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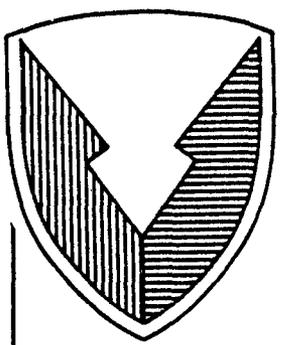
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C E N T E R

Technical Report



No. 13376

STERLING TECHNOLOGY ULTRA-PURE FILTERED DIESEL FUEL

MAY 1988

E.C. Adams
U.S. Army Tank-Automotive Command
ATTN: AMSTA-RGRD
Warren, MI 48397-5000

By _____

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U.S. ARMY TANK-AUTOMOTIVE COMMAND
RESEARCH, DEVELOPMENT & ENGINEERING CENTER
Warren, Michigan 48397-5000



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PREFACE

Mr. Stan Jordan, of Sterling Technology, Inc., Jacksonville, Florida, contacted the Diesel Engine Research Section of the U.S. Army Tank-Automotive Command (TACOM) regarding Sterling's Ultra-Pure Fuel Filtration Process. The claim for this filtration was that diesel fuel run through this process resulted in passenger car diesel engines running much cleaner, and M60 National Guard tanks at Camp Blanding, Florida with deteriorated engines noticeably improving in performance after running for a period of time on the treated fuel.

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1.0 INTRODUCTION

This report, prepared by the Diesel Engine Research Section, Tank-Automotive Technology Directorate, of the U. S. Army Tank-Automotive Command (TACOM), details testing done on ultra-pure filtered diesel fuel and unfiltered diesel fuel.

Several barrels of filtered fuel, shipped from the manufacturer--Sterling Technology, Inc., Jacksonville, Florida--had been tested using the 690-in.³ Deutz F-8L-413A Air Cooled V8 Engine. No significant difference had been found, but due to a delay in starting the tests it was suspected that some deterioration might have occurred in the fuel.

To perform a more controlled test, a new contract was awarded to Sterling Technology to bring the fuel filtration apparatus to TACOM, in order to run comparative tests with TACOM DF-2 fuel in the as-received and in the treated conditions.

2.0 OBJECTIVE

The objective was to investigate the possible benefits of the ultra-pure filtered diesel fuel in power improvement and reduction of exhaust smoke.

3.0 CONCLUSIONS

With a Cummins VTA903 laboratory engine in good condition, the ultra-pure filtered fuel gave no significant power increase or reduction of exhaust smoke.

A comparative analysis by the Fort Belvoir Fuels and Lubricants Research Facility (BFLRF), at the Southwest Research Institute, of standard DF-2 diesel fuel and the ultra-pure filtered DF-2 showed no significant differences in physical or chemical properties except that the filtered fuel showed a marked reduction in particulate contaminants (see Appendix A).

A sample of the sandlike material that is deposited in the ultra-pure precipitator was sent to the BFLRF for analysis. After fine filtering and examination with optical microscope and scanning electron microscope/energy dispersive analysis of x-rays, elemental analysis showed small amounts of iron, silicon, aluminum, zinc, chlorine, calcium and copper with some of this occurring in rust and dirt particles (see Appendix B).

In 1985 the U.S. Army Natick Research and Development Center, Natick, Mass., tested standard DF-2 and ultra-pure fuel for microbiological susceptibility. It was concluded that the ultra-pure filtration did not retard microbiological growth (see Appendix C).

A review of literature on the Sterling Electrostatic Filtering Device and an analysis of diesel fuel samples were made by the U.S. Army Belvoir Research and Development Center in 1984. It was concluded that no changes had occurred in the fuel composition due to the filtration (see Appendix D).

4.0 RECOMMENDATION

It is recommended that no further work be done with the ultra-pure filtered fuel.

5.0 DISCUSSION

The fuel filter processing rig was delivered to the TACOM on 21 Sep 87.

The filtering rig is arranged as follows:

(1) An electric motor driven pump is used to circulate about 10 gallons of fuel per minute.

(2) The first filter (about a 7-gallon volume) is a standard mechanical filter.

(3) The second filter (same size) contains a water absorbing medium at the bottom.

(4) The fuel passes through two electrostatic precipitators of 35 gallons each. A 17,000 dc voltage is applied to alternate plates. Current flow with virgin fuel is several milliamps. A sandlike material, precipitated from the fuel, is deposited on the plates (see Appendix B).

(5) The fuel is circulated through the system several times, until the current comes down to one milliamp.

A clean, 300-gallon tank was located outside the building next to cell 6, Building 212, TACOM. Standard DF-2 diesel fuel from the laboratory fuel system was used to nearly fill the tank, and then the ultra-pure filter rig was hooked up to process the fuel in the tank.

The Cummins V8 VTA 903T engine in cell 6 had been run about 460 hours on general laboratory test and was in good condition. Two full rack power runs were made using standard TACOM DF-2 diesel fuel, as shown in Table 5-1, for a baseline.

Then a run-in was begun using the TACOM DF-2 fuel that had been run through the Sterling filter-precipitation process. A representative of Sterling had stated that the full benefit of the filtered fuel would be more apparent after 20 hours of engine operation. Four full rack power runs were made starting after 12.1 hours of run-in.

Table 5-1. VTA-903T Engine 11053470, Full Rack Power Runs in Cell 6

	<u>2600 RPM</u>			<u>PEAK TORQUE</u>		
	<u>BHP</u>	<u>BSFC</u>	<u>CC Pres. in.H₂O</u>	<u>#FT @2200</u>	<u>BFSC</u>	<u>CC Pres.</u>
9/17/87 First Run TACOM DF-2 Fuel	493	.378	2.8	993	.363	1.9
9/22/87 Second Run TACOM DF-2 Fuel	490	.385	2.6	996	.363	1.6
9/23/87 12.1 Hours running on Ultra-Pure Filtered DF-2	497	.376	2.1	1003	.359	2.3
9/24/87/ 17 Hours running on Ultra-Pure Filtered DF-2	497	.377	2.9	999	.361	1.4
9/24/87 Afternoon 20 Hours running on Ultra-Pure Filtered DF-2	495	.380	2.3	1003	.360	1.0
9/25/87 22 Hours running on Ultra-Pure Filtered DF-2	492	.380	2.6	1001	.360	2.1

BSFC - Brake specific Fuel Consumption in pounds per HP hour

CC Pres. - Crankcase pressure in inches of water--a measure of blowby past pistons and rings

The results show about 1 percent variation in the peak horsepower with the ultra-pure filtered fuel and the difference between the filtered fuel and the standard DF-2 fuel is less than 1 percent, resulting in an overlap in the results. It is concluded that there was no significant difference in the power output with the two fuels. The engine had run 22 hours on the ultra-pure fuel.

Later, when smoke readings were attempted, not enough of the filtered fuel remained and a drum of filtered fuel was shipped from Sterling. Table 5-2 shows the results of the exhaust smoke test using Sterling filtered fuel and TACOM DF-2 fuel. Three runs were made with the Sterling fuel (the smoke meter malfunctioned on the first run). The density of these two fuels was checked at TACOM and is shown on Table 5-2. The .852 reading for DF-2 agrees with the BFLRF results. The higher density .861 for the Sterling fuel should give about one half of one percent lower heating value, and would account for the power difference. The filtered fuel showed no reduction in smoke.

During the earlier evaluation of ultra-pure filtered fuel in 1985 samples were sent to the U.S. Army Natick Research and Development Center. Included is a copy of their report of 11 Sep 85 (see Appendix C). It was concluded that the ultra-pure filtering process did not retard microbial growth in the fuel.

Also included are copies of the BLFRF evaluation made on Sterling Technology filtered fuel samples in 1984. In this analysis it was concluded that no changes had occurred in the fuel composition due to the filtration (see Appendix D).

Table 5-2. Cummins VTA-903T 11053470 Engine, Smoke Checks on Ultra-Pure DF-2 and Standard DF-2 Fuel

DATE	MAX BHP	MAX TORQUE	SMOKE READING - PERCENT OPACITY - FULL RACK	FUEL
After Approx. 24 Hrs Running on Ultra-Pure DF-2 Fuel	@ 2600 RPM BFSC	@ 2200 RPM BFSC	2600 2400 2000 1800 1600 1400	
11/22/87	497 .384	1019 .366	--- --- --- --- ---	Ultra-Pure * DF-2 Sterling
11/13/87 morning	498 .384	1018 .360	3.4 2.8 3.1 4.0 6.2 10.3 18.7	Ultra-Pure * Sterling
11/13/87 afternoon	498 .380	1017 .365	2.7 2.2 2.4 3.2 5.8 9.4 17.9	Ultra-Pure * Sterling
11/18/87	Run 2 Hours on DF-2 Fuel 1 Hour - 1600 RPM 150 BHP 1 Hour - 2000 RPM 300 BHP			Standard TACOM DF-2 Fuel +
11/18/87	500 .375	1025 .354	2.3 1.9 2.2 3.2 5.3 9.0 16.9	DF-2 +
11/19/87 morning	499 .376	1027 .359	1.9 1.7 2.1 2.8 5.1 8.7 15.9	DF-2 +
11/19/87 afternoon	501 .378	1024 .360	2.0 1.7 1.9 2.9 5.1 8.7 16.0	DF-2 +

* Sterling Ultra-Pure Filtered Fuel - Density .861
+ TACOM Standard DF-2 Fuel - Density .852

APPENDIX A

ANALYSIS OF STANDARD DF-2 AND "ULTRA PURE" FILTERED DF-2 FUELS

BELVOIR FUELS AND LUBRICANTS RESEARCH FACILITY (SwRI)

6220 CULEBRA ROAD-P.O. DRAWER 28510

PH: (512) 684-5111

SAN ANTONIO, TEXAS 78284

BFLRF

File: 02-1955-130

27 October 1987

Commander
U.S. Army Tank-Automotive Command (TACOM)
Attn: AMSTA-RGRD, Mr. E.C. Adams
Warren, Michigan 48397-5000

Subject: Analysis of Standard DF-2 and "Ultra Pure" Filtered DF-2 Fuels

Dear Sir:

Two 1-gallon samples each of fuels designated standard DF-2 and "Ultra Pure" filtered DF-2 were received from TACOM. The latter was reportedly filtered with a high-voltage precipitation process developed by Sterling Technology, Inc., of Jacksonville, Florida. As requested, the samples were analyzed for conformance to requirements of Federal Specification VV-F-800D, Fuel Oil, Diesel, Grade DF-2, and the results are presented in the enclosed TABLE 1.

There are no major differences between the properties of the two samples. The standard sample had considerably more particulate contaminants than the filtered sample, indicating that the process did remove contaminants from the fuel. There was a slight reduction in the net heat of combustion for the filtered fuel. All the other properties remained virtually the same after the high-voltage filtration process.

Please call if you have any questions on this matter.

Very truly yours,

S.J. Lestz
Director



John N. Bowden
Staff Scientist

SJL/JNB/lap
(JNB2.GG)

Enclosure

cf: U.S. Army Belvoir Research, Development and Engineering Center, Attn:
STRBE-VF, Mr. M.E. LePera
U.S. Army Tank-Automotive Command, Attn: AMSTA-RGE (Mr. J. Lewakowski)
Belvoir Fuels and Lubricants Research Facility (SwRI), Attn: Mr. L.L. Stavinoha

TABLE 1. Properties of DF-2 and "Ultra Pure" DF-2

Properties	ASTM Test	VV-F-800D DF-2 Requirements	Values	
			Standard DF-2 AL-16773-F	Ultra Pure AL-16772-F
Density, kg/L at 15°C	D 1298	Report	0.8525	0.8545
Gravity, °API	D 1298	NR*	34.0	34.4
Flash Point, °C	D 93	52 min	64	63
Cloud Point, °C	D 2500	**	-18	-17
Pour Point, °C	D 97	Report	-21	-20
Kin. Vis. at 40°C, cSt	D 445	1.9 to 4.1	2.64	2.60
Distillation, °C	D 86			
IBP		NR	189	188
10% Recovered		NR	218	218
50% Recovered		NR	260	261
90% Recovered		338 max	324	322
End Point		370 max	360	358
Carbon Residue on 10% Bottoms, mass%	D 524	0.35 max	0.15	0.15
Sulfur, mass%	D 2622	0.50 max	0.23	0.22
Copper Strip Corrosion, 3 hr. at 50°C, rating	D 130	1 max	1A	1A
Ash, mass%	D 482	0.01 max	<0.01	<0.01
Accelerated Stability, Total Insolubles, mg/100 mL	D 2274	1.5 max	1.3	1.0
Particulate Contaminants, mg/L	D 2276	10 max	12.8	1.4
Cetane Number	D 613	40 min	45.2	44.7
Net Heat of Combustion, mJ/kg	D 4529	NR	42.561	42.471
Btu/lb		NR	18,298	18,259
Carbon, mass%	D 1378	NR	86.46	86.51
Hydrogen, mass%	D 1378	NR	12.83	12.82

* NR = No Requirement.

** Cloud point requirement is based on guidance in Appendix A of VV-F-800D.

APPENDIX B

ANALYSIS OF RESIDUE FROM "ULTRA PURE" FILTRATION PROCESS OF DP-2

BELVOIR FUELS AND LUBRICANTS RESEARCH FACILITY (SwRI)

6220 CULEBRA ROAD—P.O.DRAWER 28510 PH:512-684-5111 SAN ANTONIO, TEXAS 78284

BFLRF

File: 02-1955-180

31 March 1988

Commander
U.S. Army Tank-Automotive
Command (TACOM)
Attn: AMSTA-RGRD, Mr. E.C. Adams
Warren, Michigan 48397-5000

Subject: Analysis of Residue From "Ultra Pure" Filtration Process of DF-2

Reference: Letter From BFLRF to AMSTA-RGRD, 27 October 1987, Subject: Analysis of Standard DF-2 and "Ultra Pure" Filtered DF-2

Dear Sir:

On 17 March 1988, a 4-oz. bottle containing a small amount of what appeared to be diesel fuel with a considerable quantity of insoluble residue, was received at Belvoir Fuels and Lubricants Research Facility (BFLRF) at Southwest Research Institute (SwRI). The DD form 1222 that accompanied the sample stated that "'Ultra Pure' filtered fuel was processed through a high voltage precipitator. This sample is the precipitate that accumulates in the precipitator during the filtering of DF-2 diesel fuel. Please analyze for what might be learned about this process."

Analysis of the sample consisted of filtering an aliquot, after stirring to get the residue in suspension, through a 0.45 μm membrane filter, then analyzing the residue with an X-ray fluorescence spectrograph for predominant elements, followed by examination through an optical microscope and a scanning electron microscope/energy dispersive analysis of X-rays (SEM/EDAX) to identify the nature of the residue. The referenced letter contains data for the DF-2 fuel before and after processing in the high voltage precipitator.

The elemental analysis results were:

<u>Element</u>	<u>wt%</u>
Al	0.93
Si	1.35
Cl	0.10
Ca	0.07
Fe	2.67
Zn	0.14
Cu	0.01

For the SEM analysis, two filters were supplied, one with heavy deposit weight, the second with less weight. The SEM/EDAX and the bulk X-ray analysis were both performed on the lighter weight filter. Both filters were scanned by optical microscope.

AMSTA-RGRD, Mr. E.C. Adams
U.S. Army Tank-Automotive
Command (TACOM)
31 March 1988
Page 2

The heavier filter had many relatively large particles that were attracted to a magnet. These particles were irregular, dark colored, globules that resembled small pieces of slag from a welding operation. Several small chips of nonmagnetic metallic material were also noted, as well as many assorted fibers. The entire filter surface was also coated with a thin cake of brown/black material which visually resembled the typically encountered dirt and/or fuel decomposition products.

The lighter weight filter had a thin coating of material that visually resembled fine dirt or fuel decomposition products and somewhat larger "rust looking" particles randomly scattered on the surface. No fibers or metal flakes were noted under the optical microscope.

The lighter weight filter was used for SEM/EDAX workup since it was the one that had been used for bulk EDAX. It should be noted that while the elemental concentration (wt%) reported for the residue on the lighter weight filter should be correct for this filter, it should not be considered a representative example of the bulk sample, since it was visually apparent that the heavier filter contained a much higher percentage of metallic material.

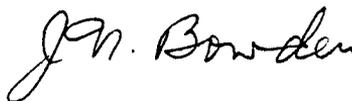
Approximately 30 individual particles from the lighter weight filter were checked for elements by EDAX while in the SEM. All of the larger "rust looking" particles examined were rich in iron, and a few of these showed traces of zinc and/or copper. The smaller particles that were examined showed varying ratios of aluminum, silicon, chlorine, and calcium. A few of these particles showed small (traces) amounts of sodium. The SEM/EDAX workup gave no indication of fuel decomposition products being present.

We conclude that the larger particles on the lighter weight filter are probably rust particles from a source that also contained small amounts of zinc and copper. The smaller particles are most likely to be common dirt particles composed of quartz-like minerals and clays.

Please advise us if you have further questions on this matter.

Very truly yours,

S.J. Lestz
Director



J.N. Bowden
Staff Scientist

SJL/JNB/lap (JNB3.Z)

cf: U.S. Army Belvoir Research, Development and Engineering Center, Attn:
STRBE-VF, Mr. M.E. LePera
U.S. Army Tank-Automotive Command (TACOM), Attn: AMSTA-RGE,
Mr. J. Lewakowski, Warren, MI 48397-5000
Belvoir Fuels and Lubricants Research Facility (SwRI), Attn: L.L. Stavinoha and
J.G. Barbee

APPENDIX C

MICROBIOLOGICAL ANALYSES



DEPARTMENT OF THE ARMY
 US ARMY NATICK RESEARCH and DEVELOPMENT CENTER
 NATICK, MASSACHUSETTS 01760-5020

September 11, 1985

REPLY TO
 ATTENTION OF:

Materials Protection Branch

Best Available Copy

Mr. Wayne K. Wheelock
 C, Prop Sys Division
 U.S. Army Tank-Automotive Command
 ATTN: AMSTA-RGRD
 Warren, Michigan 48397-5000

Dear Mr. Wheelock:

Reference is made between Mr. Graham, TECOM, AMSTA-RGRD and the undersigned on 22 July 1985 and your letter of 29 July 1985 requesting microbiological analyses of two fuel samples identified as 14A and 16B furnished by your Command and originating from Sterling Technology, Inc., Jacksonville, Florida.

These samples were tested for microbiological susceptibility using standard techniques where a 9:1 v/v fuel: Bushnell Haas (synthetic mineral water) solution was dispensed in sterile screw cap test tubes. The tubes were incubated with a mixture of the fuel fungus, *Cladosporium resinae*, QM7998, a bacterium, *Pseudomonas aeruginosa*, ATCC48 and *Candida tropicalis*, ATCC48,138 in duplicate sets. All tubes were incubated at 30°C for three weeks. Sterile controls (filter sterilized) were used together with our own control using CATIH Diesel Fuel, Marine. Results are summarized in the following Table:

CONDITIONS	FUEL ^a SAMPLES		
	CATIH	14A	16B
Unfiltered			
inoculated ^b	L-MG ^c	LG ^c	LG, MG
uninoculated	NG ^c	SG, LG	MG ^c
Filtered			
inoculated ^b	L-MG	LG	LG, MG
uninoculated	NG	NG	NG

^a Fuel: Bushnell Haas 9:1 vv in duplicate

^b Mixture of *C. resinae*, *Ps. aeruginosa* and *C. tropicalis*

^c NG = No growth, TG = Trace growth, SG = Sparse growth, LG = Light growth, MG = Moderate growth, HG = Heavy growth

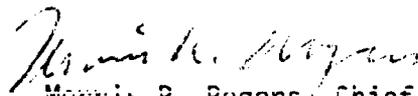
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As can be seen from the above results, the purified fuel (sample 16B) supported heavier growth than the reference fuel (sample 14B) or about the same degree of growth, by comparison, as was found in our CATIH diesel control.

These data do not support the contention put forth by the supplier that their ultra fine purification process retards microbial growth.

If you have any further questions regarding these results, please call me on AV 256-4596 or (617) 651-4596.

Sincerely,



Morris R. Rogers, Chief
Materials Protection Branch
Materials Protection & Biotechnology Div
Science & Advanced Technology Laboratory

APPENDIX D
DATA ON FUEL SAMPLES



Leitz

DEPARTMENT OF THE ARMY LEPERA/mef/AUTOVON 354-3435
US ARMY BELVOIR RESEARCH & DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

RECEIVED

APR 11 1984

STRBE--VF

6 April 1984 **APR 11**

SUBJECT: Sterling Company's Electrostatic Filter Device for Petroleum Products

Commander
US Army Tank-Automotive Command
ATTN: DRSTA-RG (Mr. G. Cheklich)
Warren, MI 48090

1. This is in reference to our recent discussion relative to our reviewing that material which was transmitted to our office describing the subject device. Subsequent to this, we were also contacted by personnel from Sterling Company who then forwarded "before" and "after" diesel fuel samples for our evaluation.

2. As your will recall, we had agreed to review the technical literature and patent application and also conduct limited laboratory testing to ascertain (1) the degree of fuel filtration and (2) what might be causing the reported improved vehicle performance that resulted from using the "filtered" fuel.

3. As was agreed, we have completed our evaluation and the following documents are attached for your review:

a. Memorandum For Record STRBE-VF dated 6 April 1984, subject: Comments on the Electrostatic Fluid Filtration Device Marketed by the Sterling Company (Encl 1).

b. Memorandum For Record STRBE-VF dated 26 March 1984, subject: Analysis of Diesel Fuel Samples from Sterling Company (Encl 2).

The attached documents are self explanatory; however, additional supporting comments are provided in the following paragraphs.

4. The review performed on the literature information which was provided by your office identifies a lack of scientific data. Copies of the previous correspondence forwarded to this office from the organization mentioned in para 3 of Encl 1 (i.e., Uni-Systems, Inc., LMF Industries, Inc., and National Bureau of Standards) can be provided if desired. Our primary concern in reviewing this information is the absence of not only scientific data but also the reported field tests results. Field testing as you are aware requires adequate controls and defined parameters for monitoring performance improvements. None of the data which was supplied met these criteria.

STRBE-VF

6 April 1984

SUBJECT: Sterling Company's Electrostatic Filter Device for Petroleum Products

5. The analysis performed on the four diesel fuel samples did not reveal any significant substantial improvement. As is noted in Encl 2, Sterling Company provided Samples 1 and 4 as "one" fuel whereas Samples 2 & 3 were the "other" fuel. They did not state which samples were "before filtration" which was not important as the analysis results would have defined the level of improvement. Since electrostatic separation is well known and used within the petroleum refining industry for removal of water, heavy oil contaminants, and refining impurities, a test protocol was developed to reflect where changes were evidenced in the "before" and "after" fuel samples. Some explanation of the test selection is given as follows:

a. All tests listed in Encl 2 were conducted in accordance with the ASTM Method identified. The Particulates determination procedure was modified because of sample size limitations. One liter was initially filtered through a 1.2 micron membrane. The filtrate was saved and then re-filtered through a 0.45 micron membrane filter. In addition to conserving sample size requirements, this procedure was to provide a relative "size" distribution of particulate contamination debris.

b. The Filterability Index is a procedure which we have been using to assess the filter plugging tendencies of sample fuels. Those fuels which are relatively clean and essentially devoid of the more amorphous-type particulate sediment which creates plugging will have Filterability Indices of 1.00 or less. Those fuels which contain some of the "plugging-prone sediment" will have values in excess of 1.00. The higher the number, the more prone that fuel is to fuel filter plugging.

c. Not knowing which fuel sample within each group was the "before" sample, one is hard-pressed to see significant changes in measured properties. For example, filtration of the type reported should have caused a lowering of Existent Gum, Accelerated Stability, Particulate Contamination, Color, and Filterability Index. One would also have expected to see an increase in the Interfacial Tension values. However, in reviewing the analyses performed on Samples 1 and 4 versus 2 and 3, there are in reality no definitive changes that could be used to support and/or explain the "reported" vehicle improvements which were described in the transmitted literature and information.

6. In view of the information obtained to date including the analyses which were performed, any further investigation of the subject system should not be undertaken at this time. Should there be any further questions relative to the above comments or the attached Enclosure, please contact the undersigned at AUTOVON 354-3435.

2 Encl
as

Maurice Lepera
MAURICE E. LEPERA
Chief, Fuels and Lubricants Division
Materials, Fuels and Lubricants Laboratory

STRBE-VF

6 March 1984

SUBJECT: Sterling Company's Electrostatic Filter Device for Petroleum Products

CF:

Sterling Company, Executive Point Towers, 5520 Los Santow Way, Jacksonville,
FL 32211 w/Encl

US Army Fuels & Lubricants Research Laboratory, SWRI, Attn: M. S. Lestz,
PO Drawer 28510, San Antonio, TX 78284 w/Encl

Commander, 24th Infantry Division, Division MMC, BLDG 508, ATTN: LT Naver),
Fr. Stewart, GA 31314 w/Encl



DEPARTMENT OF THE ARMY WILLIAMS/1a1/44594
US ARMY BELVOIR RESEARCH & DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

STRBE-VF

6 April 1984

MEMORANDUM FOR RECORD

SUBJECT: Comments on the Electrostatic Fluid Filtration Device Marketed by the Sterling Company

1. This office was furnished with literature describing an electrostatic filter device intended to remove water and suspended particles from high dielectric constant fluids. The manufacturer proposes that the system could be applicable for Army use in the upgrading/improving of fuels lubricants, and hydraulic fluids. The literature which was provided by personnel from the Tank-Automotive Command consists of patent application with references to previous patents, some limited test data, and various testimonials including some from a Florida National Guard unit.
2. As described in the patent application, the device is contained in a cylindrical vessel of unspecified dimension and capacity. It uses a combination of drying (i.e., desiccation), mechanical filtration, and electrostatics. Fluid that passes to the electrostatic section must have a high dielectric constant and be essentially moisture free. The desiccator section is intended to remove this moisture, but the type of desiccant is not described nor is any technique described to remove the collected water from the desiccant. Mechanical filtration is used to remove larger particles by means of a polyurethane foam. The electrostatic section removes sub-micronic particles by means of a strong electric field (i.e., this is supplied from a high voltage direct current power supply) that is used to break the "covalent bonding" between the fluid and the particles. These separated particles are then retained in more polyurethane foam. Some details of this mechanism are given, but the scientific basis is vague. It is doubtful in the writer's opinion that many particles form chemical bonds to the fuel. Most of the fine particles and insoluble agglomerates are in suspension in the fluid and can be surrounded by a surface active agents and/or impurities which tend to keep them from agglomerating. Nowhere does this patent explain how the retained particles are removed from the polyurethane once collected. The manufacturer and/or inventor would do well to present a clear explanation as to the working principles of this system to clarify many of the issues raised in the above paragraphs.
3. As a matter of background information, this device is at least the third in a series of similar devices submitted to this office for evaluation or comment over the past few years. Further, it would appear that all may have originated from the same organization or source. It would appear that the organization has changed its name, but many of the same names reappear. For example, in 1978 this

(ENCL 1)

STRBE-VF

6 April 1984

SUBJECT: Comments on the Electrostatic Fluid Filtration Device Marketed by the Sterling Company

office provided comments to a National Bureau of Standards (NBS) office of Energy-Related Inventions request for a submission by Uni-Systems Inc. who were marketing the "GEM Electrostatic Filtration Systems". Uni-Systems did not provide details as to the theory of operation, but did submit a "test report" from Hill Air Force Base as was found in the Sterling Co. package. In 1979, under a similar NBS program, another GCM electrostatic filter submission was evaluated; however, this time the device was being LMF Industries. LMF included in their literature the same report from the Mexican National Railroad as found in the Sterling Co. package. In 1983, an evaluation was subsequently made of one of the patents cited in the Sterling Co. literature. In this, a new theory of operation is detailed, but again its scientific bases is somewhat vague. Sterling Co. has not provided any test data that is based upon sound scientific testing (i.e., with controls). It is recommended that additional data be requested from the Sterling Co. prior to any further evaluation of this system.



W.R. WILLIAMS
Fuels and Lubricants Division
Materials, Fuels and Lubricants Laboratory

26 March 1984

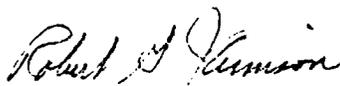
MEMORANDUM FOR RECORD

SUBJECT: Analysis of Diesel Fuel Samples from Sterling Company

1. As a result of discussions between Mr. Cheklich, TACOM, and Mr. LePera, four samples of diesel fuel were forwarded to this Center for analysis. The samples were identified as Numbers 1 through 4. A copy of the letter from Sterling is attached as Encl 1.
2. The purpose of this analysis was to determine whether or not the Electrostatic Filter Device which Sterling Company is marketing is removing any ingredients from the fuel that would explain the reported improvement noted after using "filtered" fuel. The letter does not state which samples are "before" and "after" samples but merely notes that sample numbers 1&4 are together whereas 2&3 are also together.
3. The four samples were subjected to a series of tests which would possibly show removal of things/constituents such as residual impurities, asphaltenes, etc. The removal of these constituents would possibly cause the fuel to combust more completely. The test results are shown on Encl 2.
4. All of the tests were performed as specified with the exception of the Particulate Contamination (ASTM D2276). In this case, the test was modified due to limited sample volume. The modification was as follows:
 - a. A 1 liter aliquot was initially filtered through a tared membrane filter of 1.2 micron porosity. The filtered aliquot was retained and the membrane re-weighed after washing with heptane. This gave the figure shown for "using 1.2 u". The retained 1 liter filtered aliquot was then filtered a second time through a tared membrane filter of 0.45 micron porosity. This value of particulate contamination was shown as "using 0.45 u". In both cases, the amounts of contaminants are miligrams per one liter.
5. In addition to these tests, infrared spectral scans were performed on all samples to see whether changes in the tracings could be seen. These are provided on Encls 3&4. For all practical purposes, the infrared spectra shows no changes in composition.

4 Encls
as

(Encl 1)



ROBERT G. JAMISON
Fuels and Lubricants Division
Materials, Fuels and Lubricants Laboratory



STAN JORDAN Sc.D.
PRESIDENT

STERLING

"Quality Since 1939"

February 29, 1984

Mr. Mario Le Pera
Commander U.S. Army
Belvoir R & D Center
Attn: STRBE-VF Le Pera Bldg. 335
Fort Belvoir, Virginia 22060

Dear Mr. Le Pera:

Today, as per your instructions on our phone conversation on Tuesday, February 28, I am forwarding via UPS four one gallon each diesel containers. Cans # 1 and 4 are one sample and cans # 2 and 3 are a different sample. According to UPS, you should receive our package on Monday, March 5.

I would appreciate your sending me a copy of lab analysis as well as your appropriate comments. If I can be of any further assistance, please let me know.

Sincerely,

A handwritten signature in cursive script, appearing to read "Rolando Altamirano".

Rolando Altamirano, P.E.

cc: Transport Products Group, Inc.

(ENCL 1)

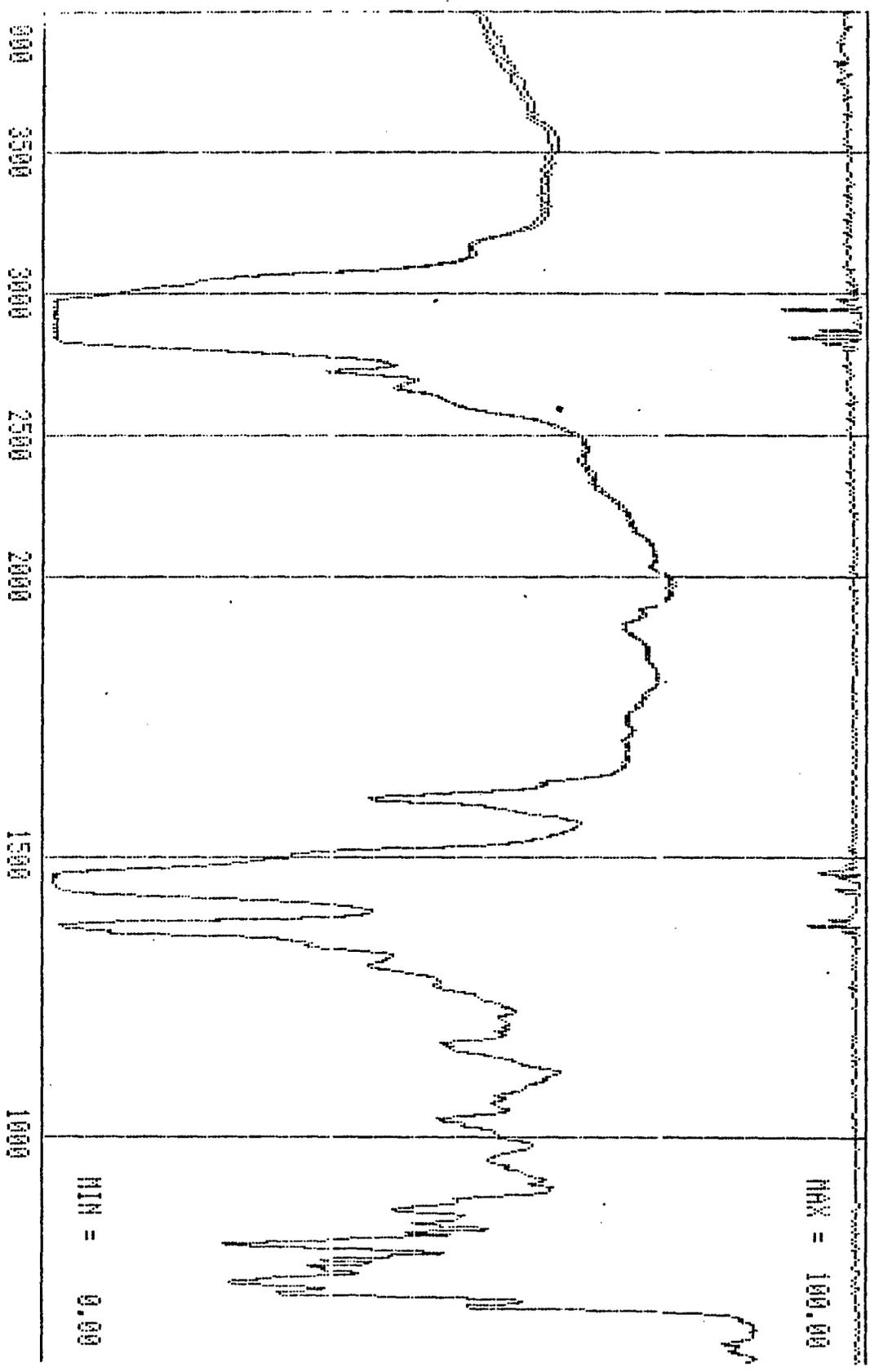
D-9

DIESEL FUEL ANALYSES

Sample No.	No. 1	No. 4	No. 2	No. 3	
<u>TEST RESULTS</u>					<u>TEST METHOD</u>
DISTILLATION, °C:					D86
IBP	194.5	113.5	196.4	194.4	
5%	212.4	203.0	212.1	214.2	
10%	222.0	216.5	221.1	223.5	
20%	235.5	233.4	234.9	237.0	
30%	246.3	244.7	246.4	247.7	
40%	256.2	255.2	256.3	257.3	
50%	265.6	264.5	266.0	266.7	
60%	275.8	274.4	275.7	277.0	
70%	286.9	285.6	287.4	288.5	
80%	300.5	299.0	301.7	303.0	
90%	319.1	317.3	321.1	322.6	
EP	353.0	352.5	353.0	353.9	
EXISTANT GUM,mg/dl	58.2	36.0	43.0	34.4	D381
INTERFACIAL TENSION	34.28	33.44	34.69	33.65	D971
WATER, wt %	0.01	0.01	0.02	0.01	D1744
CLOUD POINT, °F	+10	+10	+10	+10	D2500
COLOR	1.75	1.75	1.75	1.75	D1500
ACCLERATED STABILITY, mg/dl	2.45	2.25	0.91	1.56	D2274
PARTICULATES,mg/l:					
using 1.2 u	2.4	14.0	6.1	7.3	
using 0.45 u	7.2	0.6	1.6	3.5	
FILTERABILITY INDEX	1.02	1.03	2.42	1.95	

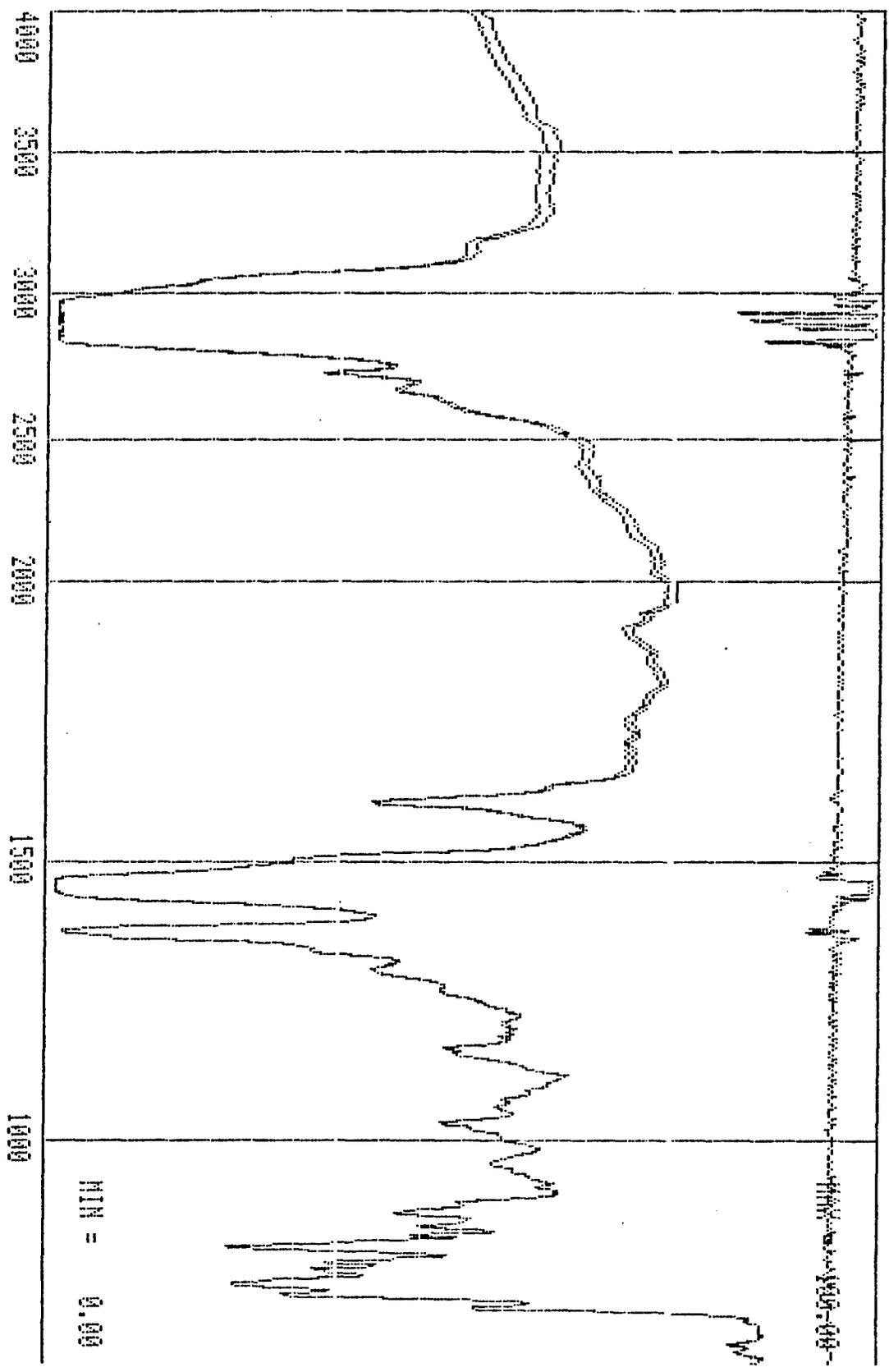
(Encl 2)

TRANSFORMED SPECTRA OF SAMPLES 1 & 4



(ENCL 3)

INFRARED SPECTRA OF SAMPLE 243



(ENCL 4)



DEPARTMENT OF THE ARMY LEPERA/mef/AUTOVON 35435
US ARMY BELVOIR RESEARCH & DEVELOPMENT CENTER
FORT BELVOIR, VIRGINIA 22060

RECEIVED

18 JUN 1984

AFLRL

STRBE-VF

22 May 1984

SUBJECT: Additional Data on Fuel Samples Filtered by the Sterling Electrostatic Filtering Device

Commander
US Army Tank-Automotive Command
ATTN: DRSTA-RG (Mr. G. Cheklich)
Warren, MI 48090

1. Reference letter STRBE-VF dated 6 April 1984, subject: Sterling Company's Electrostatic Filter Device for Petroleum Products.
2. The above reference provided our initial analysis of (1) the "Electrostatic Fluid Filtration Device" being marketed by the Sterling Company and (2) of two fuel samples which had been filtered through this device. As you will recall, our assessment revealed a questionable effectiveness of this system for filtering diesel and/or distillate products. This was based upon both the review of patent application and previous communications with other companies marketing a device of this nature and the analysis conducted on the "before" and "after" samples of fuel which had been furnished by Sterling Company.
3. The remaining portions of the four fuel samples were sent to the US Army Fuels and Lubricants Research Laboratory (AFLRL) for additional compositional analysis. AFLRL has completed their analysis on the four fuel samples and their results are provided in the attached letter dated 7 May 1984 (Encl 1). As is noted on Table 1 of this enclosure, there are no significant changes in any of the four samples. Moreover, as was noted, all four samples appear to be of the same composition.
4. Based upon this additional data, we would recommend no further evaluation with the Sterling Electrostatic Filtering Device. Should you have any questions, please contact the undersigned at AUTOVON 354-3435.

Maurice E. Lepera

MAURICE E. LEPERA
Chief, Fuels and Lubricants Division
Materials, Fuels and Lubricants Laboratory

1 Encl
as

CF:

Sterling Company, Executive Point Towers, 5520 Los Santos Way, Jacksonville, Florida 32211 w/Encl
Commander, 24th Infantry Division, Division MMC, Bldg 508 (ATTN: LT Naver), Fort Stewart, GA 31314 w/Encl
US Army Fuels and Lubricants Research Laboratory, SWRI, PO Drawer 28510, San Antonio, TX 78284

U.S. ARMY FUELS AND LUBRICANTS RESEARCH LABORATORY

6220 CULEBRA ROAD - P.O. DRAWER 28510

PH:512-684-5111

SAN ANTONIO, TEXAS 78284

USAFRL

File: 02-6800-143

07 May 1984

Commander
U.S. Army Belvoir Research &
Development Center
Attn: STRBE-VF, Mr. M.E. LePera
Fort Belvoir, Virginia 22060

Subject: Fuels Filtered Through Electrostatic-Type Filtering
Device

References: a) STRBE-VF Letter to S.J. Lestz of 21 March 1984
b) STRBE-VF Letter to S.J. Lestz of 30 March 1984
c) STRBE-VF Letter to DRSTA-RG of 6 April 1984

Dear Sir:

1. The references above contain a considerable amount of discussion on the Electrostatic Filter Device marketed by the Sterling Company.
2. Reference b) contains some analytical data on four samples of diesel fuel, two of which presumably were filtered through this device. The remainder of these samples were sent to AFLRL for additional analyses.
3. The data obtained at AFLRL are presented in Table 1. A letter from the Sterling Company stated that "Cans No. 1 and 4 are one sample and cans No. 2 and 3 are a different sample." The analytical data show no significant difference in chemical composition among the four samples.
4. Based on these data, it is concluded that no changes in fuel composition have occurred due to filtration through the electrostatic filter device.

Very truly yours,

S.J. Lestz, Director

John N. Bowden

John N. Bowden, Staff Scientist

(ENCL 1)

SJL/JNB/lap (WD10.BB)
cf: LLS, SRW, GH

TABLE 1. ANALYSES OF DIESEL FUEL SAMPLES
FROM STERLING COMPANY

Sample No.	<u>1</u>	<u>4</u>	<u>2</u>	<u>3</u>
<u>Results</u>				
Gravity, °API	33.5	33.5	33.4	33.4
Carbon, wt%	86.56	86.62	86.61	86.89
Hydrogen, wt%	12.79	12.86	12.82	12.90
Sulfur, wt%	0.27	0.30	0.28	0.28
Saturates, V%	65.6	66.1	66.1	66.1
Olefins, V%	1.7	1.8	1.8	1.7
Aromatics, V%	32.7	32.1	32.1	32.2
Net Heat of Combustion,				
Btu/lb	18,232	18,237	18,237	18,225
MJ/kg	42.408	42.419	42.419	42.392

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Commander U.S. Army Tank-Automotive Command ATTN: AMSTA-RGR (Dr. Walter Bryzik) Warren, MI 48397-5000	6
Mr. Stan Jordan Sterling Technology, Inc. 6832 Lone Star Road Jacksonville, FL 35211	2
Belvoir Fuels & Lubricants Research (SWRI) ATTN: Mr. John N. Bowden, Staff Scientist 6220 Culebra Road P.O. Drawer 28510 San Antonio, TX 78284	2
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U.S. Army Natick Research and Development Center ATTN: Mr. Morris R. Rogers, Chief Materials Protection Branch Science and Advanced Technology Lab Natick, MA 01760-5020	2