were present on the filters and maybe dirt or sphere particles material. The filterable insolubles from ADMF D contain large amounts of dirt. The dirt and debris appear to be from the packaging of the specimens. The metal particles or shavings are a problem in manufacturing the specimens. Once these elements are removed from the initial use, no additional contaminants should arise.

Discussion: Filterable and Adherent determined the total insoluble in mg/ 100 mls. The filterable insolubles ranged from 0.00 to 106 mg/100 mls. The variance in the results is due to the debris found in the mesh specimens. The mesh specimens were used as received. The debris included dirt (silicon) and paper material (from boxes), these items would be entwined in the mesh. This was observed in Mesh D (results not included in mentioned ranges of insolubles). Fuel with material F had consistently high insolubles. The overall insolubles for fuel exposed to material G was consistently low. The pressure of water during storage did not consistently increase the total insolubles. The average range for filterable insolubles is 2.17-2.51. The adherent insolubles ranged from 0.00 to 18.97 and total ranged from 0.18 to 19.68 mg/100 mls.

Table A-1. High Sulfur Diesel Fuel, AL-26971
ASTM D4625
Particulates, mg/100 ml

			Week 0			
Mesh	Water	Bottle	Lab ID	Filterable	Adherent	Total
Neat A	N	A	A5	0	0.74	0.74
Neat A	Y	A	A7	0.17	0.54	0.71

			Week 4				Week 8				Week 12			
Mesh	Water	Bottle	Lab ID	Filterable	Adherent	Total	Lab ID	Filterable	Adherent	Total	Lab ID	Filterable	Adherent	Total
Neat A	N	A	A13	0.77	1.48	2.25	A69	0.37	1.46	1.83	A125	0.98	3.56	4.54
		B	A14	0.23	1.27	1.5	A70	0	1.44	1.44	A126	1.05	3.19	4.24
Neat A	Y	A	A15	0	1.39	1.39	A71	0.38	1.64	2.02	A127	0	3.97	3.97
		B	A16	0	1.53	1.53	A72	0	1.83	1.83	A128	0	3.05	3.05
MF B	N	A	B21	0	1.06	1.06	B77	0.53	0.95	1.48	B133	0	1.14	1.14
		B	B22	0.14	0.77	0.91	B78	0.5	0.92	1.42	B134	0	1.07	1.07
MF B	Y	A	B23	0.15	2.29	2.44	B79	0.38	1.71	2.09	B135	0.36	2.5	2.86
		B	B24	0.22	2.24	2.46	B80	0.32	1.79	2.11	B136	0	1.68	1.68
MF C	N	A	C29	0.38	1.97	2.35	C85	1.13	2.05	3.18	C141	1.21	1.55	2.76
		B	C30	0	1.96	1.96	C86	0.59	1.86	2.45	C142	1.27	1.41	2.68
MF C	Y	A	C31	0.27	1.51	1.78	C87	1.14	2.42	3.56	C143	0.38	2.01	2.39
		B	0.55	0.55	1.66	2.21	C88	1.03	2.66	3.69	C144	1.16	2.54	3.7
MF D	N	A	D37	96.5	10.01	106.51	D93	7.28	0.53	7.81	D149	9.44	0.49	9.93
		B	D38	7.73	0.59	8.32	D94	6.1	0.39	6.49	D150	4.65	0.7	5.35
MF D	Y	A	D39	1.95	1.35	3.3	D95	4.61	1.83	6.44	D151	1.06	1.45	2.51
		B	D40	4.26	1.1	5.36	D96	4.93	1.35	6.28	D152	3.18	2.32	5.5
MF E	N	A	E45	1.29	1.71	3	E101	1	1.52	2.52	E157	1.74	1.18	2.92
		B	E46	1.89	1.62	3.51	E102	3.51	1.31	4.82	E158	0.28	2.93	3.21
MF E	Y	A	E47	0.31	1.19	1.5	E103	0.25	1.72	1.97	E159	0.39	0.68	1.07
		B	E48	0.38	1.38	1.76	E104	0.17	0.98	1.15	E160	0.61	0.99	1.6
MF F	N	A	F53	18.97	0.72	19.69	F109	7.56	0.55	8.11	F165	16.44	1.2	17.64
		B	F54	10.82	0.68	11.5	F110	11.4	0.62	12.02	F166	18.53	0.72	19.25
MF F	Y	A	F55	2.9	1.24	4.14	F111	3.83	1.79	5.62	F167	2.02	1.95	3.97
		B	F56	3.74	1.31	5.05	F112	2.83	1.97	4.8	F168	2.8	1.97	4.77
MF G	N	A	G61	0	0.18	0.18	G117	0.8	0.31	1.11	G173	0	0.24	0.24
		B	G62	0.63	0.24	0.87	G118	0.52	0.28	0.8	G174	0	0.28	0.28
MF G	Y	A	G63	0	0.31	0.31	G119	0	0.39	0.39	G175	0.14	0.49	0.63
		B	G64	0	0.39	0.39	G120	0	0.39	0.39	G176	0	0.49	0.49

Table. A-2. Aviation Fuel, JP-8, AL-26936
ASTM D4625
Particulates, mg/100 ml

			Week 0			
Mesh	Water	Bottle	Lab ID	Filterable	Adherent	Total
Neat A	N	A	A1	0.03	0	0.03
Neat A	Y	A	A3	0	0.08	0.08

			Week 4				Week 8				Week 12			
Mesh	Water	Bottle	Lab ID	Filterable	Adherent	Total	Lab ID	Filterable	Adherent	Total	Lab ID	Filterable	Adherent	Total
Neat A	N	A	A9	0.78	1.29	2.07	A65	1.22	1.08	2.3	A121	2.07	2.04	4.11
		B	A10	0.77	1.27	2.04	A66	0.82	1.04	1.86	A122	2.42	1.96	4.38
Neat A	Y	A	A11	0.2	1.56	1.76	A67	0	1.09	1.09	A123	0.11	1.93	2.04
		B	A12	0.14	1.59	1.73	A68	0.07	1.51	1.58	A124	0.18	1.96	2.14
MF B	N	A	B17	0.33	0.18	0.51	B73	1.3	0.15	1.45	B129	0.46	0.73	1.19
		B	B18	0.4	0.14	0.54	B74	0.52	0.15	0.67	B130	0.42	1.09	1.51
MF B	Y	A	B19	0.53	0.69	1.22	B75	0.55	0.87	1.42	B131	1.34	0.46	1.8
		B	B20	0.34	0.37	0.71	B76	0.51	0.26	0.77	B132	0.26	0.45	0.71
MF C	N	A	C25	0.32	0.46	0.78	C81	0.35	0.97	1.32	C137	0.22	0.85	1.07
		B	C26	0.28	0.34	0.62	C82	0.4	0.54	0.94	C138	0.27	0.76	1.03
MF C	Y	A	C27	0.39	0.71	1.1	C83	0.65	0.76	1.41	C139	0.81	0.63	1.44
		B	C28	0.39	1.44	1.83	C84	0.73	0.77	1.5	C140	0.57	0.71	1.28
MF D	N	A	D33	10.96	0.74	11.7	D89	7.48	0.43	7.91	D145	5	0.61	5.61
		B	D34	5.81	0.32	6.13	D90	6.33	0.35	6.68	D146	6.87	0.53	7.4
MF D	Y	A	D35	4.31	1.38	5.69	D91	2.7	1.78	4.48	D147	3.23	2.19	5.42
		B	D36	5.63	1.01	6.64	D92	1.87	1.44	3.31	D148	2.54	2.19	4.73
MF E	N	A	E41	1.19	0.98	2.17	E97	1.2	0.79	1.99	E153	1.38	0.4	1.78
		B	E42	0.72	1.31	2.03	E98	1.52	0.9	2.42	E154	1.13	0.57	1.7
MF E	Y	A	E43	0.07	1.26	1.33	E99	0.25	0.62	0.87	E155	0.11	0.55	0.66
		B	E44	0.14	0.73	0.87	E100	0.14	1.5	1.64	E156	0.17	0.73	0.9
MF F	N	A	F49	13.41	0.83	14.24	F105	11.1	0.55	11.65	F161	15.79	0.86	16.65
		B	F50	19.41	0.97	20.38	F106	10.14	0.45	10.59	F162	18.67	0.77	19.44
MF F	Y	A	F51	7.29	2.6	9.89	F107	3.01	1.01	4.02	F163	4.26	1.63	5.89
		B	F52	2.9	1.52	4.42	F108	4.06	1.4	5.46	F164	4.37	1.51	5.88
MF G	N	A	G57	0.28	0.04	0.32	G113	0.79	0.14	0.93	G169	0.63	0.14	0.77
		B	G58	0.52	0.07	0.59	G114	0.48	0.07	0.55	G170	0.28	0.14	0.42
MF G	Y	A	G59	0.21	0.98	1.19	G115	0.28	0.21	0.49	G171	0.28	0.85	1.13
		B	G60	0.11	0.56	0.67	G116	0.22	0.36	0.58	G172	0.21	0.21	0.42

ASTM D381 Standard Test Method for Gum Content in Fuels by Jet Evaporation

Existent Gums are determined by evaporating 100 ml of fuel by air or steam. The remaining residue is reported as existent gums in mg/100 mls. Existent Gums were performed on the storage stability samples (ASTM D4535).

It has been proven that high gum can cause induction-system deposits and sticking of intake valves. Therefore the low gum will ensure the absence of induction-system problems. There was an increase in gums for mesh F. Mesh G contained a high level of gums throughout the storage test.

Table A-3. Summary on Steam Jet Gums at Week 12, HSF, AL-26971

Mesh	Water Present	ASTM D381, mg/dl
Baseline	No	4.6
Baseline	Yes	1.3
ADMF B	No	3.8
ADMF B	Yes	3.8
ADMF C	No	6.5
ADMF C	Yes	2.0
ADMF D	No	5.6
ADMF D	Yes	4.7
ADMF E	No	3.1
ADMF E	Yes	4.2
ADMF F	No	20.3
ADMF F	Yes	14.2
ADMF G	No	15.8
ADMF G	Yes	11.9

Discussion of Existent Gums

HSF, AL-26971

The results of the existent gums show a tendency for lower gums in the presences of water with the exception of ADMF F. ADMF existent gums increased over time. The maximum allowable gum for aviation fuel is 8 mg/L.

JP-8, AL-26936

At week 12, the gum content by D381 was less than 2.5mg/100ml for the baseline fuel and all samples exposed to ADMF. The presence of water did not impact the gum contents.

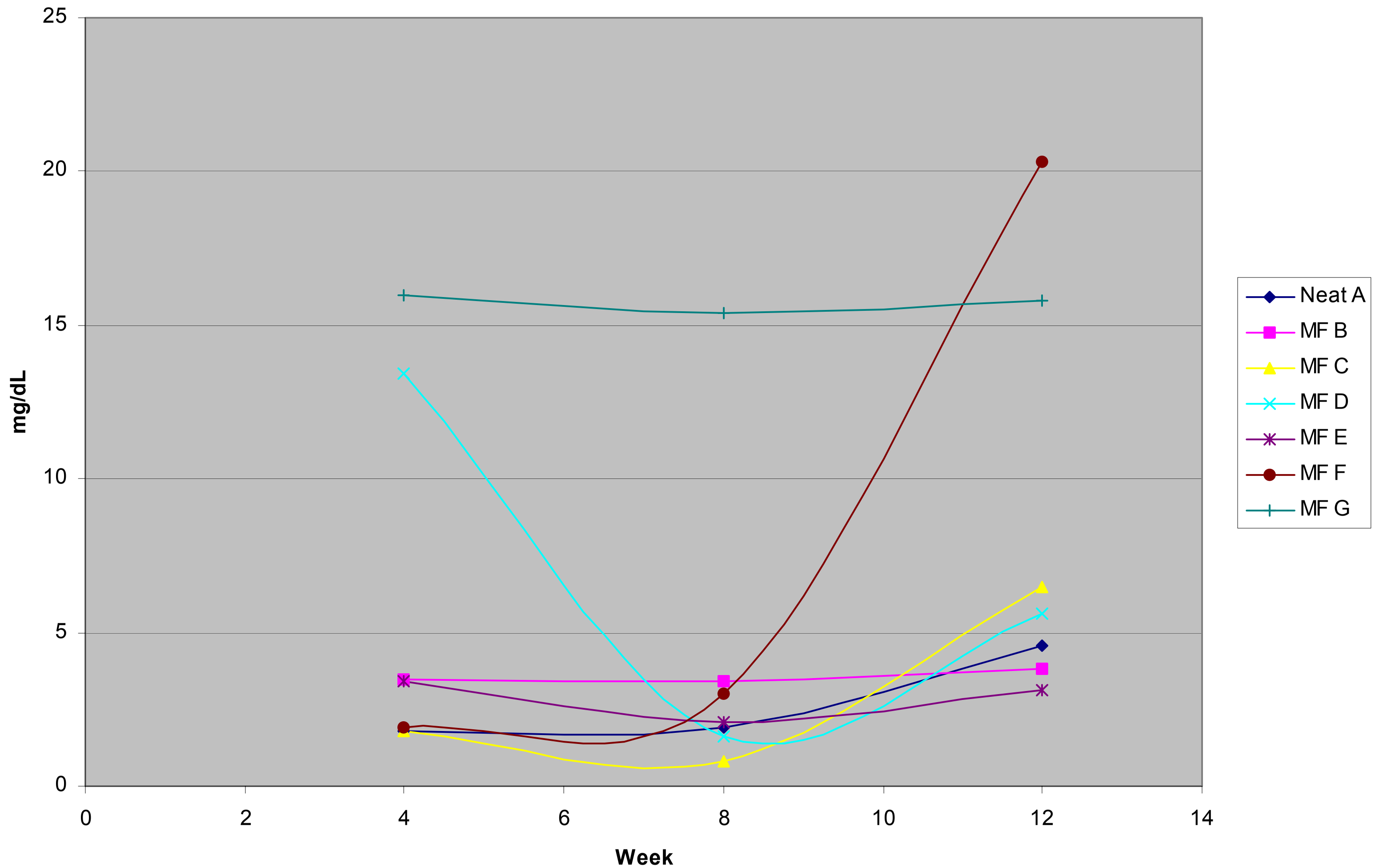

Figure A-2. Steam Jet Gums (ASTM D381), HSF, AL-26971

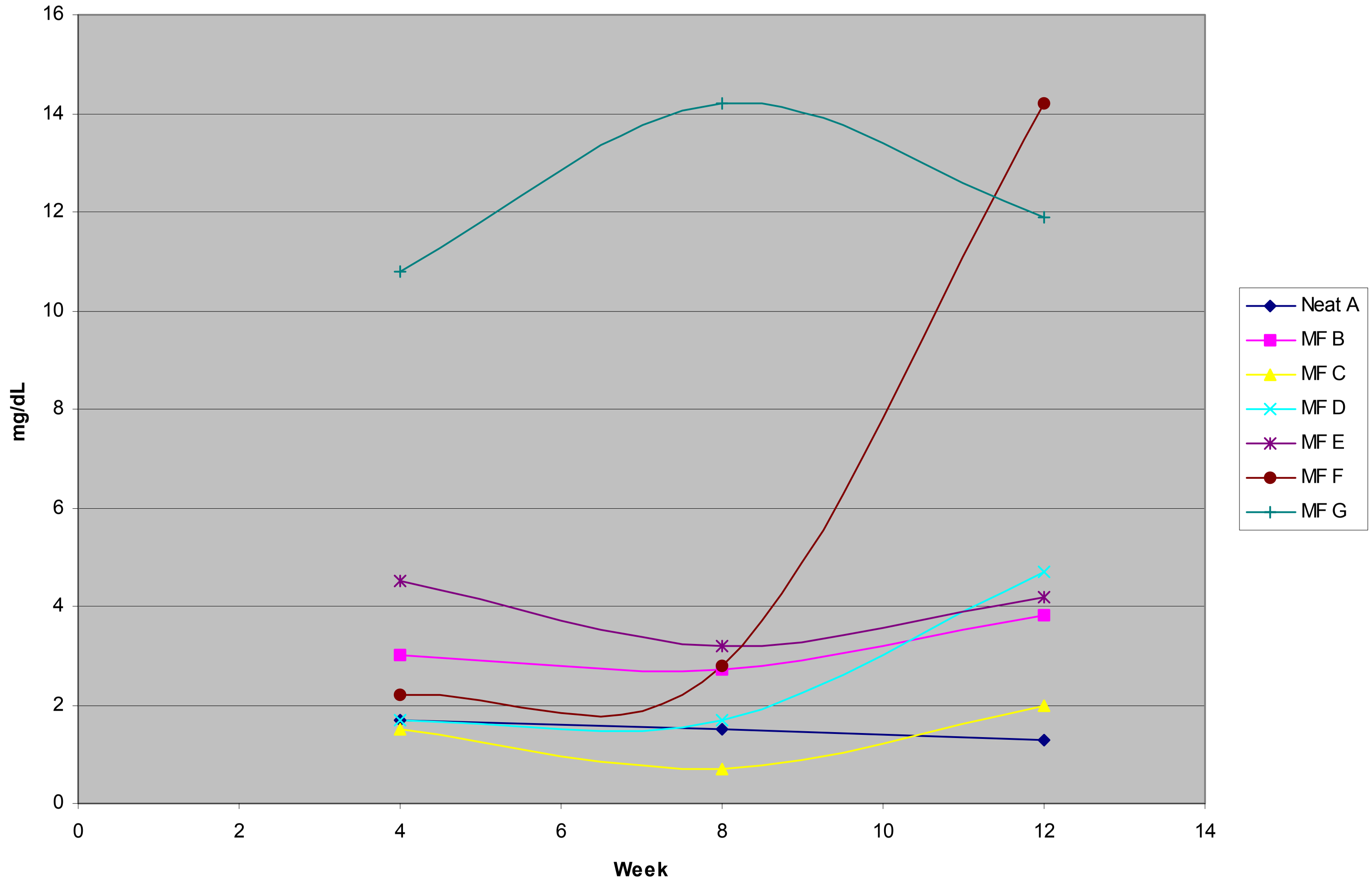

Figure A-3. Steam Jet Gums Mesh with Water (ASTM D381), HSF, AL-26971

Table A-3. High Sulfur Diesel Fuel, AL-26971
ASTM D381
Steam Jet Gums, mg/100 ml

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A5	1.4
Neat A	Y	A	A7	1.6

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A13	1.8	A69	1.4	A125	7.4
		B	A14	1.8	A70	2.4	A126	1.8
Neat A	Y	A	A15	1.8	A71	1.8	A127	1
		B	A16	1.6	A72	1.2	A128	1.6
MF B	N	A	B21	3.6	B77	3.6	B133	3.8
		B	B22	3.4	B78	3.2	B134	3.8
MF B	Y	A	B23	3.4	B79	2.8	B135	3.6
		B	B24	2.6	B80	2.6	B136	4
MF C	N	A	C29	1	C85	0.8	C141	9.6
		B	C30	2.6	C86	0.8	C142	3.4
MF C	Y	A	C31	1.6	C87	0.8	C143	3
		B	C32	1.4	C88	0.6	C144	1
MF D	N	A	D37	16.4	D93	1.2	D149	6.2
		B	D38	10.4	D94	2	D150	5
MF D	Y	A	D39	1.6	D95	1.6	D151	5
		B	D40	1.8	D96	1.8	D152	4.4
MF E	N	A	E45	3.2	E101	2	E157	3.8
		B	E46	3.6	E102	2.2	E158	2.4
MF E	Y	A	E47	3	E103	3.4	E159	5.4
		B	E48	6	E104	3	E160	3
MF F	N	A	F53	2.2	F109	3.4	F165	20
		B	F54	1.6	F110	2.6	F166	20.6
MF F	Y	A	F55	2.6	F111	2.6	F167	15
		B	F56	1.8	F112	3	F168	13.4
MF G	N	A	G61	15.6	G117	16.8	G173	16.6
		B	G62	16.4	G118	14	G174	15
MF G	Y	A	G63	11.4	G119	13.4	G175	11.2
		B	G64	10.2	G120	15	G176	12.6

Table A-4. Aviation Fuel, JP-8, AL-26936
ASTM D381
Steam Jet Gums, mg/100 ml

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A1	1
Neat A	Y	A	A3	0.4

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A9	0	A65	2	A121	0.2
		B	A10	0	A66	1.6	A122	1.2
Neat A	Y	A	A11	0.2	A67	1.4	A123	0.4
		B	A12	0	A68	1.6	A124	1.6
MF B	N	A	B17	3.8	B73	1.8	B129	2
		B	B18	2.8	B74	2.6	B130	1.8
MF B	Y	A	B19	1.6	B75	2.2	B131	2.4
		B	B20	1.6	B76	2.2	B132	2
MF C	N	A	C25	2.2	C81	1	C137	0.2
		B	C26	1.4	C82	0.8	C138	0.4
MF C	Y	A	C27	0.8	C83	1.2	C139	0
		B	C28	1.2	C84	1	C140	0.4
MF D	N	A	D33	1	D89	0.6	D145	0.8
		B	D34	0.8	D90	1.6	D146	0.4
MF D	Y	A	D35	0.6	D91	0.8	D147	0
		B	D36	1.2	D92	1	D148	0
MF E	N	A	E41	3	E97	1.2	E153	0
		B	E42	2.2	E98	0	E154	0
MF E	Y	A	E43	1.4	E99	2.4	E155	0
		B	E44	2.2	E100	0.2	E156	0
MF F	N	A	F49	0.6	F105	0.8	F161	0
		B	F50	0.4	F106	0	F162	1.2
MF F	Y	A	F51	1.2	F107	0	F163	0.6
		B	F52	1.2	F108	0	F164	0.6
MF G	N	A	G57	0.8	G113	3.2	G169	0.2
		B	G58	2	G114	2	G170	1.6
MF G	Y	A	G59	0.6	G115	0.4	G171	0.4
		B	G60	0.8	G116	0.4	G172	0.4

ASTM D974 Standard Test Method for Acid and Base Number by Color-Indicator Titration.

Objective and Plan: This test method determines the acidic or basic constituents in petroleum products. The method is used to indicate the relative changes that occur in a petroleum product during use under oxidizing conditions. This is reported as Total Acid Number (TAN).

The acids can be introduced at the refining process or naturally occurring organic acids. Some acids can have undesirable effects on fuel system component such as corrosion.

High TAN may cause:

- The formation of gums and lacquers on metal surfaces.
- A gradual speed up in the rate of TAN increase.
- System corrosion, particularly if water is present.

According to the Storage Stability procedure by ASTM D4625, TANs are to be analyzed on each container. TANs were performed on the fuel in each container at 0, 4, 8, and 12 weeks for each fuel sample that contained a mesh specimen and also a baseline. The high sulfur diesel fuel was used. The test method requires the sample to be dissolved in a toluene/isopropyl alcohol solution and is titrated with alcoholic potassium hydroxide to an end point. The acid number is express in mg KOH/g.

Discussion, HSF, AL-26971

The diesel fuel baseline acid number is reported at 0.054 mg KOH/g of sample. The results listed in Table A-3 range from 0.05 to 0.07 mg KOH/g of sample. These reported results are within the repeatability of the method. The results are inconclusive. There was a notable discoloration on the mesh specimens but no TAN increase. Overall, the ADMF did not impact TAN formation with HSF, AL-26971.

Discussion, JP-8, AL-26936

The presence of high levels of acid could have unfavorable effects on fuel systems components and on the ADMF mesh. The results did not show increase TAN. There was some discoloration on the mesh specimens but no notable effects regarding TAN and the Jet fuel. Overall, the ADMF did not impact TAN formation with jet fuel, AL-26936.

Table A-5. High Sulfur Diesel Fuel (AL-26971) Results
For ASTM D974
ACIDITY, mg/KOH/g

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A5	0.054
Neat A	Y	A	A7	0.054

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A13	0.07	A69	0.07	A125	0.06
		B	A14	0.06	A70	0.05	A126	0.06
Neat A	Y	A	A15	0.06	A71	0.06	A127	0.07
		B	A16	0.07	A72	0.05	A128	0.05
MF B	N	A	B21	0.06	B77	0.06	B133	0.05
		B	B22	0.06	B78	0.06	B134	0.05
MF B	Y	A	B23	0.06	B79	0.05	B135	0.06
		B	B24	0.06	B80	0.06	B136	0.06
MF C	N	A	C29	0.06	C85	0.06	C141	0.06
		B	C30	0.06	C86	0.06	C142	0.06
MF C	Y	A	C31	0.06	C87	0.06	C143	0.06
		B	C32	0.06	C88	0.06	C144	0.06
MF D	N	A	D37	0.05	D93	0.06	D149	0.05
		B	D38	0.06	D94	0.06	D150	0.07
MF D	Y	A	D39	0.06	D95	0.06	D151	0.06
		B	D40	0.06	D96	0.06	D152	0.06
MF E	N	A	E45	0.05	E101	0.06	E157	0.06
		B	E46	0.05	E102	0.07	E158	0.06
MF E	Y	A	E47	0.06	E103	0.06	E159	0.05
		B	E48	0.06	E104	0.07	E160	0.06
MF F	N	A	F53	0.06	F109	0.06	F165	0.06
		B	F54	0.07	F110	0.05	F166	0.06
MF F	Y	A	F55	0.06	F111	0.05	F167	0.06
		B	F56	0.06	F112	0.06	F168	0.07
MF G	N	A	G61	0.06	G117	0.05	G173	0.04
		B	G62	0.05	G118	0.05	G174	0.05
MF G	Y	A	G63	0.06	G119	0.05	G175	0.05
		B	G64	0.07	G120	0.05	G176	0.05

Table A-6. Aviation Fuel, JP-8 (AL-26936) Results
For ASTM D3241
ACIDITY, mg/KOH/g

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A1	0.009
Neat A	Y	A	A3	0.007

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A9	0.009	A65	0.012	A121	0.011
		B	A10	0.011	A66	0.009	A122	0.009
Neat A	Y	A	A11	0.008	A67	0.010	A123	0.009
		B	A12	0.010	A68	0.009	A124	0.010
MF B	N	A	B17	0.012	B73	0.012	B129	0.013
		B	B18	0.011	B74	0.013	B130	0.017
MF B	Y	A	B19	0.011	B75	0.015	B131	0.006
		B	B20	0.011	B76	0.015	B132	0.012
MF C	N	A	C25	0.011	C81	0.011	C137	0.013
		B	C26	0.009	C82	0.009	C138	0.014
MF C	Y	A	C27	0.008	C83	0.006	C139	0.012
		B	C28	0.008	C84	0.008	C140	0.013
MF D	N	A	D33	0.010	D89	0.01	D145	0.006
		B	D34	0.010	D90	0.011	D146	0.011
MF D	Y	A	D35	0.010	D91	0.009	D147	0.008
		B	D36	0.006	D92	0.008	D148	0.009
MF E	N	A	E41	0.008	E97	0.007	E153	0.01
		B	E42	0.009	E98	0.013	E154	0.009
MF E	Y	A	E43	0.008	E99	0.007	E155	0.008
		B	E44	0.008	E100	0.007	E156	0.01
MF F	N	A	F49	0.012	F105	0.011	F161	0.011
		B	F50	0.013	F106	0.01	F162	0.011
MF F	Y	A	F51	0.009	F107	0.007	F163	0.008
		B	F52	0.009	F108	0.008	F164	0.007
MF G	N	A	G57	0.005	G113	0.004	G169	0.004
		B	G58	0.005	G114	0.004	G170	0.004
MF G	Y	A	G59	0.006	G115	0.004	G171	0.004
		B	G60	0.006	G116	0.009	G172	0.005

ASTM D2624 Standard Test Method for Electrical Conductivity of Aviation and Distillate Fuels

Objective and Method Plan: Electrical Conductivity test ensures that the fuel is sufficiently high in conductivity to discharge static electricity charges and prevent voltage buildup leading to spark discharges. Electrical conductivity measurement is taken on an uncharged fuel. A voltage is applied across two electrodes in the fuel; the resulting current is expressed as a conductivity value (picosiemens per metre or pS/m). A Digital Conductivity Meter by EMCEE Instrument's, Model 1152 (S/N 12818) was used to determine the electrical conductivity.

HSF, AL-26971

Discussion

The samples analyzed for electrical conductivity were taken from the Storage Stability by ASTM D4625 at 4, 8, and 12 weeks. The electrical conductivity of the base High Sulfur fuel was reported at 0 pS/m. Mesh C without water, Mesh E with and without water had a 0 pS/m. All other meshes including the base fuel report values from 10-120 pS/m at 4 weeks. The 8 and 12-week results ranged from 0 to 140 pS/m. There were no conclusive determinations obtained from the electrical conductivity measurements. The Diesel Fuel specification does not have a minimum requirement for conductivity.

Aviation Fuel, AL-26936

Discussion

The samples analyzed for electrical conductivity were taken from the Storage Stability by ASTM D4625 at 4, 8, and 12 weeks. The Conductivity of Aviation base fuel was zero initially and remained zero throughout the 12 week test. Some minor increases (45 max) in conductivity were observed for the jet fuels stored in the presence of ADMF.

Table A-7. High Sulfur Diesel Fuel (AL-56971) Results
For ASTM D2624
CONDUCTIVITY, pS/m

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A5	0
Neat A	Y	A	A7	0

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A13	30	A69	60	A125	0
		B	A14	40	A70	60	A126	0
Neat A	Y	A	A15	70	A71	0	A127	0
		B	A16	105	A72	0	A128	0
MF B	N	A	B21	30	B77	10	B133	10
		B	B22	30	B78	10	B134	10
MF B	Y	A	B23	120	B79	20	B135	20
		B	B24	20	B80	20	B136	20
MF C	N	A	C29	0	C85	0	C141	0
		B	C30	0	C86	0	C142	0
MF C	Y	A	C31	20	C87	0	C143	0
		B	C32	10	C88	0	C144	0
MF D	N	A	D37	20	D93	10	D149	10
		B	D38	10	D94	10	D150	10
MF D	Y	A	D39	10	D95	0	D151	0
		B	D40	10	D96	5	D152	0
MF E	N	A	E45	0	E101	20	E157	70
		B	E46	0	E102	0	E158	140
MF E	Y	A	E47	0	E103	0	E159	0
		B	E48	0	E104	0	E160	0
MF F	N	A	F53	0	F109	30	F165	30
		B	F54	10	F110	30	F166	20
MF F	Y	A	F55	10	F111	10	F167	10
		B	F56	10	F112	10	F168	10
MF G	N	A	G61	10	G117	5	G173	10
		B	G62	10	G118	5	G174	10
MF G	Y	A	G63	10	G119	0	G175	0
		B	G64	10	G120	0	G176	0

Table A-8. Aviation Fuel, JP-8 (AL-26936) Results
For ASTM D2624
CONDUCTIVITY, pS/m

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A1	0
Neat A	Y	A	A3	0

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A9	0	A65	0	A121	0
		B	A10	0	A66	0	A122	0
Neat A	Y	A	A11	0	A67	0	A123	0
		B	A12	0	A68	0	A124	0
MF B	N	A	B17	20	B73	30	B129	45
		B	B18	20	B74	30	B130	35
MF B	Y	A	B19	20	B75	20	B131	20
		B	B20	20	B76	20	B132	20
MF C	N	A	C25	0	C81	10	C137	10
		B	C26	0	C82	10	C138	10
MF C	Y	A	C27	0	C83	0	C139	0
		B	C28	0	C84	0	C140	0
MF D	N	A	D33	30	D89	20	D145	20
		B	D34	30	D90	20	D146	20
MF D	Y	A	D35	0	D91	0	D147	0
		B	D36	10	D92	10	D148	0
MF E	N	A	E41	0	E97	0	E153	0
		B	E42	0	E98	0	E154	0
MF E	Y	A	E43	0	E99	10	E155	0
		B	E44	0	E100	0	E156	0
MF F	N	A	F49	0	F105	0	F161	0
		B	F50	0	F106	0	F162	0
MF F	Y	A	F51	0	F107	0	F163	0
		B	F52	0	F108	0	F164	0
MF G	N	A	G57	30	G113	20	G169	30
		B	G58	30	G114	20	G170	30
MF G	Y	A	G59	20	G115	10	G171	20
		B	G60	20	G116	10	G172	20

ASTM D5185 Standard Test Method for Determination of Additive Elements, Wear Metals, and Contaminations in Used Lubricity Oils, and Determination of Selected Elements in Base Oils by Inductively Coupled Plasma Atomic Emission Spectrometry (ICP-AES).

Objective and Plan: The objective of this method is to determine the amounts of mesh material that may leach into the base fuel and cause an increase in metals. This method determines elements; wear metals, and contaminants by inductively coupled plasma atomic emission spectrometry (ICP-AES). Testing was performed on a weighed portion of sample and is mixed a solvent. The sample is introduced into the instrument by free aspiration and the result is compared with calibrated elements intensities. A Perkin-Elmer Instrument 3300 radial instrument was used to determine the metals. The elements analyzed by ICP are listed in the table below with detection limits:

Table A-9. Elements Analyzed by ASTM D5185

Element	Detection Limit, ppm	Element	Detection Limit, ppm
Aluminum (Al)	1	Phosphorous (P)	1
Antimony (Sb)	1	Silicon (Si)	1
Barium (Ba)	1	Molybdenum (Mo)	1
Boron (B)	1	Silver (Ag)	1
Calcium (Ca)	1	Sodium (Na)	5
Chromium (Cr)	1	Tin (Sn)	1
Copper (Cu)	1	Zinc (Zn)	1
Iron (Fe)	1	Potassium (K)	5
Lead (Pb)	1	Strontium (Sr)	1
Magnesium (Mg)	1	Vanadium (V)	1
Manganese (Mn)	1	Titanium (Ti)	1
Nickel (Ni)	1	Cadmium (Cd)	1

The results reported do not include all these elements. The metals not reported in the results table are: Antimony, Barium, Copper, Lead, Manganese, Nickel, Molybdenum, Silver, Potassium, Strontium, Titanium, and Cadmium. These elements determinations were unchanged over the 12-week testing period.

Discussion

There was no change in the fuel composition (an increase in metals concentration) due to the presents of the ADMF for either fuel, HSF or JP-8.

Table A-10. High Sulfur Diesel Fuel (AL-26971) Results
By ASTM D5185
ELEMENTS BY ICP, ppm

Week 0

Mesh	Water	Bottle		Lab ID	Al	B	Ca	Cr	Fe	Mg	P	Si	Na	Sn	Zn
Neat A	N	A		A5	<1	<1	<1	<1	<1	<1	53	<1	<5	2	<1
Neat A	Y	A		A7	<1	<1	<1	<1	<1	<1	65	<1	<5	<1	3

Week 4

Mesh	Water	Bottle		Lab ID	Al	B	Ca	Cr	Fe	Mg	P	Si	Na	Sn	Zn
Neat A	N	A		A13	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		A14	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
Neat A	Y	A		A15	<1	1	<1	<1	<1	<1	1	<1	<5	1	<1
		B		A16	<1	1	<1	<1	<1	<1	1	<1	<5	<1	<1
MF B	N	A		B21	x	x	x	x	x	x	x	x	x	x	x
		B		B22	x	x	x	x	x	x	x	x	x	x	x
MF B	Y	A		B23	x	x	x	x	x	x	x	x	x	x	x
		B		B24	x	x	x	x	x	x	x	x	x	x	x
MF C	N	A		C29	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		C30	<1	<1	1	<1	<1	6	<1	<1	<5	<1	<1
MF C	Y	A		C31	<1	1	<1	<1	<1	1	<1	<1	<5	<1	<1
		B		C32	<!	1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF D	N	A		D37	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		D38	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF D	Y	A		D39	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		D40	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF E	N	A		E45	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		E46	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF E	Y	A		E47	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		E48	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF F	N	A		F53	<1	2	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F54	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF F	Y	A		F55	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F56	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF G	N	A		G61	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		G62	<1	3	<1	<1	<1	<1	<1	<1	<5	1	<1
MF G	Y	A		G63	<1	2	<1	<1	<1	<1	<1	<1	<5	2	<1
		B		G64	<1	<1	<1	<1	<1	<1	<1	<1	<5	2	<1

Table A-11. High Sulfur Diesel Fuel (AL-26971) Results
By ASTM D5185
ELEMENTS BY ICP, ppm

Week 8

Mesh	Water	Bottle		Lab ID	Al	B	Ca	Cr	Fe	Mg	P	Si	Na	Sn	Zn
Neat A	N	A		A69	<1	2	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		A70	<1	2	<1	<1	<1	<1	1	<1	<5	2	<1
Neat A	Y	A		A71	<1	2	<1	<1	<1	<1	<1	<1	<5	1	<1
		B		A72	<1	2	<1	<1	<1	<1	<1	<1	<5	1	<5
MF B	N	A		B77	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		B78	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF B	Y	A		B79	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		B80	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	1
MF C	N	A		C85	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		C86	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF C	Y	A		C87	<1	4	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		C88	<1	2	<1	<1	<1	<1	1	<1	<5	<1	<1
MF D	N	A		D93	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		D94	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF D	Y	A		D95	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		D96	<1	4	<1	<1	<1	<1	3	<1	<5	<1	<1
MF E	N	A		E101	<1	3	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		E102	<1	3	<1	<1	<1	<1	2	<1	<5	<1	<1
MF E	Y	A		E103	<1	2	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		E104	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF F	N	A		F109	<1	1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F110	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF F	Y	A		F111	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F112	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF G	N	A		G117	<1	3	<1	<1	<1	<1	<1	2	6	<1	<1
		B		G118	<1	2	<1	<1	<1	<1	<1	2	6	<1	<1
MF G	Y	A		G119	<1	3	<1	<1	<1	<1	<1	1	6	<1	<1
		B		G120	<1	3	<1	<1	<1	<1	<1	2	6	<1	<1

Table A-12. High Sulfur Diesel Fuel (AL-26971) Results
by ASTM D5185
ELEMENTS BY ICP, ppm

Week 12

Mesh	Water	Bottle		Lab ID	Al	B	Ca	Cr	Fe	Mg	P	Si	Na	Sn	Zn
Neat A	N	A		A125	<1	3	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		A126	<1	2	<1	<1	<1	<1	<!	<1	<5	<1	<1
Neat A	Y	A		A127	<1	2	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		A128	<1	2	<1	<1	<1	<1	1	<1	<5	<1	<1
MF B	N	A		B133	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		B134	<1	4	<1	<1	<1	<1	1	<1	<5	<1	<1
MF B	Y	A		B135	<1	3	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		B136	<1	2	<1	<1	<1	<1	1	<1	<5	<1	<1
MF C	N	A		C141	<1	16	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		C142	<1	13	<1	<1	<1	<1	1	<1	<5	<1	<1
MF C	Y	A		C143	<1	11	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		C144	<1	10	<1	<1	<1	<1	1	<1	<5	<1	<1
MF D	N	A		D149	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		D150	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
MF D	Y	A		D151	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		D152	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
MF E	N	A		E157	<1	2	<1	<1	<1	<1	1	<1	<5	2	<1
		B		E158	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
MF E	Y	A		E159	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
		B		E160	<1	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
MF F	N	A		F165	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F166	<1	6	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF F	Y	A		F167	<1	5	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F168	<1	4	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF G	N	A		G173	<1	3	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		G174	<1	2	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF G	Y	A		G175	<1	2	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		G176	<1	2	<1	<1	<1	<1	<1	<1	<5	<1	<1

Table A-13. Aviation Fuel, JP-8 (AL-26936) Results by ASTM D5185 Elements, ppm

Week 0															
Mesh	**Water**	**Bottle**		**Lab ID**		**B**	**Ca**	**Cr**	**Fe**	**Mg**	**P**	**Si**	**Na**	**Sn**	**Zn**
Neat A	N	A		A1	<1	18	<1	<1	<1	<1	1	<1	<5	<1	<1
Week 4															
Mesh	**Water**	**Bottle**		**Lab ID**	**Al**	**B**	**Ca**	**Cr**	**Fe**	**Mg**	**P**	**Si**	**Na**	**Sn**	**Zn**
Neat A	N	A		A9	<1	3	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		A10	<1	8	<1	<1	<1	<1	<1	<1	<5	<1	<1
Neat A	Y	A		A11	<1	5	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		A12	<1	<1	<!	<!	<!	<1	<!	<!	<5	1	1
MF B	N	A		B17	<1	2	32	<1	<1	<1	<1	<1	<5	<1	<1
		B		B18	<!	3	4	<1	<1	<1	<1	<1	<5	<1	<1
MF B	Y	A		B19	<1	2	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		B20	<1	2	<1	<1	<1	<1	<!	<1	<5	<1	<1
MF C	N	A		C25	<1	<1	2	<1	<1	<1	<1	<1	<5	<1	<1
		B		C26	<1	<1	3	<1	<1	<1	<1	<1	<5	<1	<1
MF C	Y	A		C27	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		C28	<1	<!	<1	<1	<1	<1	<!	<1	<5	<1	<1
MF D	N	A		D33	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		D34	<!	<1	<1	<1	<1	<1	1	<1	<5	<1	<1
MF D	Y	A		D35	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		D36	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF E	N	A		E41	<1	x	x	x	x	x	x	x	x	x	x
		B		E42	<1	<1	1	<1	<1	<1	2	<1	<5	2	<1
MF E	Y	A		E43	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		E44	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF F	N	A		F49	<1	7	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		F50	<1	6	<1	<1	<1	<1	2	<1	<5	<1	<1
MF F	Y	A		F51	<1	3	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		F52	<1	2	<1	<1	<1	<1	2	<1	<5	<1	<1
MF G	N	A		G57/G59	x	x	x	x	x	x	x	x	x	x	x
		B		G58/G60	x	x	x	x	x	x	x	x	x	x	x

Table A-14. Aviation Fuel, JP-8 (AL-26936) Results by ASTM D5185 Elements, ppm

Week 8															
Mesh	Water	Bottle		Lab ID	Al	B	Ca	Cr	Fe	Mg	P	Si	Na	Sn	Zn
Neat A	N	A		A65	<1	<1	3	<1	<1	<1	<1	<1	<5	<1	<1
		B		A66	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
Neat A	Y	A		A67	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		A68	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF B	N	A		B73	<1	<1	3	<1	<1	<1	<1	<1	<5	<1	<1
		B		B74	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF B	Y	A		B75	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		B76	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF C	N	A		C81	<1	2	<1	<1	<1	<1	3	<1	<5	<1	<1
		B		C82	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF C	Y	A		C83	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		C84	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF D	N	A		D89	<1	<1	<1	<1	<1	<1	3	<1	<5	<1	<1
		B		D90	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF D	Y	A		D91	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		D92	<1	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF E	N	A		E97	<1	2	<1	<1	<1	<1	2	<1	6	<1	<1
		B		E98	<1	2	<1	<1	<1	<1	3	<1	6	<1	<1
MF E	Y	A		E99	<1	<1	<1	<1	<1	<1	3	<1	6	<1	<1
		B		E100	<1	<1	<1	<1	<1	<1	2	<1	6	<1	<1
MF F	N	A		F105	<1	7	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F106	<1	5	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF F	Y	A		F107	<1	3	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F108	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF G	N	A		G113	<1	<1	2	<1	<1	<1	<1	<1	<5	<1	<1
		B		G114	<1	<1	2	5	<1	3	<1	<1	<5	<1	<1
MF G	Y	A		G115	<1	<1	<1	1	<1	1	<1	<1	<5	<1	<1
		B		G116	<1	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1

Table A-15. Aviation Fuel, JP-8 (AL-26936) Results by ASTM D5185 Elements, ppm

Week 12														
Mesh	Water	Bottle		Lab ID	Al	B	Ca	Fe	Mg	P	Si	Na	Sn	Zn
Neat A	N	A		A121	<1	<1	<1	<1	<1	76	<1	<5	1	2
		B		A122	<1	<1	<1	<1	<1	79	1	<5	<1	3
Neat A	Y	A		A123	<1	<1	<1	<1	<1	3	<1	<5	<1	<1
		B		A124	<1	<1	<1	<1	<1	73	2	<5	1	<1
MF B	N	A		B129	<1	5	<1	<1	<1	3	<1	<5	<1	<1
		B		B130	<1	9	<1	<1	<1	3	<1	<5	<1	<1
MF B	Y	A		B131	<1	5	<1	<1	<1	2	<1	<5	<1	<1
		B		B132	<1	3	<1	<1	<1	3	<1	<5	<1	<1
MF C	N	A		C137	<1	5	<1	<1	<1	<1	<1	<5	1	<1
		B		C138	<1	3	<1	<1	<1	<1	<1	<5	2	<1
MF C	Y	A		C139	<1	1	<1	<1	<1	<!	<1	<5	<1	<1
		B		C140	X	x	x	x	x	x	x	x	x	x
MF D	N	A		D145	<1	2	1	<1	<1	2	<1	<5	<1	<1
		B		D146	<1	4	<1	<1	<1	2	<1	5	<1	<1
MF D	Y	A		D147	<1	<1	<1	<1	<1	3	<1	<5	<1	<1
		B		D148	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF E	N	A		E153	<1	14	<1	<1	<1	<1	<1	<5	<1	<1
		B		E154	<1	8	<1	<1	<1	<1	<1	<5	<1	<1
MF E	Y	A		E155	<1	5	<1	<1	<1	<1	<1	<5	<1	<1
		B		E156	<1	2	<1	<1	<1	<1	<1	<5	<1	<1
MF F	N	A		F161	<1	2	<1	<1	<1	<1	<1	<5	<1	<1
		B		F162	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
MF F	Y	A		F163	<1	<1	<1	<1	<1	<1	<1	<5	<1	<1
		B		F164	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF G	N	A		G169	<1	1	<1	<1	<1	2	<1	<5	<1	<1
		B		G170	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
MF G	Y	A		G171	<1	<1	<1	<1	<1	2	<1	<5	<1	<1
		B		G172	X	x	x	x	x	x	x	x	x	x

ASTM D1500 Standard Test Method for ASTM Color of Petroleum Products (ASTM Color Scale)

This test method determines the visual color of a wide variety of petroleum products. A comparison of the specimen is made with colored glass disks ranging from 0.5 to 8.0. When a color falls between to colors, the higher number is reported. Although color variation of products is a wide range, this can get an indication of degradation occurring.

Discussion

The samples obtaining for this study were obtained from the Storage Stability study. Testing was performed on all samples a 0, 4, 8, and 12-week periods. The high sulfur fuel samples were L1.0 at the start and most darkened to L1.5 by 12 weeks. The ADMF did not impact fuel color for either fuel, HSF or JP-8.

Table A-16. High Sulfur Diesel Fuel (AL-26971) Results by ASTM D1500 SAYBOLT COLOR

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A5	L 1.0
Neat A	Y	A	A7	L 1.0

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A13	L 1.0	A69	L 1.5	A125	L 1.5
		B	A14	L 1.0	A70	L 1.5	A126	L 1.5
Neat A	Y	A	A15	L 1.0	A71	L 1.5	A127	L 1.5
		B	A16	L 1.0	A72	L 1.5	A128	L 1.5
MF B	N	A	B21	L 1.0	B77	1	B133	L 1.5
		B	B22	L 1.0	B78	1	B134	L 1.5
MF B	Y	A	B23	L 1.0	B79	1	B135	L 1.5
		B	B24	L 1.0	B80	1	B136	L 1.5
MF C	N	A	C29	L 1.0	C85	1	C141	L 1.5
		B	C30	L 1.0	C86	1	C142	L 1.5
MF C	Y	A	C31	L 1.0	C87	1	C143	L 1.5
		B	C32	L 1.0	C88	1	C144	L 1.5
MF D	N	A	D37	L 1.5	D93	L 1.5	D149	L 1.5
		B	D38	L 1.5	D94	L 1.5	D150	L 1.5
MF D	Y	A	D39	1	D95	1	D151	1
		B	D40	1	D96	1	D152	1
MF E	N	A	E45	1	E101	L 1.5	E157	L 1.5
		B	E46	1	E102	L 1.5	E158	1.5
MF E	Y	A	E47	1	E103	L 1.5	E159	1.5
		B	E48	1	E104	L 1.5	E160	1.5
MF F	N	A	F53	L 1.5	F109	L 1.5	F165	L 1.5
		B	F54	L 1.5	F110	L 1.5	F166	L 1.5
MF F	Y	A	F55	L 1.5	F111	L 1.5	F167	L 1.5
		B	F56	L 1.5	F112	L 1.5	F168	L 1.5
MF G	N	A	G61	L 1.0	G117	L 1.0	G173	1
		B	G62	L 1.0	G118	L 1.0	G174	L 1.0
MF G	Y	A	G63	L 1.0	G119	L 1.0	G175	1
		B	G64	L 1.0	G120	L 1.0	G176	1

Table A-17. Aviation Fuel JP-8 (AL-26936) Results For COLOR By JT100

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A1	26
Neat B	Y	A	A3	26

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A9	25	A65	23	A121	22
		B	A10	25	A66	23	A122	22
Neat A	Y	A	A11	25	A67	24	A123	24
		B	A12	24	A68	24	A124	25
MF B	N	A	B17	24	B73	24	B129	24
		B	B18	24	B74	24	B130	24
MF B	Y	A	B19	25	B75	25	B131	25
		B	B20	25	B76	24	B132	25
MF C	N	A	C25	24	C81	23	C137	23
		B	C26	24	C82	24	C138	22
MF C	Y	A	C27	24	C83	24	C139	24
		B	C28	24	C84	24	C140	25
MF D	N	A	D33	24	D89	22	D145	20
		B	D34	25	D90	23	D146	22
MF D	Y	A	D35	25	D91	26	D147	24
		B	D36	26	D92	25	D148	24
MF E	N	A	E41	2	E97	21	E153	7
		B	E42	6	E98	21	E154	9
MF E	Y	A	E43	21	E99	22	E155	-4
		B	E44	21	E100	24	E156	-2
MF F	N	A	F49	22	F105	15	F161	-6
		B	F50	20	F106	22	F162	16
MF F	Y	A	F51	22	F107	23	F163	22
		B	F52	25	F108	22	F164	22
MF G	N	A	G57	25	G113	26	G169	25
		B	G58	25	G114	25	G170	25
MF G	Y	A	G59	26	G115	26	G171	25
		B	G60	26	G116	26	G172	26

ASTM D6304 Standard Test Method for Determination of Water in Petroleum Products, Lubricating Oils, and Additives by Coulometric Karl Fischer Titration.

This test method determines the water entrained in petroleum products by a Karl Fischer titration reaction. A specimen is injected into a titration vessel in which a stoichiometric reaction occurs on 1 molecule of iodine reacts with 1 molecule of water, thus the quantity of water is proportional. The significance of this determination is that moisture can lead to premature corrosion and wear. The premature plugging of filters and undesirable bacterial growth are some of the effects water has on fuel-systems.

Discussion

The fuels were analyzed for water content at 4, 8, and 12 weeks of storage, in the presence of ADMF materials. The introduction of water in the storage samples did not have a dramatic effect. The water content with ADMF Specimen E did decrease with time from 117 to 36 ppm. All of the other ADMF specimens maintained water content between the ranges of 36 to 179-ppm.

Table A-18. High Sulfur Diesel Fuel (AL-26971) Results
By ASTM D6304
WATER CONTENT, ppm

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A5	137
Neat A	Y	A	A7	135

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A13	118	A69	121	A125	129
		B	A14	124	A70	107	A126	168
Neat A	Y	A	A15	121	A71	110	A127	131
		B	A16	120	A72	132	A128	173
MF B	N	A	B21	135	B77	129	B133	133
		B	B22	134	B78	150	B134	139
MF B	Y	A	B23	135	B79	144	B135	105
		B	B24	141	B80	156	B136	117
MF C	N	A	C29	152	C85	82	C141	145
		B	C30	157	C86	108	C142	142
MF C	Y	A	C31	125	C87	132	C143	119
		B	C32	161	C88	116	C144	133
MF D	N	A	D37	134	D93	139	D149	172
		B	D38	123	D94	133	D150	163
MF D	Y	A	D39	109	D95	131	D151	182
		B	D40	102	D96	117	D152	175
MF E	N	A	E45	122	E101	121	E157	34
		B	E46	112	E102	105	E158	38
MF E	Y	A	E47	78	E103	82	E159	38
		B	E48	91	E104	81	E160	35
MF F	N	A	F53	121	F109	85	F165	115
		B	F54	130	F110	83	F166	91
MF F	Y	A	F55	113	F111	72	F167	99
		B	F56	115	F112	57	F168	96
MF G	N	A	G61	128	G117	142	G173	147
		B	G62	126	G118	128	G174	133
MF G	Y	A	G63	130	G119	128	G175	124
		B	G64	118	G120	142	G176	104

Table A-19. Aviation Fuel, JP-8 (AL-26936) Results
By ASTM D6304
WATER CONTENT, ppm

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A1	170
Neat A	Y	A	A3	126

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A9	128	A65	33	A121	112
		B	A10	107	A66	30	A122	96
Neat A	Y	A	A11	133	A67	43	A123	114
		B	A12	101	A68	49	A124	133
MF B	N	A	B17	44	B73	100	B129	78
		B	B18	32	B74	94	B130	87
MF B	Y	A	B19	31	B75	91	B131	90
		B	B20	33	B76	91	B132	102
MF C	N	A	C25	30	C81	106	C137	119
		B	C26	42	C82	125	C138	104
MF C	Y	A	C27	45	C83	112	C139	107
		B	C28	36	C84	109	C140	79
MF D	N	A	D33	78	D89	102	D145	136
		B	D34	132	D90	100	D146	111
MF D	Y	A	D35	142	D91	86	D147	132
		B	D36	153	D92	106	D148	143
MF E	N	A	E41	87	E97	68	E153	14
		B	E42	85	E98	77	E154	13
MF E	Y	A	E43	80	E99	87	E155	14
		B	E44	53	E100	68	E156	13
MF F	N	A	F49	79	F105	38	F161	71
		B	F50	103	F106	35	F162	98
MF F	Y	A	F51	76	F107	45	F163	58
		B	F52	139	F108	36	F164	54
MF G	N	A	G57	79	G113	78	G169	59
		B	G58	78	G114	67	G170	62
MF G	Y	A	G59	85	G115	65	G171	74
		B	G60	89	G116	97	G172	62

Test Plan to Evaluate Microbiological Growth in the Presence of ADMF

Preparation of Inoculants

Inoculant A

In glass bottle pour 750 mL of diesel fuel and 250 mL of Deionized Water. Add 2 teaspoons of yard dirt. Put the bottle in a warm, dark place to incubate.

Inoculant B

In glass bottle pour 750 mL of diesel fuel and 250 mL of Dionized Water. Add 20 mL of contaminated water received from FQS. Put the bottle in a warm, dark place to incubate.

The project manager will determine when the inoculants are ready for use.

Materials:

- 2 fuels, JP-8 and diesel fuel
- 6 types of ADMF
- 2 inoculants
- 28 each, one-quart jars – mason jars

Procedure:

1. Label each of the jars with a code to designate the test fuel and mesh to be put in the jar. These jars will need to be repeatedly photographed so use a small label, close to the top of the jar.

2. To 6 sets of 4 jars each add 400 mL of mesh; using a different mesh for each set. Leave one set of 4 jars for the fuels without mesh.

3. To all 28 jars, add 130 mL of water. Then add 10 mL of each inoculant (A or B) to each jar.

4. To 2 jars from each set of 4, add 450 mL of the JP-8/Diesel test fuel.

5. To the remaining 2 jars from each set of 4, add 450 mL of the high sulfur diesel fuel test fuel.

6. Take a digital picture of each jar and then place all the jars in a warm, dark place to incubate. The label on the jar should be clearly visible in the photograph. There should also be an additional small label on the jar to indicate the weeks of storage. It is the intent that the photographs clearly show the nature of the fuel/water interface. The camera and lighting should be placed appropriately.

7. After 7 days of incubation, remove the jars from their storage and again photograph each jar.

8. Once the picture is taken, remove the cover from the jar and gently blow across the top of the jar to circulate the air in the ullage. Replace the lid and gently shake the jar. Return the jars for another 7 days of incubation.

9. Repeat steps 7 and 8 for a total of 16 weeks storage unless otherwise directed by the project manager.

10. Store all the photographs on an appropriately labeled CD and give the CD to Program Manager Steve Westbrook.

11. Additional work-up may be required so do not dispose of anything until directed to do so by the project manager.

*Note: Change to Deionized Water as tap water may contain Chlorine.

Table A-20. Microbiological Growth in High Sulfur Diesel Fuel, AL-26971

Diesel Fuel	Week 1		Week 4		Week 8		Week 12		Week 16	
mesh	Inoculate A	Inoculate B	Inoculate A	Inoculate B	Inoculate A	Inoculate B	Inoculate A	Inoculate B	Inoculate A	Inoculate B
neat	growth	none	growth at layer	growth at layer	thick layer of microbial at interface	thick layer of microbial at interface	thick layer of growth @ interface; fuel slightly cloudy	thick layer of growth @ interface; fuel slightly cloudy	Thick layer of growth @ interface; water yellow & hazy; fuel slight cloudy	Thick layer of growth @ interface; water yellow & hazy; fuel slight cloudy
ADMF B	none	none	water yellow	water yellow	water dark yellow/fuel pale yellow	dark yellow water/growth at interface	water layer clear dark yellow; fuel clear pale yellow	dark yellow color water-clear; fuel hazy; mesh discolored	water layer clear dark yellow/fuel clear pale yellow	clear dark yellow color water; fuel hazy; mesh discolored
ADMF C	none	none	growth at interface	growth at interface; fuel cloudy	grow at interface; water clear	growth at interface; fuel cloudy	water clear; fuel layer cloudy; tarnish mesh	water clear; fuel layer hazy	water clear; fuel layer cloudy; tarnish mesh	water clear; fuel layer hazy
ADMF D	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear; microbol growth @ interface	water clear; fuel clear; growth @ interface	water clear & on walls; fuel clear/growth @ interface	water clear & ;fuel clear; growth @ interface	water clear/fuel clear/growth @ layer/water on walls	water clear & water on walls; fuel clear; growth @ interface; mesh tarnished.
ADMF E	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear yellow & on walls; fuel clear	water clear & on walls; fuel clear; growth @ interface	water clear yellow & on walls; fuel clear; growth @ interface	water clear yellow & on walls; fuel clear; growth @ interface
ADMF F	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear; fuel clear	water clear & on walls; fuel clear; growth @ interface	water clear & on walls; fuel clear; growth @ interface	water clear and on walls/fuel clear/growth @ interface	water clear yellow & on walls; fuel clear; growth @ interface	water clear; fuel clear; growth @ interface; condensation on walls	water yellow; fuel clear; growth @ interface; condensation on walls
ADMF G	water clear; fuel clear	water clear; fuel clear	water clear yellow ;fuel hazy	water clear yellow color; fuel hazy	water clear & on wall; fuel hazy-murky growth @ interface	water clear yellow & on walls; fuel clear; growth @ interface	water hazy yellow & dusty bottom with condensation on walls; fuel hazy & murky	water & fuel hazy; fuel hazy' water condensation on walls	water yellow & hazy with dusty bottom; fuel hazy & murky; water condensation on walls	water yellow & hazy; fuel hazy; water condensation on walls

Table A-21. Microbiological Growth in JP-8, AL-26936

Aviation	Week 1		Week 4		Week 8		Week 12		Week 14		Week 16	
mesh	Inoculate A	Inoculate B	Inoculate A	Inoculate B	Inoculate A	Inoculate B	Inoculate A	Inoculate B	Inoculate A	Inoculate B	Inoculate A	Inoculate B
neat	none	none	none	none	growth	slight growth	growth	slight growth	growth	slight growth	growth	growth
ADMF B	none	none	none	none	slight growth	slight growth	slight growth	slight growth	slight growth	slight growth	slight growth	slight growth
ADMF C	none	none	none	none	slight growth	slight growth	growth fuel cloudy*	slight growth	growth fuel cloudy*	growth @ bottom & interface	tarnished mesh; growth @ bottom; water & fuel cloudy	growth @ bottom; water cloudy; fuel clear
ADMF D	none	water clear; fuel hazy; growth at interface	none	water & fuel clear; growth @ interface	water & fuel clear; growth @ interface	water & fuel hazy; growth @ interface	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls
ADMF E	none	none	none	none	none	none	water & fuel clear; condensation on walls	water & fuel clear; condensation on walls	water & fuel clear; condensation on walls	water & fuel clear; condensation on walls	water & fuel clear; condensation on walls	water & fuel clear; condensation on walls
ADMF F	none	none	none	none	water clear/fuel clear/microbial growth @ layer	water clear/fuel clear/growth a layer	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls	water & fuel clear; growth @ interface; condensation on walls
ADMF G	none	none	water yellow & hazy yellow & hazy; growth @ bottom; fuel murky; condensation on walls	none	water yellow & hazy yellow & hazy; growth @ bottom; fuel murky; condensation on walls	water hazy; fuel clear; condensation on walls	water yellow & hazy yellow & hazy; growth @ bottom; fuel murky; condensation on walls	water hazy; fuel clear; condensation on walls	water yellow & hazy yellow & hazy; growth @ bottom; fuel murky; condensation on walls	water hazy; fuel clear; condensation on walls	water yellow & hazy yellow & hazy; growth @ bottom; fuel murky; condensation on walls	water hazy; fuel clear; condensation on walls

ASTM D4539 Standard Test Method of Filterability of Diesel Fuels by Low-Temperature

Objective and Method Plan

The presence of ADMF in fuel tanks adds a new dimension to the discussion of low temperature flow. How will the massive increase in surface area effect the wax formation and fluid characteristics of distillate fuels? In this effort we have examined a series of ASTM standard low temperature tests and have found none that can provide the information we need as written.

Of the methods examined the D97 Pour Point, the D 2500 Cloud Point, the D 4539 Low Temperature Flow Tests (LTFT), and the D 6371 Cold Filter Plugging Point (CFPP) offered the most promise. The pour point is considered the lowest temperature that the fuel will move at all, a point well below the operable temperature. The cloud point measures the temperature at which wax first becomes visible when the fuel is cooled. The LTFT and CFPP tests were devised to examine the operational limitation of distillate fuel in automotive service.

The choice between these two tests usually falls to CFPP because it is an easier test to perform. For this program we choose to use LTFT despite its time and material penalties. The increased sample volume in the LTFT test allows a better reproduction of the proposed application of ADMF in fuel tanks.

The test will not be used strictly as written. The primary modification will be running unfiltered samples. The sample filter assembly will be immersed in fuel containing ADMF material(s). Because we do not know the effect on the test simply from the presence of the ADMF material(s) a baseline performance at 15°C will be generated for each combination. Based on this testing the sample size of the fuel may be adjusted.

<u>The First Step</u>

Our initial effort will be to find the Minimum LTFT Pass Temperature of the base fuel. We know the cloud point of the base material so we know where to start testing.

<u>Setting a Baseline</u>

For each ADMF material we will prepare two ADMF/Fuel samples to generate a baseline. The samples will be placed in a bath stabilized to 15°C and then the fuel will then be extracted from the vessels using the standard technique. The results from these extractions will be averaged and that value will be set as the performance standard.

<u>Checking the LTFT Performance for the ADMF/Fuel Combination(s)</u>

First two ADMF/Fuel samples will be prepared and cooled to the minimum pass temperature. The fuel will be extracted per the method and the results compared to previously generated baseline. If there is a significant loss in performance, > 10%, five additional ADMF/Fuel samples will be prepared and placed in the low temperature bath. The bath will then be cooled to the known cloud point for the fuel and Minimum LTFT Pass Temperature will be determined per the method. Results shown in Figure A-5 indicate a change in low temperature filtration of less than 1°C, which is insignificant.

Discussion

This method covers the filterability of diesel fuels at low temperatures. The fuel is placed into a testing container and the sample is cooled at rate of -1°C per hour. The filtering system contains a 17-µm screen and the sample must completely flow in 60 seconds or less. When the sample does not completely flow through the system that is recorded as failure. The LTFT is reported as the minimum temperature of the last passing temperature in °C.

Results

The LTFT of the Diesel Fuel was recorded at –6.9°C and this was considered as the baseline. Mesh B performed at –7.0°C, just below the baseline fuel. The other five meshes (C, D, E, F and G) averaged a –6.8°C for LTFT. The low temperature filterability of the fuel with the addition of meshes had no change in temperature. The only notable data is that when fuel seems to reach a "pour point" and the fuel would not flow through the test apparatus.

Table A-22. Low Temperature Filterability Test (LTFT)
ASTM D4539

	HSDF	SPECIMENS					
TEMP, °C	Baseline	Mesh B	Mesh C	Mesh D	Mesh E	Mesh F	Mesh G
Run 1	-6.9	-6.9	-6.9	-6.8	-6.5	-6.6	-6.6
Run 2	-6.9	-7.0	-6.9	-6.8	-6.8	-6.8	-6.8
Run 3	-7.0	-7.0	-7.0	-6.9	-6.8	-6.8	-6.8
Report	-6.9	-7.0	-6.9	-6.8	-6.8	-6.8	-6.8

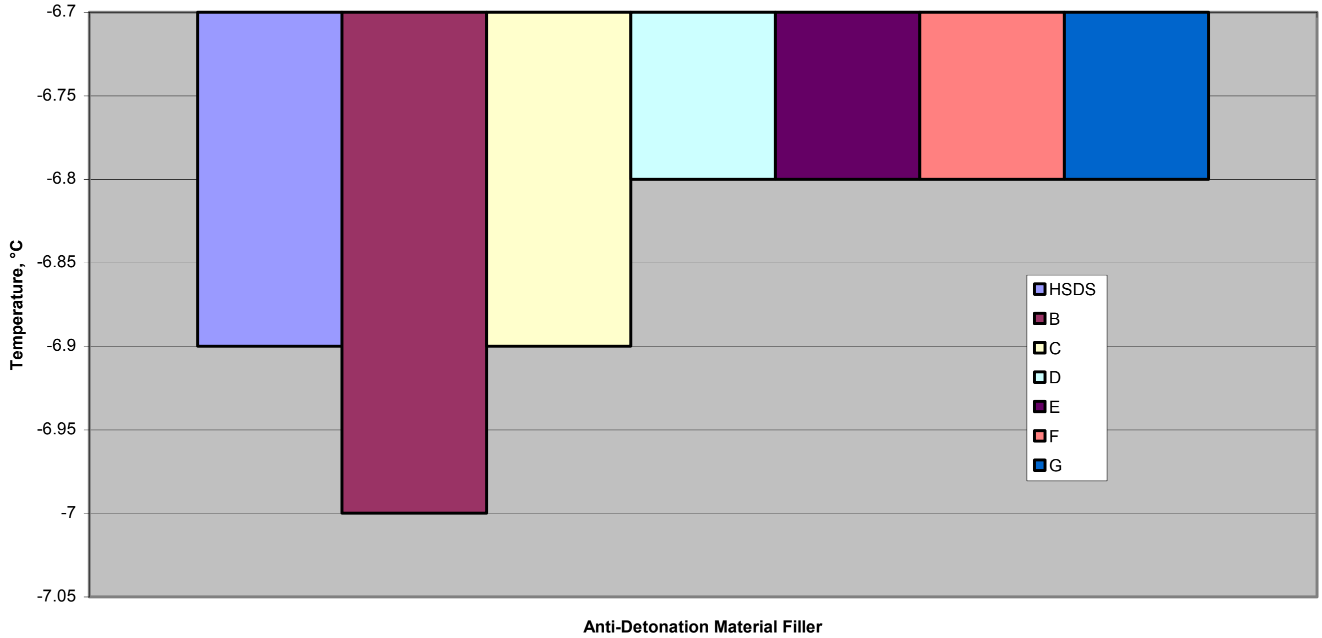

Figure A-4. Low Temperature Filterability

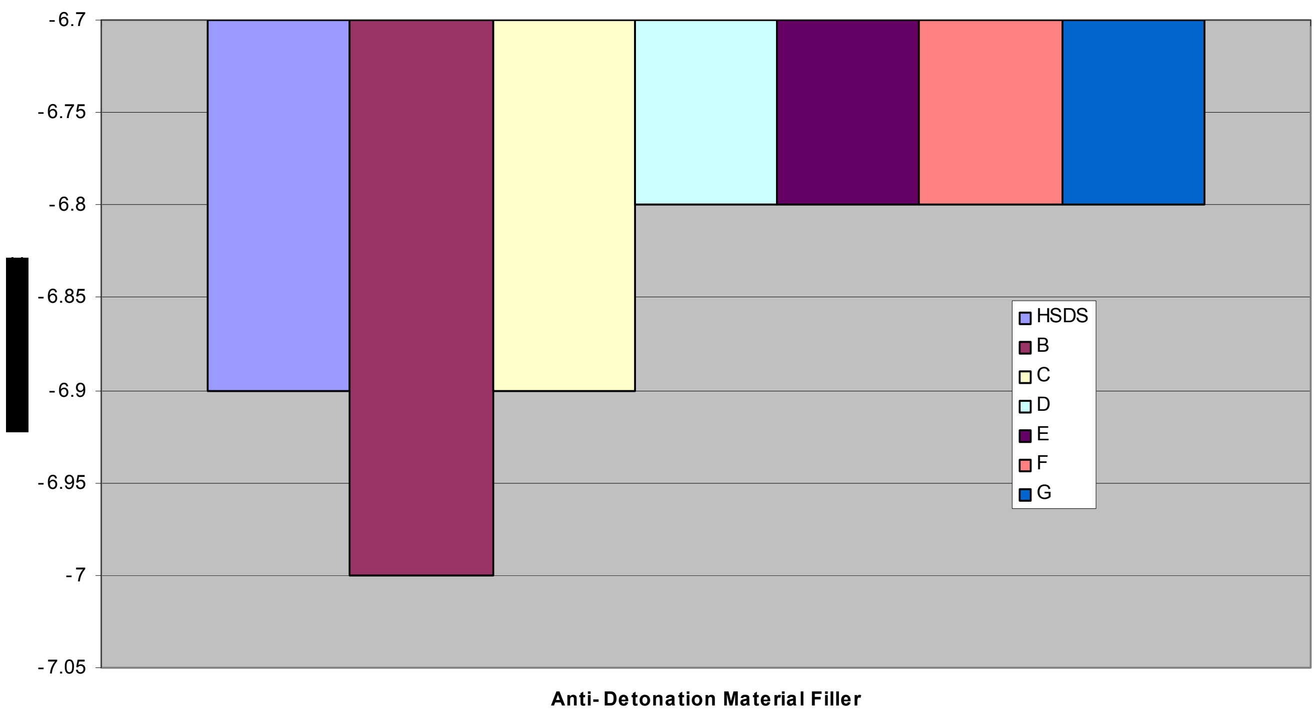

Figure A-5 Low Temperature Filterability

Test Plan to Evaluate the Effects of DiEGME/Water Blends on ADMF

The purpose of this test is to evaluate the effects of DiEGME/water blends on each of the six ADMF.

1.1 Use the same clay-treated JP-8 test fuel used in the microbiological evaluations.

1.2 Prepare a blend of 500 mL of DiEGME and 500 mL of deionized water. Store the blend in an appropriately labeled bottle.

1.3 Collect 7 each, 250-mL Erlenmeyer flasks. To each flask add 150 mL of the 50/50 blend and 50 mL of test fuel.

1.4 Wash the ADMF (see the table below for amount) with heptane, allow it to air-dry. Weigh the ADMF and record the weight. Then put the pre-weighed ADMF in the appropriate flask.

1.5 Visually examine each jar every 24 hours for 3 weeks (not on weekends) and record the visual appearance of the liquid and also the mesh.

1.6 At the end of 3 weeks storage, remove the mesh and record the visual appearance. Then rinse the mesh with heptane, allow the mesh to air dry, and reweigh the ADMF. Report the change in weight.

1.7 Filter the liquid through a pair of pre-weighed GF-F filters. Report the weight of any particulates on the filter.

Table A-23. Test Matrix from DiEGME/Water Blends

Jar	Mesh	150 mL 50/50 Blend & 50 mL of Fuel
1	None	√
2	1 (4 spheres)	√
3	2 (4 spheres)	√
4	3 (TBD)	√
5	4 (TBD)	√
6	5 (TBD)	√
7	6 (TBD)	√

Table A-24. Visual Notes of the DiEGME/Water Blends with ADMF Specimens

Day	Neat: (50 mls) + 50:50 Blend (150 mls)	Fuel (50 mls) 50:50 Blend (150 mls) ADMF B	Fuel (50 mls) 50:50 Blend (150 mls) ADMF C
0	small amt of foam* between layers	small amt of foam between layers	small amt of foam between layers
1	Small bubbles	small bubbles	small bubbles
2	no change	no change	no change
3	no change	no change	no change
4	Saturday	Saturday	Saturday
5	Sunday	Sunday	Sunday
6	no change	no change	no change
7	no change	no change	no change
8	no change	no change	no change
9	no change	no change	no change
10	no change	no change	possible tarnish of mesh
11	Saturday	Saturday	Saturday
12	Sunday	Sunday	Sunday
13	no change	Tarnish on mesh in water layer	Tarnish on mesh in water layer
14	no change	Tarnish on mesh	Tarnish on mesh
15	no change	Tarnish on mesh	Tarnish on mesh
16	no change	Tarnish on mesh	Tarnish on mesh
17	no change	Tarnish on mesh	Tarnish on mesh
18	Saturday	Saturday	Saturday
19	Sunday	Sunday	Sunday
20	no change	Tarnish on mesh	Tarnish on mesh
21	no change	Tarnish on mesh	Tarnish on mesh

Note:50:50 Blend-50% water/50% DIEGME

*The term foam, in this instance, means froth on the liquid layer – not a tested product.

This study was to determine any effects the DiEGME with water would have on the ADMF specimens. No visual fuel effects were noticeable, and no physical testing was performed on the fuel. The ADMF specimens did not exhibit any change until 2 weeks of being submersed. Tarnishing occurred on the mesh specimens. No other visual changes occurred within the three weeks of testing.

Long-Term Study for Lubricity by ASTM D5001 and ASTM D6079

Lubricity samples from the long-term storage were selected at longer intervals. The effects on lubricity were thought to be subjected to chaffing or particles released from the specimens. Although the specimen particles would be large, this could affect the lubricity in the fuel system. Some of the larges seen in the chaffing study were larger and could affect the fuel system. The metals study (ASTM D5185) did not show any increase in metals. This is due to the particles being too large for the analysis by ICP. The maximum micron size for detection by the ICP is 15µ or less. The metal particles seen in the chaffing study ranged up to 4mm (4,000µ).

Table A-25. Lubricity of Aviation Fuel, JP-8, AL-26936
ASTM D5001 AND ASTM D6078

			Week 0		
Mesh	Water	Bottle	Lab ID	BOCLE D5001 (mm)	SLBOCLE D6079 (grams)
Neat A	N	A	A1	0.51	2150

			Week 4						Week 8						Week 12		
Mesh	Water	Bottle	Lab ID	BOCLE D5001 (mm)	SLBOCLE D6079 (grams)	Mesh	Water	Bottle	Lab ID	BOCLE D5001 (mm)	SLBOCLE D6079 (grams)	Mesh	Water	Bottle	Lab ID	BOCLE D5001 (mm)	SLBOCLE D6079 (grams)
Neat A	N	A	A9	0.49	2550	Neat A	N	A	A65	0.54	2000	Neat A	N	A	A121	0.53	2300
		B	A10	x	x			B	A66	x	x			B	A122	x	x
Neat A	Y	A	A11	0.49	2450	Neat A	Y	A	A67	x	x	Neat A	Y	A	A123	x	x
		B	A12	x	x			B	A68	0.53	2100			B	A124	0.53	2050
MF B	N	A	B17	0.50	2700	MF B	N	A	B73	0.49	2200	MF B	N	A	B129	x	x
		B	B18	x	x			B	B74	x	x			B	B130	0.50	2300
MF B	Y	A	B19	0.50	2500	MF B	Y	A	B75	0.49	2300	MF B	Y	A	B131	x	x
		B	B20	x	x			B	B76	x	x			B	B132	0.50	2550
MF C	N	A	C25	x	x	MF C	N	A	C81	x	x	MF C	N	A	C137	0.53	2150
		B	C26	0.52	2100			B	C82	0.50	1850			B	C138	x	x
MF C	Y	A	C27	0.54	1950	MF C	Y	A	C83	0.51	1800	MF C	Y	A	C139	0.54	2200
		B	C28	x	x			B	C84	x	x			B	C140	x	x
MF D	N	A	D33	x	x	MF D	N	A	D89	0.51	1950	MF D	N	A	D145	0.52	1650
		B	D34	0.47	1900			B	D90	x	x			B	D146	x	x
MF D	Y	A	D35	x	x	MF D	Y	A	D91	x	x	MF D	Y	A	D147	x	x
		B	D36	0.52	1950			B	D92	0.53	1950			B	D148	0.55	1700
MF E	N	A	E41	0.49	1950	MF E	N	A	E97	x	x	MF E	N	A	E153	0.49	2050
		B	E42	x	x			B	E98	0.52	1250			B	E154	x	x
MF E	Y	A	E43	0.55	1800	MF E	Y	A	E99	0.5	1700	MF E	Y	A	E155	0.48	1950
		B	E44	x	x			B	E100	x	x			B	E156	x	x
MF F	N	A	F49	x	x	MF F	N	A	F105	0.53	2000	MF F	N	A	F161	x	x
		B	F50	0.54	2050			B	F106	x	x			B	F162	0.54	1700
MF F	Y	A	F51	x	x	MF F	Y	A	F107	0.53	1800	MF F	Y	A	F163	0.55	2050
		B	F52	0.51	1500			B	F108	x	x			B	F164	x	x
MF G	N	A	G57	0.5	1900	MF G	N	A	G113	0.54	1600	MF G	N	A	G169	x	x
		B	G58	x	x			B	G114	x	x			B	G170	0.51	2350
MF G	Y	A	G59	0.55	1900	MF G	Y	A	G115	x	x	MF G	Y	A	G171	0.55	1600
		B	G60	x	x			B	G116	0.53	1600			B	G172	x	x

Test Plan to Evaluate the Effects of ADMF on
Fuel Conductivity and Static Dissipater Additive

The purpose of this test is to evaluate the loss of static dissipater additive from JP-8 stored in the presence of ADMF.

Materials

1.8 Five gallons clay-treated JP-8 test fuel used in the microbiological evaluations
1.9 Static Dissipater Additive, Stadis 450
1.10 One quart jars, fourteen (14) ea
1.11 Five gallon epoxy lined mixing vessel
1.11.1 Remove top from can
1.11.2 Prepare a foil cover for the can to keep the vessel light tight
1.12 One liter graduated cylinder

Base Fuel Preparation

1.13 Treat 500 ml of the test fuel with 50 mg of SDA (100 ppm). Store this in a properly labeled glass bottle.
1.14 Add 12 l of the test fuel to the mixing vessel.
1.15 Add 120 ml of the dilute SDA to the mixing vessel
1.16 Mix the fuel gently to disperse the additive
1.17 Allow one hour for the fuel to stabilize and then measure the conductivity
1.17.1 The required conductivity is found in MIL-DTL-83133E. To wit: "The conductivity must be between 150 and 450 pS/m for F-34 (JP-8)…"
1.17.2 The target for this program will be 300-400 pS/m.
1.17.3 If the initial addition does not reach the target prepare for a second addition
1.17.3.1 If conductivity < 150 pS/m, add a second 120 ml of dilute SDA
1.17.3.2 If conductivity < 300 pS/m but > 150 pS/m, add 60 ml of dilute SDA
1.17.4 If the initial addition exceeds the target contact George Wilson

Preparing the Samples

1.18 Clean sample jars per ASTM D4306
1.18.1 From the method, "Borosilicate glass bottles are preferred for immediate use or storage of samples. Prepare containers by rinsing with water, acetone, and air drying, or by rinsing with hot water followed by de-ionized water and air-drying."
1.19 Fill the jars as per Table A-26

Data Collection

1.20 After the jars are filled, allow the fuel to rest for 4 hours. Measure and record the conductivity of the fuel in each jar.
1.21 Put the jars in room temperature, dark storage. After 24 hours storage, measure and record the conductivity of the fuel in each jar.
1.22 Repeat 1.7 for a total of 14 days of storage. It is not necessary to make measurements on weekends.

Table A-26. Test Matrix for Electrical Conductivity

	ADMF (500 ml)	Fuel (750 ml)
1	None	Neat
2	None	SDA Blend
3	ADMF B	Neat
4	ADMF B	SDA Blend
5	ADMF C	Neat
6	ADMF C	SDA Blend
7	ADMF D	Neat
8	ADMF D	SDA Blend
9	ADMF E	Neat
10	ADMF E	SDA Blend
11	ADMF F	Neat
12	ADMF F	SDA Blend
13	ADMF G	Neat
14	ADMF G	SDA Blend

Table A-27. Conductivity Measurements Picosiemens Per Meter
ASTM D2624

JP-8 with ADMF Specimens								
	0 hr	**1 hr**	**3 hr**	**19 hr**	**24 hr**	**3 day**	**7 day**	**14 day**
Neat	6	8	2	6	7		1	11
ADMF B (Suppress X-S)		2	2	8	4		8	2
ADMF C (Deto-Stop)		2	6	2	2		2	2
ADMF D (FireXX)		90	90	80	90		70	49
ADMF E (ADI SS)		0	0	2	2		0	0
ADMF F (Safetypacs)		0	0	2	2		0	0
ADMF G (Foamex)		32	10	13	12		18	14
JP-8 with ADMF Specimens and Statis 450 (Dissapitor)								
	0 hr	**1 hr**	**3 hr**	**19 hr**	**24 hr**	**3 Day**	**7 day**	**14 day**
Neat Fuel with Dissapitor (JP8/Statis 450)	320	300	300	340	340		340	330
ADMF B (Suppress X-S/Statis 450)		320	320	300	310		280	290
ADMF C (Deto-Stop/Statis 450)		330	330	340	360		320	300
ADMF D (FireXX/Statis 450)		410	430	440	420		380	380
ADMF E (ADI SS/Statis 450)		260	230	130	110**		28	20
ADMF F (Safetypacs/Statis 450)		320	320	260	250		160	110
ADMF G (Foamex/Statis 450)		380	410	480	480		480	490

The baseline conditions of the electrical conductivity for specimens B, C, E, and F were normal. The electrical conductivity of ADMF D (FireXX) was considerably higher and there was a slight increase with ADMF G (foamex). For the addition of the static Dissapitor, the results were as expected. ADMF D and G increased with the additional pS/m as seen in the baseline. ADFM E (ADI SS/Statis 450) decreased over time. The 1 hour reading for ADMF E was lower than expected and the reading drop to 20 pS/m after 14 days. ADMF F (Safetypac/Statis 450) dropped also to 110 after 14 days.

ASTM D3241 Thermal Oxidation Stability of Aviation Turbine Fuels (JFTOT Procedure)

This test method is to rate decomposition products of turbine fuels with the fuel system. This method measures the high temperature stability of fuels using the Jet Fuel Thermal Oxidation Tester (JFTOT). This instrument subjects the fuel to conditions that are related to those occurring in aviation fuel systems.

Table A-28. ASTM D3241
THERMAL STABILITY, JP-8, AL-26936
Breakpoint Temperatures, °C

Mesh	Water	Bottle	Lab ID	Week 0
Neat A	N	A	A1	300

Mesh	Water	Bottle	Lab ID	Week 4	Lab ID	Week 8	Lab ID	Week 12
Neat A	N	A	A9	295	A65	300	A121	295
		B	A10	x	A66	x	A122	x
Neat A	Y	A	A11	290	A67	x	A123	x
		B	A12	x	A68	285	A124	290
MF B	N	A	B17	295	B73	280	B129	x
		B	B18	x	B74	x	B130	295
MF B	Y	A	B19	x	B75	285	B131	x
		B	B20	280	B76	x	B132	285
MF C	N	A	C25	x	C81	x	C137	300
		B	C26	295	C82	295	C138	x
MF C	Y	A	C27	290	C83	290	C139	290
		B	C28	x	C84	x	C140	x
MF D	N	A	D33	x	D89	260	D145	270
		B	D34	270	D90	x	D146	x
MF D	Y	A	D35	x	D91	x	D147	x
		B	D36	250	D92	275	D148	290
MF E	N	A	E41	245	E97	x	E153	225
		B	E42	x	E98	280	E154	x
MF E	Y	A	E43	270	E99	280	E155	235
		B	E44	x	E100	x	E156	x
MF F	N	A	F49	x	F105	270	F161	x
		B	F50	280	F106	x	F162	275
MF F	Y	A	F51	x	F107	290	F163	285
		B	F52	290	F108	x	F164	x
MF G	N	A	G57	290	G113	hold	G169	x
		B	G58	x	G114	hold	G170	290
MF G	Y	A	G59	290	G115	hold	G171	285
		B	G60	x	G116	hold	G172	x

Test Plan to Evaluate Loss of Corrosion Inhibitor from JP-8 Stored in Presence of ADMF

The purpose of this program is to evaluate the potential loss of corrosion inhibitor additive from JP-8 stored in the presence of ADMF.

1. Corrosion Inhibitor

1.23 Obtain 5 gallons of JP-8 test fuel and clay-treat it according to the procedures in D5001. Assign a new laboratory identification number to the 5 gallons of clay-treated fuel.

1.24 Create a series of standard solutions using the clay-treated fuel and the corrosion inhibitor additive.

1.25 Use 1 liter of fuel for each standard. Prepare standards at approximately 0, 5, 10, 15, 20, and 25 mg/L.

1.26 Place each standard in a properly labeled, 1-liter, glass bottle. Put aluminum foil over the opening of the bottle before putting the cap on. This will minimize contamination from the cap.

1.27 Analyze each standard twice using D5001.

1.28 Using a separate 1-liter sample of the clay-treated fuel, make a test fuel by adding corrosion inhibitor. Store the test fuel in a 1-liter bottle as with the standard solutions. Assign a new laboratory identification number to this test fuel.

1.29 Fill a 1-liter jar with the first ADMF then fill the jar with the additive-treated test fuel.

1.30 Allow the jar to sit at room temperature for 24 hours.

1.31 After 24 hours, withdraw approximately 120 mL of fuel from the bottle. Leave the mesh and the remaining fuel in the bottle and put it back in storage for another 24 hours.

1.32 Perform duplicate D5001 analyses on the fuel.

1.33 Repeat steps 1.8 to 1.10 until the D5001 test results correlate with an additive concentration of <5 mg/L or until there is insufficient test fuel in the bottle. @ 1 week, 2 weeks, 5 weeks, X weeks.

1.34 Perform steps 1.6 to 1.11 for each of the five other types of mesh.

1.35 Also, perform steps 1.7 to 1.11 using the clay-treated fuel (no additive). Run daily tests until there is no longer sufficient fuel in the bottle. Do this for each of the six types of mesh.

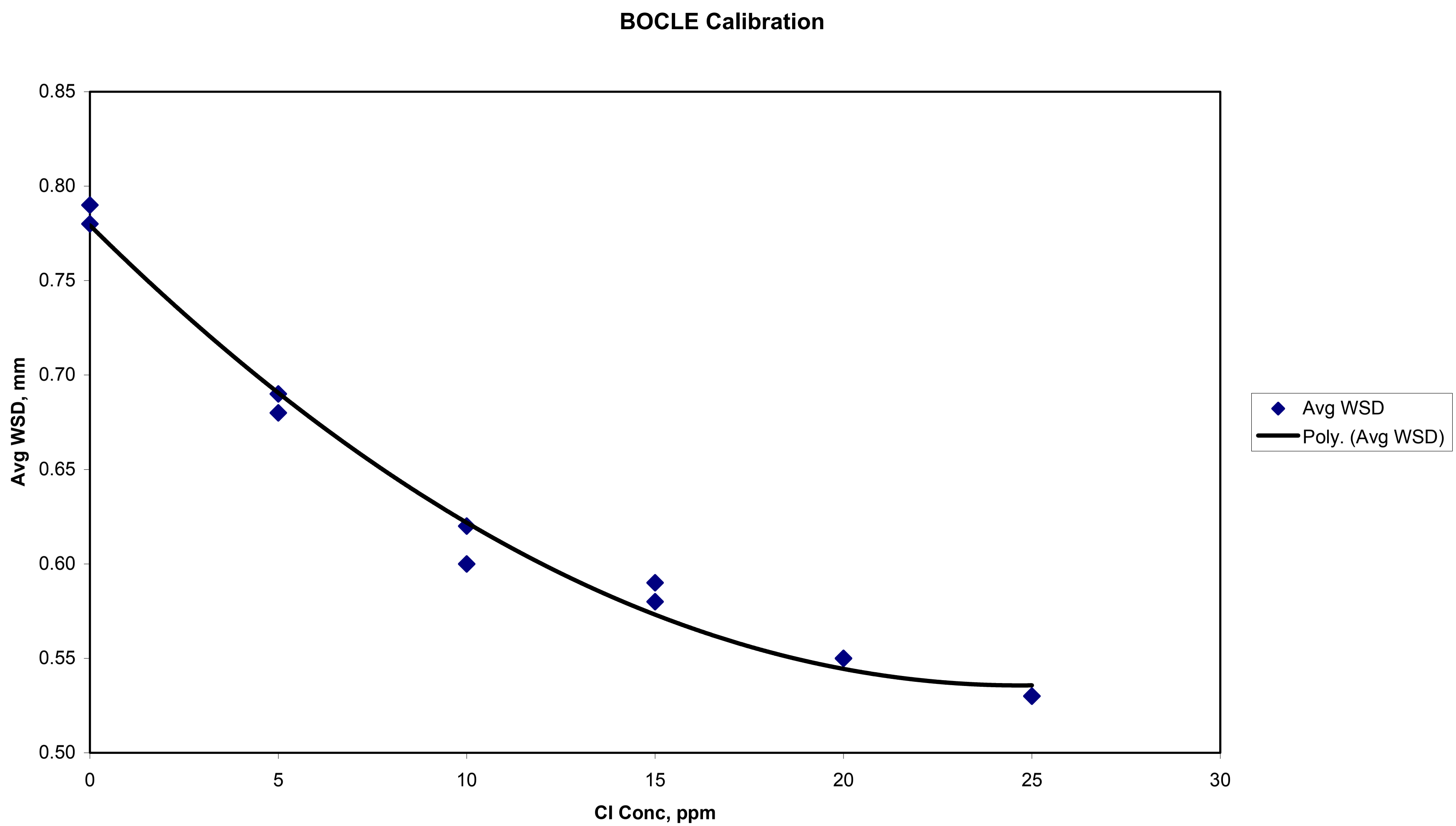

Figure A-6. BOCLE Calibration

Table A-29. Corrosion Inhibitor Results after Storage at Room Temperature

JP-8 ADMF B 20 mg/L				
lab id	hrs	BOCLE run 1	BOCLE run 2	DATE ANALYZED
base fuel		0.78	0.79	3/27/2003
CL03-0301	0	0.55	0.55	
	24	0.50	0.49	4/4/2003
	96	0.50	0.50	4/7/2003
	240	0.50	0.50	4/16/2003
	408	0.50	0.51	4/25/2003
	1824	0.49	0.49	7/10/2003

JP-8 ADMF C 20 mg/L				
lab id	hrs	BOCLE run 1	BOCLE run 2	DATE ANALYZED
base fuel		0.78	0.79	3/27/2003
CL03-0302	0	0.55	0.55	
	24	0.55	0.55	4/4/2003
	96	0.57	0.57	4/7/2003
	240	0.57	0.57	4/16/2003
	408	0.55	0.56	4/25/2003
	1824	0.58	0.58	7/10/2003

JP-8 ADMF D 20 mg/L				
lab id	hrs	BOCLE run 1	BOCLE run 2	DATE ANALYZED
basefuel		0.70	0.70	8/14/2003
CL03-613	0	0.55	0.60	
	48	0.54	0.54	8/27/2003
	96	0.55	0.53	9/3/2003
	240	0.53	0.53	9/12/2003
	408	0.62	0.62	9/18/2003
	1824	0.55	0.57	11/7/2003

JP-8 ADMF E 20 mg/L				
lab id	hrs	BOCLE run 1	BOCLE run 2	DATE ANALYZED
base fuel		0.70	0.70	8/14/2003
CL03-614	0	0.55	0.60	
	48	0.54	0.54	8/27/2003
	96	0.56	0.54	9/3/2003
	240	0.54	0.54	09/12/03
	408	0.52	0.52	9/18/2003
	1824	0.54	0.55	11/7/2003

JP-8 ADMF F 20 mg/L				
lab id	hrs	BOCLE run 1	BOCLE run 2	DATE ANALYZED
base fuel		0.70	0.70	8/14/2003
CL03-615	0	0.55	0.60	
	48	0.56	0.56	8/28/2003
	96	0.54	0.54	9/4/2003
	240	0.50	0.53	9/12/2003
	408	0.54	0.54	9/19/2003
	1824	0.53	0.53	11/7/2003

JP-8 ADMF G 20 mg/L				
lab id	hrs	BOCLE run 1	BOCLE run 2	DATE ANALYZED
base fuel		0.70	0.70	8/14/2003
CL03-616	0	0.55	0.60	
	24	0.55	0.55	8/27/2003
	48	0.58	0.55	9/4/2003
	240	0.56	0.57	9/12/2003
	408	0.55	0.55	9/19/2003
	1824	0.57	0.57	11/7/2003

APPENDIX B

In-Vehicle Evaluation

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/02/03	Run Number	1			
	Fuel Tank I.D. #	H1			
	Fill Rate (gpm)	10.9	2:03 (fill time)		
	Total Fuel Dispensed(gal.)	21.3			
	Drive	No			
	Weight of drums empty	------lbs----------	n/a	n/a	37.58
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	2.93			
	Drain Rate 1 @ start	1.73	1:18 PM		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.32	1:28 PM		
	Drain Rate 3 @14min	0.84	1:32 PM		
	16.5 min. to drain	Drained	1:34:30 PM		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	n/a	n/a	157.80
	Weight of jars full	------lbs----------	7.68	8.16	7.91
	Weight of filter after use	3.63			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.30
		Total Fuel Drained (lbs)	137.62
		Gallons drained	20.63
drum 3 full - empty (lbs)	120.22	fuel held up (gal.)	0.67
jar 1 full - empty (lbs)	5.33		
jar 2 full - empty (lbs)	5.81		
jar 3 full - empty (lbs)	5.56		
filter full - empty (lbs)	0.70		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/03/03	Run Number	1			
	Fuel Tank I.D. #	H2			
	Fill Rate (gpm)	10.9	2:06 (fill time)		
	Total Fuel Dispensed(gal.)	22.8			
	Drive	Yes			
	Weight of drums empty	------lbs----------	n/a	n/a	50.56
	Weight of jars empty	------lbs----------	2.36	2.35	2.35
	Weight of filter empty	2.93			
	Drain Rate 1 @ start	2.15	3:38 PM		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.42	3:48 PM		
	Drain Rate 3 @14min	1.47	3:52 PM		
	16.0 min. to drain	Drained	3:54:00 PM		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	n/a	n/a	168.60
	Weight of jars full	------lbs----------	7.78	8.17	8.28
	Weight of filter after use	3.63			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.68	
			Total Fuel Drained (lbs)	135.91	
			Gallons drained	20.38	
	drum 3 full - empty (lbs)	118.04	fuel held up (gal.)	2.42	
	jar 1 full - empty (lbs)	5.42			
	jar 2 full - empty (lbs)	5.82			
	jar 3 full - empty (lbs)	5.93			
	filter full - empty (lbs)	0.70			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/04/03	Run Number	1			
	Fuel Tank I.D. #	H3			
	Fill Rate (gpm)	9.3	triggered auto shut off at 10 gpm		
	Total Fuel Dispensed(gal.)	21.3			
	Drive	Yes			
	Weight of drums empty	------lbs----------	n/a	n/a	35.2
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty (lbs)	2.93			
08/05/03	Drain Rate 1 @ start	1.32			
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.16			
	Drain Rate 3 @10min	0.84	19.5 min. from start of drain		
	23.3 min. to drain	Drained			
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	n/a	n/a	153.00
	Weight of jars full	------lbs----------	7.70	7.75	8.05
	Weight of filter after use (lbs	3.65			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpn	1.11	
			Total Fuel Drained (lbs)	134.97	
			Gallons drained	20.24	
	drum 3 full - empty (lbs)	117.80	fuel held up (gal.)	1.06	
	jar 1 full - empty (lbs)	5.35			
	jar 2 full - empty (lbs)	5.40			
	jar 3 full - empty (lbs)	5.70			
	filter full - empty (lbs)	0.72			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/08/03	Run Number	1			
	Fuel Tank I.D. #	H4			
	Fill Rate (gpm)	9.8	2:16.12 min fill time		
	Total Fuel Dispensed(gal.)	22.3			
	Drive	Yes			
	Weight of drums empty	------lbs----------	n/a	n/a	69.6
	Weight of jars empty	------lbs----------	2.34	2.35	2.35
	Weight of filter empty (lbs)	2.93			
08/08/03	Drain Rate 1 @ start	1.57			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.37			
	Drain Rate 3 @10min	1.10	14 min. from start of drain		
		Drained			
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	------lbs----------	n/a	n/a	185.00
	Weight of jars full	------lbs----------	8.10	7.96	8.29
	Weight of filter after use (lbs)	3.60			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.35
		Total Fuel Drained (lbs)	133.38
		Gallons drained	20.00
drum 3 full - empty (lbs)	115.40	fuel held up (gal.)	2.30
jar 1 full - empty (lbs)	5.76		
jar 2 full - empty (lbs)	5.61		
jar 3 full - empty (lbs)	5.94		
filter full - empty (lbs)	0.67		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3	
08/15/03	Run Number	1				
	Fuel Tank I.D. #	H-5				
	Fill Rate (gpm)	10.9	2:03.31 min fill time			
	Total Fuel Dispensed(gal.)	22.0				
	Drive	Yes				
	Weight of drums empty	——lbs——	n/a	n/a	35.4	
	Weight of jars empty	——lbs——	2.36	2.36	2.36	
	Weight of filter empty (lbs)	2.93				
08/15/03	Drain Rate 1 @ start	2.21				
	1 Gal. Drain Sample		lab filter			
	1 Gal. Drain Sample		gravity through filter/lab sample			
	Drain Rate 2 @10min	1.52				
	Drain Rate 3 @10min	1.10	14 min. from start of drain			
		Drained	20:41.47 min			
	1 Gal. Drain Sample		lab filter			
	Weight of drums w/fuel	——lbs——	n/a	n/a	150.40	
	Weight of jars full	——lbs——	8.05	8.25	8.17	
	Weight of filter after use (lbs)	3.65				
	Calculations					
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.61		
			Total Fuel Drained (lbs)	133.11		
			Gallons drained	19.96		
	drum 3 full - empty (lbs)	115.00	fuel held up (gal.)	2.04		
	jar 1 full - empty (lbs)	5.69				
	jar 2 full - empty (lbs)	5.89				
	jar 3 full - empty (lbs)	5.81				
	filter full - empty (lbs)	0.72				

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/19/03	Run Number	1			
	Fuel Tank I.D. #	H-6			
	Fill Rate (gpm)	10.3	2:04.97 min fill time		
	Total Fuel Dispensed(gal.)	21.8			
	Drive	Yes			
	Weight of drums empty	------lbs---------	n/a	n/a	33.6
	Weight of jars empty	------lbs---------	2.35	2.35	2.35
	Weight of filter empty (lbs)	2.93			
08/19/03	Drain Rate 1 @ start	1.84			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.42			
	Drain Rate 3 @10min	1.16	14 min. from start of drain		
		Drained	20:10.01 min		
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	------lbs---------	n/a	n/a	150.40
	Weight of jars full	------lbs---------	8.11	8.26	8.21
	Weight of filter after use (lbs)	3.62			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.47	
			Total Fuel Drained (lbs)	135.02	
			Gallons drained	20.24	
	drum 3 full - empty (lbs)	116.80	fuel held up (gal.)	1.56	
	jar 1 full - empty (lbs)	5.76			
	jar 2 full - empty (lbs)	5.91			
	jar 3 full - empty (lbs)	5.86			
	filter full - empty (lbs)	0.69			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
09/10/03	Run Number	1			
	Fuel Tank I.D. #	H-7			
	Fill Rate (gpm)	10.9	1:43.34 min fill time		
	Total Fuel Dispensed(gal.)	19.3			
	Drive	Yes			
	Weight of drums empty	----lbs----	n/a	n/a	49.4
	Weight of jars empty	----lbs----	2.36	2.36	2.36
	Weight of filter empty (lbs)	2.93			
08/10/03	Drain Rate 1 @ start	1.94			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.16			
	Drain Rate 3 @10min	0.84	14 min. from start of drain		
		Drained	22:48.86 min		
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	----lbs----	n/a	n/a	155.40
	Weight of jars full	----lbs----	8.22	8.03	8.22
	Weight of filter after use (lbs)	3.63			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.31
		Total Fuel Drained (lbs)	124.09
		Gallons drained	18.60
drum 3 full - empty (lbs)	106.00	fuel held up (gal.)	0.70
jar 1 full - empty (lbs)	5.86		
jar 2 full - empty (lbs)	5.67		
jar 3 full - empty (lbs)	5.86		
filter full - empty (lbs)	0.70		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/02/03	Run Number	1			
	Fuel Tank I.D. #	M916.1			
	Fill Rate (gpm)	21.8	4:10 min (fill time)		
	Total Fuel Dispensed(gal.)	92.8			
	Drive	No			
	Weight of drums empty	------lbs----------	45.72	41.68	n/a
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	3.22			
	Drain Rate 1 @ start	1.47	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.32	(gpm)		
	Drain Rate 3 @10min	1.21	(gpm)		
	Drain Rate 4 @10min	1.05	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	293.4	373.6	@ 86.5 deg F
	Weight of jars full	------lbs----------	8.13	8.04	7.85
	Weight of filter after use	4.92			

Calculations

Net fuel in containers	Result		
drum 1 full - empty (lbs)	247.68	Average Drain Rate (gpm)	1.26
drum 2 full - empty (lbs)	331.92	Total Fuel Drained (lbs)	603.79
jar 1 full - empty (lbs)	5.78	Gallons drained	90.52
jar 2 full - empty (lbs)	5.69	fuel held up (gal.)	2.28
jar 3 full - empty (lbs)	5.50	jar 4 (first gallon drained)	5.52
filter full - empty (lbs)	1.70		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/03/03	Run Number	1			
	Fuel Tank I.D. #	M916.2			
	Fill Rate (gpm)	21.8	4:08 min (fill time)		
	Total Fuel Dispensed(gal)	90.6			
	Drive	Yes			
	Weight of drums empty	------lbs---------	34.95	38.54	n/a
	Weight of jars empty	------lbs---------	2.36	2.35	2.35
	Weight of filter empty	3.65			
06/04/03	Drain Rate 1 @ start	2.52	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.32	(gpm)		
	Drain Rate 3 @10min	1.16	(gpm)		
	Drain Rate 4 @10min	1.00	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs---------	226.00	363.40	@ 78.3 deg F
	Weight of jars full	------lbs---------	7.78	8.29	8.06
	Weight of filter after use	5.29			

Calculations

Net fuel in containers	Result		
drum 1 full - empty (lbs)	191.05	Average Drain Rate (gpm)	1.50
drum 2 full - empty (lbs)	324.86	Total Fuel Drained (lbs)	534.62
jar 1 full - empty (lbs)	5.42	Gallons drained	80.15
jar 2 full - empty (lbs)	5.94	fuel held up(gal)	10.45
jar 3 full - empty (lbs)	5.71		
filter full - empty (lbs)	1.64		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/04/03	Run Number	1			
	Fuel Tank I.D. #	M916.3			
	Fill Rate (gpm)	21.6	4:25 min (fill time)		
	Total Fuel Dispensed(gal)	90.6			
	Drive	Yes			
	Weight of drums empty	------lbs---------	40.40	36.8	n/a
	Weight of jars empty	------lbs---------	2.35	2.35	2.35
	Weight of filter empty	3.63			
08/05/03	Drain Rate 1 @ start	0.89	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	0.73	(gpm)		
	Drain Rate 3 @10min	0.68	(gpm)		
	Drain Rate 4 @10min	0.58	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs---------	276.00	379.40	
	Weight of jars full	------lbs---------	8.10	8.16	7.84
	Weight of filter after use	5.30			

Calculations

Net fuel in containers	Result		
drum 1 full - empty (lbs)	235.6	Average Drain Rate (gpm)	0.72
drum 2 full - empty (lbs)	342.6	Total Fuel Drained (lbs)	596.92
jar 1 full - empty (lbs)	5.75	Gallons drained	89.49
jar 2 full - empty (lbs)	5.81	fuel held up(gal)	1.11
jar 3 full - empty (lbs)	5.49	pounds/gal	6.67
filter full - empty (lbs)	1.67		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/08/03	Run Number	1			
	Fuel Tank I.D. #	M916.4			
	Fill Rate (gpm)	22.1	4:19.71 min (fill time)		
	Total Fuel Dispensed(gal)	94.1			
	Drive	Yes			
	Weight of drums empty	------lbs----------	40.20	47.60	n/a
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	3.63			
08/08/03	Drain Rate 1 @ start	1.51	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	0.89	(gpm)		
	Drain Rate 3 @10min	0.79	(gpm)		
	Drain Rate 4 @10min	0.63	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	297.60	367.40	n/a
	Weight of jars full	------lbs----------	7.99	8.26	8.21
	Weight of filter after use	5.28			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	0.96	
	drum 1 full - empty (lbs)	257.40	Total Fuel Drained (lbs)	596.26	
	drum 2 full - empty (lbs)	319.80	Gallons drained	89.39	
	jar 1 full - empty (lbs)	5.64	fuel held up(gal)	4.71	
	jar 2 full - empty (lbs)	5.91			
	jar 3 full - empty (lbs)	5.86	pounds/gal	6.67	
	filter full - empty (lbs)	1.65			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/08/03	Run Number	1			
	Fuel Tank I.D. #	M916.5			
	Fill Rate (gpm)	21.3	4:22.88 min (fill time)		
	Total Fuel Dispensed(gal	93.0			
	Drive	Yes			
	Weight of drums empty	------lbs---------	35.40	45.80	n/a
	Weight of jars empty	------lbs---------	2.35	2.35	2.35
	Weight of filter empty	3.64			
08/08/03	Drain Rate 1 @ start	1.57	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	0.79	(gpm)		
	Drain Rate 3 @10min	0.73	(gpm)		
	Drain Rate 4 @10min	0.63	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs---------	266.20	388.80	n/a
	Weight of jars full	------lbs---------	8.27	8.14	8.24
	Weight of filter after use	5.26			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	0.93
drum 1 full - empty (lbs)	230.80	Total Fuel Drained (lbs)	593.02
drum 2 full - empty (lbs)	343.00	Gallons drained	88.91
jar 1 full - empty (lbs)	5.92	fuel held up(gal)	4.09
jar 2 full - empty (lbs)	5.79		
jar 3 full - empty (lbs)	5.89	pounds/gal	6.67
filter full - empty (lbs)	1.62		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/19/03	Run Number	1			
	Fuel Tank I.D. #	M916.6			
	Fill Rate (gpm)	21.3	4:24.32 min (fill time)		
	Total Fuel Dispensed(gal	92.7			
	Drive	Yes			
	Weight of drums empty	------lbs---------	33.40	43.40	n/a
	Weight of jars empty	------lbs---------	2.36	2.35	2.35
	Weight of filter empty	3.64			
08/19/03	Drain Rate 1 @ start	1.47	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	0.00	(gpm)		
	Drain Rate 3 @10min	0.00	(gpm)		
	Drain Rate 4 @10min	0.00	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs---------	370.80	273.60	n/a
	Weight of jars full	------lbs---------	7.98	8.21	7.86
	Weight of filter after use	5.28			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	0.37
drum 1 full - empty (lbs)	337.40	Total Fuel Drained (lbs)	586.23
drum 2 full - empty (lbs)	230.20	Gallons drained	87.89
jar 1 full - empty (lbs)	5.62	fuel held up(gal)	4.81
jar 2 full - empty (lbs)	5.86		
jar 3 full - empty (lbs)	5.51	pounds/gal	6.67
filter full - empty (lbs)	1.64		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
09/10/03	Run Number	1			
	Fuel Tank I.D. #	M916.7			
	Fill Rate (gpm)	21.8	4:06.81 min (fill time)		
	Total Fuel Dispensed(gal	87.8			
	Drive	Yes			
	Weight of drums empty	------lbs----------	37.80	47.80	n/a
	Weight of jars empty	------lbs----------	2.36	2.35	2.35
	Weight of filter empty	3.64			
09/10/03	Drain Rate 1 @ start	1.84	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.00	(gpm)		
	Drain Rate 3 @10min	0.89	(gpm)		
	Drain Rate 4 @10min	0.73	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	248.20	371.00	n/a
	Weight of jars full	------lbs----------	8.14	8.47	8.14
	Weight of filter after use	5.25			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.12
drum 1 full - empty (lbs)	210.40	Total Fuel Drained (lbs)	552.90
drum 2 full - empty (lbs)	323.20	Gallons drained	82.89
jar 1 full - empty (lbs)	5.78	fuel held up(gal)	4.91
jar 2 full - empty (lbs)	6.12		
jar 3 full - empty (lbs)	5.79	pounds/gal	6.67
filter full - empty (lbs)	1.61		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/02/03	Run Number	2			
	Fuel Tank I.D. #	H1			
	Fill Rate (gpm)	10.3	2:05 (fill time)		
	Total Fuel Dispensed (gal.)	21.5	(calc of rate*time)		
	Drive	No			
	Weight of drums empty	------lbs----------	n/a	n/a	35.85
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	2.93			
	Drain Rate 1 @ start	1.42	4:00 PM		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.26	4:10 PM		
	Drain Rate 3 @16min	1.47	4:16 PM		
	17.25 min. to drain	Drained	4:17:13 PM		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	n/a	n/a	158.40
	Weight of jars full	------lbs----------	8.00	7.92	7.80
	Weight of filter after use	3.64			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.38	
			Total Fuel Drained (lbs)	139.93	
			Gallons drained	20.98	
	drum 3 full - empty (lbs)	122.55	fuel held up (gal.)	0.52	
	jar 1 full - empty (lbs)	5.65			
	jar 2 full - empty (lbs)	5.57			
	jar 3 full - empty (lbs)	5.45			
	filter full - empty (lbs)	0.71			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/12/03	Run Number	2			
	Fuel Tank I.D. #	H2			
	Fill Rate (gpm)	10.3	2:05 (fill time)		
	Total Fuel Dispensed(gal.)	20.9			
	Drive	No			
	Weight of drums empty	------lbs----------	n/a	n/a	45.8
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	2.93			
	Drain Rate 1 @ start	1.37	3:38 PM		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.10	3:48 PM		
	Drain Rate 3 @10min	0.95	3:52 PM		
	16.0 min. to drain	Drained	3:54:00 PM		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	n/a	n/a	164.00
	Weight of jars full	------lbs----------	7.90	7.89	8.25
	Weight of filter after use	3.64			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.14	
			Total Fuel Drained (lbs)	135.90	
			Gallons drained	20.37	
	drum 3 full - empty (lbs)	118.2	fuel held up (gal.)	0.53	
	jar 1 full - empty (lbs)	5.55			
	jar 2 full - empty (lbs)	5.54			
	jar 3 full - empty (lbs)	5.90			
	filter full - empty (lbs)	0.71			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/06/03	Run Number	2			
	Fuel Tank I.D. #	H3			
	Fill Rate (gpm)	10.3	2:03.44 min fill time		
	Total Fuel Dispensed(gal.)	21.4			
	Drive	No			
	Weight of drums empty	----lbs----	n/a	n/a	48
	Weight of jars empty	----lbs----	2.35	2.35	2.35
	Weight of filter empty (lbs)	2.93			
08/06/03	Drain Rate 1 @ start	1.47			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.32			
	Drain Rate 3 @10min	0.95	14 min. from start of drain		
	23.07 min. to drain	Drained			
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	----lbs----	n/a	n/a	170.00
	Weight of jars full	----lbs----	7.92	7.83	7.94
	Weight of filter after use (lbs)	3.64			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.25
		Total Fuel Drained (lbs)	139.35
		Gallons drained	20.89
drum 3 full - empty (lbs)	122.00	fuel held up (gal.)	0.51
jar 1 full - empty (lbs)	5.57		
jar 2 full - empty (lbs)	5.48		
jar 3 full - empty (lbs)	5.59		
filter full - empty (lbs)	0.71		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/08/03	Run Number	2			
	Fuel Tank I.D. #	H4			
	Fill Rate (gpm)	9.8	2:08.84 min fill time		
	Total Fuel Dispensed(gal.)	20.8			
	Drive	No			
	Weight of drums empty	——lbs——	n/a	n/a	49.00
	Weight of jars empty	——lbs——	2.36	2.35	2.36
	Weight of filter empty (lbs)	2.94			
08/08/03	Drain Rate 1 @ start	2.21			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.52			
	Drain Rate 3 @10min	1.32	14 min. from start of drain		
	Time to drain 20min. 18sec.	Drained			
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	——lbs——	n/a	n/a	167.60
	Weight of jars full	——lbs——	7.94	8.01	7.53
	Weight of filter after use (lbs)	3.63			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.68	
			Total Fuel Drained (lbs)	135.70	
			Gallons drained	20.34	
	drum 3 full - empty (lbs)	118.60	fuel held up (gal.)	0.46	
	jar 1 full - empty (lbs)	5.58			
	jar 2 full - empty (lbs)	5.66			
	jar 3 full - empty (lbs)	5.17			
	filter full - empty (lbs)	0.69			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/18/03	Run Number	2			
	Fuel Tank I.D. #	H5			
	Fill Rate (gpm)	10.9	1:56.69 min fill time		
	Total Fuel Dispensed(gal.)	20.3			
	Drive	No			
	Weight of drums empty	------lbs-------	n/a	n/a	46.20
	Weight of jars empty	------lbs-------	2.36	2.36	2.36
	Weight of filter empty (lbs)	2.93			
08/18/03	Drain Rate 1 @ start	1.84			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.57			
	Drain Rate 3 @10min	1.10	14 min. from start of drain		
	Time to drain 20min. 43sec.	Drained			
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	------lbs-------	n/a	n/a	160.80
	Weight of jars full	------lbs-------	8.15	8.12	8.09
	Weight of filter after use (lbs)	3.64			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.50	
			Total Fuel Drained (lbs)	132.59	
			Gallons drained	19.88	
	drum 3 full - empty (lbs)	114.60	fuel held up (gal.)	0.42	
	jar 1 full - empty (lbs)	5.79			
	jar 2 full - empty (lbs)	5.76			
	jar 3 full - empty (lbs)	5.73			
	filter full - empty (lbs)	0.71			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
09/09/03	Run Number	2			
	Fuel Tank I.D. #	H6			
	Fill Rate (gpm)	10.9	1:49.63 min fill time		
	Total Fuel Dispensed(gal.)	20.7			
	Drive	No			
	Weight of drums empty	------lbs----------	n/a	n/a	42.60
	Weight of jars empty	------lbs----------	2.36	2.36	2.35
	Weight of filter empty (lbs)	2.93			
09/09/03	Drain Rate 1 @ start	1.68			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.21			
	Drain Rate 3 @10min	0.89	14 min. from start of drain		
	Time to drain 23min. 0sec.	Drained			
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	------lbs----------	n/a	n/a	159.40
	Weight of jars full	------lbs----------	7.77	8.06	8.18
	Weight of filter after use (lbs)	3.63			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.26	
			Total Fuel Drained (lbs)	134.44	
			Gallons drained	20.16	
	drum 3 full - empty (lbs)	116.80	fuel held up (gal.)	0.54	
	jar 1 full - empty (lbs)	5.41			
	jar 2 full - empty (lbs)	5.70			
	jar 3 full - empty (lbs)	5.83			
	filter full - empty (lbs)	0.70			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
09/11/03	Run Number	2			
	Fuel Tank I.D. #	H7			
	Fill Rate (gpm)	10.9	1:45.31 min fill time		
	Total Fuel Dispensed(gal.)	19.0			
	Drive	No			
	Weight of drums empty	------lbs-------	n/a	n/a	39.60
	Weight of jars empty	------lbs-------	2.36	2.36	2.36
	Weight of filter empty (lbs)	3.20			
09/11/03	Drain Rate 1 @ start	1.42			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.00			
	Drain Rate 3 @10min	0.89	14 min. from start of drain		
	Time to drain 21min. 1sec.	Drained			
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	------lbs-------	n/a	n/a	145.60
	Weight of jars full	------lbs-------	8.21	8.24	8.27
	Weight of filter after use (lbs)	3.53			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.10	
			Total Fuel Drained (lbs)	123.97	
			Gallons drained	18.59	
	drum 3 full - empty (lbs)	106.00	fuel held up (gal.)	0.41	
	jar 1 full - empty (lbs)	5.85			
	jar 2 full - empty (lbs)	5.88			
	jar 3 full - empty (lbs)	5.91			
	filter full - empty (lbs)	0.33			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/02/03	Run Number	2			
	Fuel Tank I.D. #	M916.1			
	Fill Rate (gpm)	21.8	4:23 min (fill time)		
	Total Fuel Dispensed(gal)	93.8			
	Drive	No			
	Weight of drums empty	------lbs----------	34.10	50.17	n/a
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	3.63			
	Drain Rate 1 @ start	1.52	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.32	(gpm)		
	Drain Rate 3 @10min	1.21	(gpm)		
	Drain Rate 4 @10min	1.10	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	276.4	393.2	@ 86.5 deg F
	Weight of jars full	------lbs----------	7.95	7.86	7.92
	Weight of filter after use	5.30			
	Calculations				
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.29	
	drum 1 full - empty (lbs)	242.3	Total Fuel Drained (lbs)	603.68	
	drum 2 full - empty (lbs)	343.03	Gallons drained	90.51	
	jar 1 full - empty (lbs)	5.6	fuel held up (gal)	3.29	
	jar 2 full - empty (lbs)	5.51			
	jar 3 full - empty (lbs)	5.57			
	filter full - empty (lbs)	1.67			

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
06/12/03	Run Number	2			
	Fuel Tank I.D. #	M916.2			
	Fill Rate (gpm)	21.8	4:01 min (fill time)		
	Total Fuel Dispensed(gal)	83.6			
	Drive	No			
	Weight of drums empty	------lbs----------	34.40	37.2	n/a
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	3.61			
06/04/03	Drain Rate 1 @ start	1.42	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.32	(gpm)		
	Drain Rate 3 @10min	1.16	(gpm)		
	Drain Rate 4 @10min	1.05	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	257.80	344.40	@ 94.2 deg F
	Weight of jars full	------lbs----------	8.00	8.21	7.94
	Weight of filter after use	5.30			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.24
drum 1 full - empty (lbs)	223.4	Total Fuel Drained (lbs)	549.39
drum 2 full - empty (lbs)	307.2	Gallons drained	82.37
jar 1 full - empty (lbs)	5.65	fuel held up(gal)	1.23
jar 2 full - empty (lbs)	5.86		
jar 3 full - empty (lbs)	5.59		
filter full - empty (lbs)	1.69		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3	
08/06/03	Run Number	2				
	Fuel Tank I.D. #	M916.3				
	Fill Rate (gpm)	20.7	4:29 min (fill time)			
	Total Fuel Dispensed(gal)	91.7				
	Drive	No				
	Weight of drums empty	------lbs---------	37.60	46.20	n/a	
	Weight of jars empty	------lbs---------	2.35	2.35	2.35	
	Weight of filter empty	3.63				
08/06/03	Drain Rate 1 @ start	0.95	(gpm)			
	1 Gal. Drain Sample					
	1 Gal. Drain Sample					
	Drain Rate 2 @10min	0.84	(gpm)			
	Drain Rate 3 @10min	0.68	(gpm)			
	Drain Rate 4 @10min	0.63	(gpm)			
	1 Gal. Drain Sample					
	Weight of drums w/fuel	------lbs---------	340.80	321.20		
	Weight of jars full	------lbs---------	7.75	7.87	7.91	
	Weight of filter after use	5.33				

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	0.78
drum 1 full - empty (lbs)	303.20	Total Fuel Drained (lbs)	596.38
drum 2 full - empty (lbs)	275.00	Gallons drained	89.41
jar 1 full - empty (lbs)	5.40	fuel held up(gal)	2.29
jar 2 full - empty (lbs)	5.52		
jar 3 full - empty (lbs)	5.56	pounds/gal	6.67
filter full - empty (lbs)	1.70		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2
08/08/03	Run Number	2		
	Fuel Tank I.D. #	M916.4		
	Fill Rate (gpm)	21.0	4:16.71 min (fill time)	
	Total Fuel Dispensed(gal)	90.1		
	Drive	No		
	Weight of drums empty	------lbs----------	39.20	47.00
	Weight of jars empty	------lbs----------	2.35	2.36
	Weight of filter empty	3.64		
08/08/03	Drain Rate 1 @ start	1.84	(gpm)	
	1 Gal. Drain Sample			
	1 Gal. Drain Sample			
	Drain Rate 2 @10min	0.89	(gpm)	
	Drain Rate 3 @10min	0.89	(gpm)	
	Drain Rate 4 @10min	0.79	(gpm)	
	1 Gal. Drain Sample			
	Weight of drums w/fuel	------lbs----------	273.20	384.20
	Weight of jars full	------lbs----------	7.74	8.24
	Weight of filter after use	5.26		
	Calculations			
	Net fuel in containers	Result	Average Drain Rate (gpm)	1.10
	drum 1 full - empty (lbs)	234.00	Total Fuel Drained (lbs)	589.79
	drum 2 full - empty (lbs)	337.20	Gallons drained	88.42
	jar 1 full - empty (lbs)	5.39	fuel held up(gal)	1.68
	jar 2 full - empty (lbs)	5.88		
	jar 3 full - empty (lbs)	5.70	pounds/gal	6.67
	filter full - empty (lbs)	1.62		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/18/03	Run Number	2			
	Fuel Tank I.D. #	M916.5			
	Fill Rate (gpm)	21.3	4:21.75 min (fill time)		
	Total Fuel Dispensed(gal	90.1			
	Drive	No			
	Weight of drums empty	------lbs----------	38.40	35.40	n/a
	Weight of jars empty	------lbs----------	2.35	2.36	2.35
	Weight of filter empty	3.63			
08/18/03	Drain Rate 1 @ start	1.52	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	0.73	(gpm)		
	Drain Rate 3 @10min	0.73	(gpm)		
	Drain Rate 4 @10min	0.68	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	373.40	269.00	n/a
	Weight of jars full	------lbs----------	8.06	8.05	8.21
	Weight of filter after use	5.09			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	0.92
drum 1 full - empty (lbs)	335.00	Total Fuel Drained (lbs)	587.32
drum 2 full - empty (lbs)	233.60	Gallons drained	88.05
jar 1 full - empty (lbs)	5.71	fuel held up(gal)	2.05
jar 2 full - empty (lbs)	5.69		
jar 3 full - empty (lbs)	5.86	pounds/gal	6.67
filter full - empty (lbs)	1.46		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
09/09/03	Run Number	2			
	Fuel Tank I.D. #	M916.6			
	Fill Rate (gpm)	21.3	4:25.19 min (fill time)		
	Total Fuel Dispensed(gal	91.1			
	Drive	No			
	Weight of drums empty	------lbs----------	33.60	45.20	n/a
	Weight of jars empty	------lbs----------	2.35	2.35	2.36
	Weight of filter empty	3.63			
09/09/03	Drain Rate 1 @ start	1.32	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	1.16	(gpm)		
	Drain Rate 3 @10min	1.05	(gpm)		
	Drain Rate 4 @10min	0.95	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	378.60	276.20	n/a
	Weight of jars full	------lbs----------	8.26	8.30	8.17
	Weight of filter after use	5.23			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.12
drum 1 full - empty (lbs)	345.00	Total Fuel Drained (lbs)	595.27
drum 2 full - empty (lbs)	231.00	Gallons drained	89.25
jar 1 full - empty (lbs)	5.91	fuel held up(gal)	1.85
jar 2 full - empty (lbs)	5.95		
jar 3 full - empty (lbs)	5.81	pounds/gal	6.67
filter full - empty (lbs)	1.60		

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
09/11/03	Run Number	2			
	Fuel Tank I.D. #	M916.7			
	Fill Rate (gpm)	21.8	3:57.59 min (fill time)		
	Total Fuel Dispensed(gal	84.4			
	Drive	No			
	Weight of drums empty	------lbs----------	42.60	44.20	n/a
	Weight of jars empty	------lbs----------	2.35	2.35	2.35
	Weight of filter empty	3.64			
09/11/03	Drain Rate 1 @ start	1.1	(gpm)		
	1 Gal. Drain Sample				
	1 Gal. Drain Sample				
	Drain Rate 2 @10min	0.89	(gpm)		
	Drain Rate 3 @10min	0.84	(gpm)		
	Drain Rate 4 @10min	0.79	(gpm)		
	1 Gal. Drain Sample				
	Weight of drums w/fuel	------lbs----------	362.20	256.80	n/a
	Weight of jars full	------lbs----------	8.28	8.21	8.22
	Weight of filter after use	5.33			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	0.91
drum 1 full - empty (lbs)	319.60	Total Fuel Drained (lbs)	551.55
drum 2 full - empty (lbs)	212.60	Gallons drained	82.69
jar 1 full - empty (lbs)	5.93	fuel held up(gal)	1.71
jar 2 full - empty (lbs)	5.86		
jar 3 full - empty (lbs)	5.87	pounds/gal	6.67
filter full - empty (lbs)	1.69		

ADMF Testing Run Sheet

Date	Required Step	Reading	Technician Notes
	Run Number		
	Fuel Tank I.D. #		
	Fill Rate		
	Total Fuel Dispensed		
	Drive	Yes / No	
	Weight of drums empty	------------------	1.) lbs. 2.) lbs. 3.) lbs.
	Weight of jars empty	------------------	1.) lbs. 2.) lbs. 3.) lbs.
	Weight of filter empty	lbs.	
	Drain Rate 1 @ start		
	1 Gal. Drain Sample		for lab filtration (0.7 mic.)
	1 Gal. Drain Sample		gravity through equivalent filter / lab
	Drain Rate 2 @10min		
	Drain Rate 3 @10min		
	Drain Rate 4 @10min		
	1 Gal. Drain Sample		for lab filtration (0.7 mic.) estimate 1/2 drained
	Weight of drums w/fuel	------------------	1.) lbs. 2.) lbs. 3.) lbs.
	Weight of jars full	------------------	1.) lbs. 2.) lbs. 3.) lbs.
	Weight of filter after use	lbs.	
	Total Fuel Drained	lbs.	(all containers w/fuel)minus (all empty containers)

						Weights	before	fuel
Freightliner	Tank Serial Number	ADMF AL#	Manufacturer	Fuel AL#	Empty (lb)	Full (lb)	ADMF (lb)	% of increase
M916.1	M.916.1	None	None	AL-26936-F	61.6	n/a	n/a	n/a
M916.2	M.916.2	AL-26941-MF	SuppressX	AL-26936-F	61.6	140.00	78.4	127%
M916.3	M.916.3	AL-26942-MF	DetoStop	AL-26936-F	61.6	87.00	25.4	41%
M916.4	M.916.4	AL-27000-MF	Foamex Intl.	AL-26936-F	61.6	72.60	11	18%
M916.5	M.916.5	AL-26991-MF	FireXX	AL-26936-F	61.6	89.60	28.0	45%
M916.6	M.916.6	AL-26997-MF	ADI Tech.	AL-26936-F	61.6	145.00	83.4	135%
M916.7	M.916.7	AL-26998-MF	Safety Pacs	AL-26936-F	61.6	220.80	159.2	258%
						Weights	before	fuel
Hummer	Tank Serial Number	ADMF AL#	Manufacturer	Fuel AL#	Empty (lb)	Full (lb)	ADMF (lb)	% of increase
H-1	41662-2 (H-1)	None	None	AL-26936-F	23.2	n/a	n/a	n/a
H-2	41672-2 (H-2)	AL-26941-MF	SuppressX	AL-26936-F	23.2	37.0	13.8	59%
H-3	41675-2 (H-3)	AL-26942-MF	DetoStop	AL-26936-F	23.2	30.0	6.8	29%
H-4	42138-3 (H-4)	AL-27000-MF	Foamex Intl.	AL-26936-F	23.2	26.4	3.2	14%
H-5	42142-3 (H-5)	AL-26991-MF	FireXX	AL-26936-F	23.2	32.6	9.4	41%
H-6	42143 (H-6)	AL-26997-MF	ADI Tech.	AL-26936-F	23.2	42.2	19.0	82%
H-7	42146-3 (H-7)	AL-26998-MF	Safety Pacs	AL-26936-F	23.2	60.6	37.4	161%

ADMF Testing Run Sheet

Date	Required Step	Reading	1	2	3
08/08/03	Run Number	1			
	Fuel Tank I.D. #	H4			
	Fill Rate (gpm)	9.8	2:16.12 min fill time		
	Total Fuel Dispensed(gal.)	22.3			
	Drive	Yes			
	Weight of drums empty	------lbs-------	n/a	n/a	69.6
	Weight of jars empty	------lbs-------	2.34	2.35	2.35
	Weight of filter empty (lbs)	2.93			
08/08/03	Drain Rate 1 @ start	1.57			
	1 Gal. Drain Sample		lab filter		
	1 Gal. Drain Sample		gravity through filter/lab sample		
	Drain Rate 2 @10min	1.37			
	Drain Rate 3 @10min	1.10	14 min. from start of drain		
		Drained			
	1 Gal. Drain Sample		lab filter		
	Weight of drums w/fuel	------lbs-------	n/a	n/a	185.00
	Weight of jars full	------lbs-------	8.10	7.96	8.29
	Weight of filter after use (lbs)	3.60			

Calculations			
Net fuel in containers	Result	Average Drain Rate (gpm)	1.35
		Total Fuel Drained (lbs)	133.38
		Gallons drained	20.00
drum 3 full - empty (lbs)	115.40	fuel held up (gal.)	2.30
jar 1 full - empty (lbs)	5.76		
jar 2 full - empty (lbs)	5.61		
jar 3 full - empty (lbs)	5.94		
filter full - empty (lbs)	0.67		