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(Please read Instructions on the reverse before completing)

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7. AUTHOR(S) Stanley L.Syria		8. PERFORMING ORGANIZATION REPORT NO.
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15. SUPPLEMENTARY NOTES		

16. ABSTRACT

This document announces the conclusions of the EPA evaluation of the "SYNeRGy-1" device under provisions of Section 511 of the Motor Vehicle Information and Cost Savings Act. This additive is intended to improve fuel economy and exhaust emission levels of two and four cycle gasoline fueled engines.

17. KEY WORDS AND DOCUMENT ANALYSIS

a. DESCRIPTORS	b. IDENTIFIERS/OPEN ENDED TERMS	c. COSATI Field/Group
Fuel Consumption Automobiles Exhaust Emissions Fuel Additives	Fuel Economy Fuel Saving Devices	
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EPA-AA-TEB-511-81-16A

EPA Evaluation of the SYNeRGy-1 Fuel Additive Under Section 511 of the Motor Vehicle Information and Cost Savings Act

by

Stanley L. Syria

June, 1981

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
U.S. Environmental Protection Agency

EPA-AA-TEB-511-81-16

6560-26

ENVIRONMENTAL PROTECTION AGENCY

[40 CFR Part 610]

[FRL ______________]

FUEL ECONOMY RETROFIT DEVICES

Announcement of Fuel Economy Retrofit Device Evaluation
for "SYNeRGy-1 "

AGENCY: Environmental Protection Agency (EPA).

ACTION: Notice of Fuel Economy Retrofit Device Evaluation.

SUMMARY: This document announces the conclusions of the EPA evaluation of the "SYNeRGy-1 " device (fuel additive) under provisions of Section 511 of the Motor Vehicle Information and Cost Savings Act.

<u>BACKGROUND INFORMATION:</u> Section 511(b)(1) and Section 511(c) of the Motor Vehicle Information and Cost Savings Act (15 U.S.C. 2011(b)) requires that:

(b)(1) "Upon application of any manufacturer of a retrofit device (or prototype thereof), upon the request of the Federal Trade Commission pursuant to subsection (a), or upon his own motion, the EPA Administrator shall evaluate, in accordance with rules prescribed under subsection (d), any retrofit device to determine whether the retrofit device increases fuel economy and to determine whether the representations (if any) made with respect to such retrofit devices are accurate."

(c) "The EPA Administrator shall publish in the <u>Federal Register</u> a summary of the results of all tests conducted under this section, together with the EPA Administrator's conclusions as to -

(1) the effect of any retrofit device on fuel economy;

(2) the effect of any such device on emissions of air pollutants; and

(3) any other information which the Administrator determines to be relevant in evaluating such device."

EPA published final regulations establishing procedures for conducting fuel economy retrofit device evaluations on March 23, 1979 [44 FR 17946].

<u>ORIGIN OF REQUEST FOR EVALUATION</u>: On September 24, 1980, the EPA received a request from XRG International, Incorporated for evaluation of a fuel additive termed "SYNeRGy-1". This additive is intended to improve fuel economy and exhaust emission levels of two and four cycle gasoline fueled engines.

<u>Availability of Evaluation Report</u>: An evaluation has been made and the results are described completely in a report entitled: "EPA Evaluation of the "SYNeRGy-1" Fuel Additive Under Section 511 of the Motor Vehicle Information and Cost Savings Act." This entire report is contained in two volumes. The discussions, conclusions, and list of all attachments are listed in EPA-AA-TEB-511-81-16A, which consists of 7 pages. The attachments are contained in EPA-AA-TEB-511-81-16B, which consists of 43 pages. The attachments include correspondence between the Applicant and EPA and all documents submitted in support of the application.

Copies of these reports may be obtained from the National Technical Information Service by using the above report numbers. Address requests to:

National Technical Information Service
U.S. Department of Commerce
Springfield, VA 22161
Phone: Federal Telecommunication System (FTS) 737-4650
Commercial 703-487-4650

Summary of Evaluation

The stated intent of the additive is to improve fuel economy and decrease emissions in gasoline engines.

The applicant did submit test data to support the claims made for "SYNeRGy-1". A portion of the test data did not support the applicant's claims. The remaining test data was not useful without further clarifications. Clarification of the data was requested of the applicant on two occasions, however, no additional information was received.

Previous EPA testing of other similar fuel additives has shown no significant impact on fuel economy or exhaust emission levels. Thus, there is no technical basis for EPA testing of the additive or to support any claims made for "SYNeRGy-1".

Notification to the applicant that the evaluation of "SYNeRGy-1" would be concluded based on available data also failed to produce a response. Eventually, the application for evaluation of "SYNeRGy-1" was superceded by an application for a new fuel additive termed "Gas Aid".

FOR FURTHER INFORMATION CONTACT: Merrill W. Korth, Emission Control Technology Division, Office of Mobile Source Air Pollution Control, Environmental Protection Agency, 2565 Plymouth Road, Ann Arbor, Michigan 48105, 313-668-4299.

Date

Edward F. Tuerk
Acting Assistant Administrator
for Air, Noise, and Radiation

EPA Evaluation of the "SYNeRGy-1" Fuel Additive Under Section 511 of the Motor Vehicle Information and Cost Savings Act

The following is a summary of the information on the device (additive) as supplied by the Applicant and the resulting EPA analysis and conclusions.

1. Marketing Identification of the Additive:

   "XRG-1" "i.e., SYNeRGy-1"

2. Inventor of Additive and Patents:

   a) Dr. Harry Webb - deceased
      (1) Assignee: XRG International, Inc., Stuart, Florida
   b) "Patent Number 4145190 Enclosed" (Attachment A of this evaluation)

3. Manufacturer of Additive:

   XRG International, Inc.
   4125 S.W. Martin Highway
   Stuart, Florida 33494

4. Manufacturing Organization Principals:

   Michael A. Krebser---Chairman of the Board, President
   Kenneth P. Ray--------Executive Vice President and General Counsel
   Dr. Kenneth R. Olen--Vice President, Operations
   Edward Arcardo--------Vice President, Public Relations

5. Marketing Organization in U.S./Identity of Applicant:

   XRG International, Inc.
   4125 S.W. Martin Highway
   Stuart, Florida 33494

6. Identification of Applying Organization Principals:

   Michael A. Krebser---Chairman of the Board, President
   Kenneth P. Ray--------Executive Vice President and General Counsel
   Dr. Kenneth R. Olen--Vice President, Operations
   Edward Arcardo--------Vice President, Public Relations

7. Description of Additive (as supplied by Applicant):

   a) "Purpose of the Device: To improve fuel economy and decrease emissions in gasoline engines."
   b) "Theory of Operation: Not Applicable"
   c) "Detailed Description of Construction and Operation: Not Applicable"

8. Applicability of the Additive (claimed):

   "XRG-1 (SYNeRGy-1) is applicable to all two (2) and four (4) cycle gasoline engines."

9. Costs (claimed):

Cost information not submitted.

10. Additive Installation, Tools and Expertise Required (claimed):

"Not Applicable"

11. Additive Operation (claimed):

"Not Applicable"

12. Additive Maintenance (claimed):

"Not Applicable"

13. Effect on Vehicle Emissions (non-regulated) (claimed):

a) "EPA Evaluation - February 1980 - Enclosed" (Attachment B of this evaluation. Attachment B references the EPA evaluation of NRG#1, TAEB Report 77-19 which is Attachment C of this evaluation).

b) "AESi Evaluation - August 1980 - Enclosed" (Attachment D of this evaluation)

14. Effects on Vehicle Safety (claimed):

"Not Applicable"

15. Test Results - Regulated Emissions and Fuel Economy (submitted by Applicant):

a) "EPA Evaluation - February 1980 - Enclosed" (Attachment B and C)
b) "AESi Evaluation - August 1980 - Enclosed" (Attachment D)

16. Testing by EPA:

EPA did not test the additive for this evaluation for three reasons. First, previous EPA testing (see Attachments B and C) of two similar fuel additives have shown no significant benefits in terms of emissions or fuel economy. Second, the applicant has not shown there to be a significant difference between "SYNeRGy-1" and the additives previously tested in respect to chemical composition. Third, the applicant did not submit acceptable test data which may substantiate the need for EPA testing. Therefore, in accordance with 40 CFR 610.30(b) EPA elected not to test the additive.

17. Analysis:

A. Description of the Additive:

(1) The additive is claimed to "improve fuel economy and decrease emissions in gasoline engines". Further, the patent provided by the applicant states that use of the additive "contributes to the more efficient and longer life of the lubricating oil at the same time giving a clean carbon and gum-free internal combustion engine."

(2) The applicant did not describe the theory of operation. However, the patent submitted by the applicant states the additive works as a catalyst thereby causing the heavier and less volatile ends of the fuel to completely burn, thus increasing the energy and decreasing the emissions of raw hydracarbons.

(3) Considering the combustion and thermal efficiencies of most modern engines, it is highly unlikely that fuel economy improvements as much as 20% can be realized by causing a more complete burning of the fuel. Of course this conjecture is based on late model vehicles when properly tuned and meeting all applicable emission standards. Testing of similar additives by EPA (and reported in Attachments B and C) showed that in general there was no significant change in fuel economy or emission levels through the use of the additives.

Data was not provided to EPA which would substantiate the claim for cleaner engines and extended lubricating oil life through the use of "SYNeRGy-1". Without data from an extensive test program, EPA cannot determine the impact the additive may have on those two parameters.

B. Applicability of the Additive:

The applicability of the additive, as stated in the application, "XRG-1 (SYNeRGy-1) is applicable to all two (2) and four (4) cycle gasoline engines," is judged to be correct.

C. Cost of the Additive:

Information on the retail price of the additive was not provided. Therefore, EPA is not able to evaluate the reasonableness of its cost.

D. Additive Installation - Tools and Expertise Required:

The applicant did not provide installation instructions. However, the patent stated that the additive could be introduced into the engine by 1) premixing of the additive and fuel in a bulk container or, 2) direct injection of the Additive "utilizing a system such as Harlo Klean Fuel System (manufactured by Harlo Repower Ltd., Clearbrook, B.C., Canada) for direct injection into the line leading into the manifold." The instructions for bulk mixing were judged to be adequate.

EPA also believes direct injection to be a feasible approach. However, system description, test data, and sample hardware were not made available to EPA for any direct injection system. Therefore, EPA can not judge the acceptability of any direct injection system for introducing "SYNeRGy-1" into the engine.

E. Additive Operation:

No specific instructions were provided for operation of a vehicle with the additive, and none were judged to be required.

F. Additive Maintenance:

Maintenance instructions were not provided for the additive, however, it was judged that maintenance would not be required.

G. Effects on Vehicle Emissions (non-regulated):

The applicant references test evaluations (Attachments B, C, and D) by EPA and Automotive Environmental Systems, Incorporated (AESi). These data address only regulated pollutants and normal atmospheric constituents (e.g., carbon dioxide) and do not address non-regulated pollutants. Further, the applicant did not provide any other information which may show the effect of the additive on non-regulated pollutants.

The patent submitted with the application provides a breakdown of the additive by constituent and weight. A large percentage of the additive consist of compounds normally found in most commercially available gasolines. These compounds are not known to be a problem in respect to non-regulated pollutants. The remaining compounds constitute a small percentage and when also considering the recommended ratio of additive to fuel of 1:1600 by volume, the actual percentage of these compounds in a tank of fuel is extremely small. However, there is concern that a mixture of these compounds, when subjected to the high temperatures and pressures found in internal combustion engines, may form hazardous unregulated pollutants. For example, it is possible that the nitrobenzene and tertiary dodecylamine may react to form nitrosamine which is considered to be substantially more carcinogenic than formaldehyde. Although the formation process for nitrosamine is still being studied, there is no doubt that the compound is carcinogenic. The relative carcinogenic risk associated with exposure to any nitrosamine emissions that may be formed from this additive would have to be evaluated.

Because of the lack of appropriate test data, and the number and types of compounds and variables involved, EPA cannot say for sure what effect the additive will have on non-regulated pollutants.

H. Effects on Vehicle Safety:

The applicant did not provide warnings, cautions, or any information relating to the use of the additive and the safety of the vehicle, its occupants, or persons and/or property in close proximity to the vehicle. Therefore, EPA is not able to fully determine the safety element in respect to the use of the additive. However, because the additive is a highly flammable liquid, all safety measures practiced with other similar liquids should also be applied to the additive.

I. Test Results Supplied by the Applicant:

The applicant referenced EPA test reports (Attachments B and C) which address the testing performed on similar additives. Both reports conclude there were no significant changes in emission or fuel economy levels as a result of using the additives. Therefore, EPA expects there will not be any significant emissions or fuel economy benefits as a result of using "SYNeRGy-1".

The applicant also provided test data generated at Automotive Environmental Systems, Incorporated, (AESi). EPA evaluated the AESi data and was not able to determine, without clarification of the data, the impact on emission and fuel economy levels. EPA requested (Attachments E and F of this evaluation) clarification of the data, however, the applicant did not submit any additional information.

17. Conclusions:

EPA fully considered all of the information submitted by the applicant. The evaluation of "SYNeRGy-1" was based on that information. The applicant was requested on two occasions to clarify certain test data, however, no additional information was received. Analysis of the available data did not prove that the use of "SYNeRGy-1" would enable a vehicle operator to achieve fuel economy and emission benefits. Thus, there is no technical basis to support any claims made for "SYNeRGy-1".

List of Attachments

Attachment A	United States Patent, No. 4145190, "Catalytic Fuel Additive for Jet, Gasoline, Diesel, and Bunker Fuels," March 20, 1979.
Attachment B	Environmental Protection Agency, TEB Report EPA-AA-TEB-80-12, "Evaluation of XRG #1, A Fuel Additive," February, 1980.
Attachment C	Environmental Protection Agency, TEB Report 77-19 CH, "Evaluation of NRG #1, A Fuel Additive," February, 1978.
Attachemnt D	Automotive Environmental Systems, Incorporated Report, "Additive Testing Project Conducted for XRG International, Inc.," August, 1980.
Attachment E	Letter, EPA to Brian Boshart of XRG International, Inc., December 2, 1980.
Attachment F	Letter, EPA to Brian Boshart of XRG International, Inc., March 4, 1981.

EPA-AA-TEB-511-81-16B

Attachments to

EPA Evaluation of the SYNeRGy-1 Fuel Additive Under
Section 511 of the Motor Vehicle Information and Cost Savings Act

June, 1981

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
U.S. Environmental Protection Agency

Attachment A

No. 4145190

THE UNITED STATES OF AMERICA

TO ALL TO WHOM THESE PRESENTS SHALL COME:

Whereas, THERE HAS BEEN PRESENTED TO THE

Commissioner of Patents and Trademarks

A PETITION PRAYING FOR THE GRANT OF LETTERS PATENT FOR AN ALLEGED NEW AND USEFUL INVENTION THE TITLE AND DESCRIPTION OF WHICH ARE CONTAINED IN THE SPECIFICATIONS OF WHICH A COPY IS HEREUNTO ANNEXED AND MADE A PART HEREOF, AND THE VARIOUS REQUIREMENTS OF LAW IN SUCH CASES MADE AND PROVIDED HAVE BEEN COMPLIED WITH, AND THE TITLE THERETO IS, FROM THE RECORDS OF THE PATENT AND TRADEMARK OFFICE IN THE CLAIMANT(S) INDICATED IN THE SAID COPY, AND WHEREAS, UPON DUE EXAMINATION MADE, THE SAID CLAIMANT(S) IS (ARE) ADJUDGED TO BE ENTITLED TO A PATENT UNDER THE LAW.

NOW, THEREFORE, THESE Letters Patent ARE TO GRANT UNTO THE SAID CLAIMANT(S) AND THE SUCCESSORS, HEIRS OR ASSIGNS OF THE SAID CLAIMANT(S) FOR THE TERM OF SEVENTEEN YEARS FROM THE DATE OF THIS GRANT, SUBJECT TO THE PAYMENT OF ISSUE FEES AS PROVIDED BY LAW, THE RIGHT TO EXCLUDE OTHERS FROM MAKING, USING OR SELLING THE SAID INVENTION THROUGHOUT THE UNITED STATES.

In testimony whereof *I have hereunto set my hand and caused the seal of the* Patent and Trademark Office *to be affixed at the City of Washington this twentieth day of March in the year of our Lord one thousand nine hundred and seventy-nine, and of the Independence of the United States of America the two hundred and third.*

Attest:

Jean G. Bettemore
Attesting Officer.

Donald W. Banner
Commissioner of Patents and Trademarks.

United States Patent [19]

Webb

[11] 4,145,190

[45] * Mar. 20, 1979

[54] CATALYTIC FUEL ADDITIVE FOR JET, GASOLINE, DIESEL, AND BUNKER FUELS

[75] Inventor: Harry M. Webb, Toronto, Canada

[73] Assignee: Natural Resources Guardianship International, Inc., Clayville, N.Y.

[*] Notice: The portion of the term of this patent subsequent to Jul. 11, 1995, has been disclaimed.

[21] Appl. No.: 841,905

[22] Filed: Oct. 13, 1977

Related U.S. Application Data

[63] Continuation-in-part of Ser. No. 809,864, Jun. 24, 1977, and a continuation-in-part of Ser. No. 783,777, Apr. 1, 1977.

[51] Int. Cl.² C10L 1/22

[52] U.S. Cl. 44/56; 44/57

[58] Field of Search 44/56, 57, 58, 51

[56] References Cited

U.S. PATENT DOCUMENTS

1,677,273	7/1928	Costaguta	44/56
1,820,983	9/1931	Loomis	44/72
3,282,858	11/1966	Simmon et al.	44/57

FOREIGN PATENT DOCUMENTS

491648	9/1938	United Kingdom	44/57

Primary Examiner—Winston A. Douglas
Assistant Examiner—Y. Harris-Smith
Attorney, Agent, or Firm—John S. Roberts, Jr.

[57] ABSTRACT

An energy-saving fuel additive for jet engines, gasoline and diesel engines, including additions to domestic heating and light industrial oils (#2 and #3) and residual or bunker fuel (#4, 5, and 6), which comprises as active ingredients a catalytic mixture of a major proportion of picric acid and a minor proportion of ferrous sulfate.

17 Claims, No Drawings

CATALYTIC FUEL ADDITIVE FOR JET, GASOLINE, DIESEL, AND BUNKER FUELS

This application is a continuation-in-part application of pending U.S. Ser. No. 783,777 filed Apr. 1, 1977, by Harry M. Webb, and pending U.S. Ser. No. 809,864 filed June 24, 1977, by Harry M. Webb.

The present invention relates to an energy-saving fuel additive for jet, gasoline, and diesel engines, including the use as an additive for domestic heating and light industrial oils (#2 and #3) and bunker or residual fuels (#4, 5, and 6) which comprises as active ingredients a catalytic mixture of a major proportion of picric acid and a minor proportion of ferrous sulfate. These general designations or gradations of fuel oils are as accepted by the American Society of Testing Materials, Philadelphia, Pa., and cited in *Encyclopedia of Chemical Technology* II, Volume 15, page 81 (1968, Wiley-Interscience).

A preferred solvent suitable for use is a combination of an alkyl benzene, such as toluene, and a lower alcohol, such as isopropanol. Operable substitutes for isopropyl alcohol, although not preferred, are ethanol and methanol together with water and the two may be used in a composite relationship. The combination specially may include a minor amount of nitrobenzene as well as a particulate reducer such as a long chain tertiary amine (Primene 81R).

The additive mix or concentiate denotes MSX Mix useful for bulk addition is as follows for one gallon:

	U.S. Gallon		Imperial Gallon	
	Preferred	Range	Preferred	Range
Ferrous sulfate	1.4 g	.08 – 1.4 g	1.7 g	0.1 – 1.7 g
Picric acid (trinitrophenol)	45.0 g	2.8 – 45.0 g	54.0 g	3.5 – 54.0 g
Toluene	2.4 kg	2.4 – 1.0 kg	2.9 kg	2.9 – 1.2 kg
Isopropyl alcohol	1.0 kg	1.0 – 2.4 kg	1.2 kg	1.2 – 2.9 kg
Nitrobenzene	2.7 g	.08 – 2.7 g	3.2 g	0.1 – 3.2 g
Long chain amine; e.g., tertiary dodecylamine	1.7 g	.2 – 1.7 g	2.0 g	.24 – 2.0 g
Water	Balance	Balance	Balance	Balance

In the solvent the preferred relationship of toluene and isopropyl alcohol is about 2:1 by weight.

Additionally, where heavy oils are involved as with bunker and residual fuels (#4, 5, and 6) the following formulation is utilized per gallon:

	U.S. Gallon		Imperial Gallon	
	Preferred	Range	Preferred	Range
Ferrous sulfate	4 g	4–5.6 g	5 g	5–7 g
Picric acid (trinitrophenol)	8 g	8–12 g	10 g	10–15 g
Toluene	4 kg	4–5.6 kg	5 kg	5–7 kg
Isopropanol	.8 kg	.8–1.2 kg	1 kg	1–1.5 kg
Long chain amine; e.g., tertiary dodecylamine	.2 g	.2–1.7 g	.24 g	.24–2.0 g
Water	Balance	Balance	Balance	Balance

The MSX Mix is utilized for dosage to fuels in the ratio of 1:1,000 to 1:2,000 with a preferred dosage of 1:1600 parts by volume.

In the aforesaid formula which is set out for U.S. and Canadian use, it is noted that the preferred range in the MSX Mix is at or near the highest range given, which gives a more active composition. In addition, where nitrobenzene is utilized the top values of the range are near the delimiting value presently set out by Energy Research and Development Administration for NOx emissions. A catalytic action occurs in the binary active ingredient due to the presence of the metallic ion Fe^{++} in the composition, causing the slightly heavier and less volatile ends to burn completely, thus increasing the energy and decreasing the emissions of raw hydrocarbons from the exhaust.

The prior art statement for the present invention is set out below.

Relating to Picric Acid

U.S. Pat. No. 928,803 Seiden teaches at column 1 use of picrates of fused ring compounds such as naphthalene in a solvent selected from alcohols, benzene, and acetone.

U.S. Pat. No. 3,294,501 Kawahara notes the use of picric acid at column 1 as a lead appreciator.

U.S. Pat. No. 3,434,814 Dubeck speaks of the reduction of hydrocarbon emission from internal combustion engines by operating the gasoline containing ortho-substituted aromatic nitro compounds and prefers picryl acetate.

Art Bearing on Ferrous Sulfate

U.S. Pat. No. 3,002,826 Norris as an additive incorporates preferably aluminum sulfate and other salts, both inorganic and organic, to reduce vanadium deposition which causes corrosion and deposits.

U.S. Pat. No. 3,348,932 Kukin at column 2 states that a small percentage of iron salts may be used as part of a salt combination as a combustion aid in domestic furnaces, diesel equipment, jet engines, etc., to force combustion of the fuel to final products, such as carbon dioxide and water.

Art Pertaining to the Solvent

U.S. Pat. No. 914,624 Winand, at page 1, column 2, mentions the use of nitrobenzene as "an oxygen-bearer."

U.S. Pat. No. 1,423,050 Tunison, at column 2, line 103, mentions nitrobenzol or nitrobenzene as an explosion promoter for internal combustion engines and diesel engines.

U.S. Pat. No. 4,002,435 Wenzel illustrates a water-in-oil emulsion of hydrocarbons, water, and an alcohol suitable for injection methods as noted in column 2.

The energy-saving compositions and method of treating fuels set out in the present invention differ from the above-cited prior art. Primarily this invention lies in a novel mixture of active ingredients; namely, picric acid (2,4,6-trinitrophenol) and ferrous sulfate $FeSO_4$). These constitute the active ingredients of the present composition utilizing picric acid in the majority amount. In a preferred bulk composition, the amount of picric acid in a U.S. gallon ranges from 2.8–45.36 grams and the ferrous sulfate 0.08–1.36 grams. Thus, as has been stated as to the thrust of use, the picric acid provides the major oxidizing component of the composition and the ferrous iron in the ferrous sulfate provides the catalytic action. Nitrobenzene is used primarily as a solvent and has a secondary use as an auxiliary oxidant. The active ingredients, as well as the solvents of the present invention, have a unique utility over compositions having other salts in that this composition is compatible with the "catalytic converter" containing platinum and paladium compounds which has been mandatory in the United States for new cars since 1975. Thus, it is an appreciator for "no lead" fuel used in such cars.

COMPONENTS OF THE INVENTION

The Active Ingredients

Picric acid, also known as 2,4,6-trinitrophenol, is used in this invention as a strong oxidizing agent.

Ferrous sulfate is used for catalytic action in combination with the superior amount of picric acid noted above. The Fe^{++} ion is readily oxidizing to ferric or reduced to Fe^{*}. The compound is included since it represents a metal compound which can be oxidized and then retransformed into the lower oxidized state or first transformed to ferric and then retransformed to ferrous. The presence of the ferrous sulfate salt lends greater activity to the composition than would be expected when considering its minor percentile inclusion in the composition and thus may be viewed as a catalytic agent. Also, and quite importantly, iron sulfate has shown less corrosion on iron than such compounds as nickel sulfate, nickel nitrate, and cadmium sulfate in comparative testing. Additionally, the combination of picric acid and ferrous sulfate may be termed true synergistic mixture of other additives. In all cases, a catalytic action takes place due to the presence of a ferrous ion in the compound. The slightly heavier and less volatile ends are completely burned, thus increasing the energy and decreasing the emissions of raw hydrocarbons from the exhaust. Without the catalytic complete combustion of the fuel, the heavy ends condense on the comparatively cooler cylinder walls, eventually manifesting themselves as crankcase dilution elements, gum, sludge, etc. Therefore, the addition of the product to the fuel not only increases the energy output but also contributes to the more efficient and longer life of the lubricating oil at the same time giving a clean carbon and gum-free internal combustion engine.

Other Ingredients

Toluene. Of the alkyl benzenes possible, toluene, ortho-, meta-, and paraxylenes are preferred, and the mesitylenes are operable.

Alkanol. Of the lower alkanols, isopropanol is utilized in the MSX Mix as solvent of choice. Methyl and ethyl alcohols are operable but not as effective.

Nitrobenzene. This compound, as in the bulk formulations, is utilized as an additional solvent useful in the bulk formulations. It is miscible with alkanols and is a superior organic solvent for the picric acid.

Tertiary long chain amines. The action of the amine is as a particulate reducer and a preferred compound is Primene 81R which is tertiary dodecyl amine.

Water. As to the water additive, a purified water free of extraneous metal ions is preferred, although tap water is operable.

INTRODUCTION OF THE COMPOSITION INTO THE COMBUSTION CHAMBER OF BULK FUEL

The introduction of the composition into a diesel or gasoline bulk container is made in a facile manner by premeasurement and adding the composition based upon the number of gallons in the container. Such bulk addition may be made per U.S. gallon by utilizing a ratio of 1:1,000 to 1:2,000 dosage addition by volume with a preferred dosage of 1:1600.

For atomized use, a preferred modus is to introduce a mixture of alcohol and active ingredients into the motor utilizing a system such as the Harlo MotorKlean Fuel System (manufactured by Harlo Repower Ltd., Clearbrook, B.C., Canada) for direct injection into the line leading into the manifold. A preferred solvent utilized in the Harlo equipment or the injection is (by volume):

25%: Isopropyl alcohol
25%: Water
12.5%: Ethanol
12.5%: MSX Mix
25%: Methanol

The introduction of the MSX Mix into the combustion chamber when using the water-alcohol mixture in the "Harlo Device" further enhances the operation. This results from being able to actually control the amount of catalytic material being introduced. By a very carefully selected orifice, one milliliter of the atomized mixture is introduced for every mile traveled. In this way, at no time is a heavy concentration of the "fuel saver" or "energy extender" introduced into the combustion chamber to be wasted. By the very makeup of the compound and its volatility, it is introduced in the usable vapor phase.

As a result of utilization of the present composition, it has been found by tests that improvements in fuel economy between 12.5 and 15.5 percent urban and up to 27 percent highway conditions have been experienced. The variable range is due to make, condition, size of the vehicle, coupled with the variations in road conditions that drivers have at city versus highway driving, etc. It can be further stated that a mean average mileage improvement for all tests is about 20%. Based currently on the U.S. price per gallon of about 70 cents per gallon, this means that about 14 cents on every gallon of gasoline can be effected in savings.

The present invention also has use for domestic heating and light industrial oils (#2 and #3) used in furnaces and boilers. Here the same catalytic action of the ferrous ion takes place and more complete combustion is the result. Less carbon and residue is formed and the heat is not insulated from the transfer equipment. A greater calorific value (in BTU's) is released, giving more heat and energy for the same given amount of fuel. This, of course, results in less and more acceptable emissions from the chimney or stack.

In the case of bunker fuels (#6), these fuels are heavier and much more viscous compounds, often containing considerable amounts of organic or inorganic salts, which upon burning can diffuse and cause heavy melts or ash.

Stated otherwise, when used with residual fuels (#4, #5) where high temperature, slagging, or corrosion may be the main problem, the present additive may be used in order to serve as a combustion catalyst to further improve the burning properties of the fuel proper, i.e., to improve the CO_2 content of the flue gas and reduce the amount of the organic or carbonaceous material that would be left behind.

With respect to jet engines and jet fuels, which are lighter, and aviation-type fuels or with naphthas and special distillates for gas turbines, the additive combinations will reduce coke and varnish deposits in the engines and exhaust parts.

EXAMPLE 1

MSX Mix Formulation

Toluene and isopropyl alcohol were mixed together. The trinitrophenol (picric acid) was introduced to this mixture and stirred gently. It dissolved completely when left overnight. The nitrobenzene was added with a slight stir. The ferrous sulfate was dissolved in a small amount of hot water (a maximum of one-half gallon for one hundred gallon mix) and added to the mixture.

The product was allowed to stand overnight. It was inspected for any sediment settling, after Quality Control Tests were made and the product passed. It was released for ultimate packaging.

The water usually present with the trinitrophenol (picric acid) was taken into consideration in the formulation of this product.

EXAMPLE 2

Exhaust Emission Test with MSX Mix

In May 1977 at the testing site of Scott Environmental Technology, Inc., two series of tests were run according to the 1975 Cold Start Exhaust Emission Test with the objective to determine the effectiveness of the MSX fuel additive when mixed directly in bulk with in-tank gasoline in reducing exhaust emissions and improving fuel economy. The site of the test was Scott's Plumsteadville, Pa., facility, which is certified by the U.S. Environmental Protection Agency for conducting the federal exhaust emission test herein described.

Test Vehicle Description

Both emission tests were performed on a 1976 Chevrolet Impala sedan (vin: 1L57H5113039) equipped with a standard 350 cid, V-8 engine with 2-bbl. carburetor and automatic transmission. The vehicle was received in stock condition for the first emission test, with a pretest mileage of 23,605.7. The vehicle was equipped with the stock 1976 Chevrolet emission control equipment, including catalytic converter.

Basic Test Data

The additive (Natural Resources Guardianship International, Inc., West Orange, New Jersey) consisted of a gasoline fuel additive (MSX Mix) mixed directly in the gasoline fuel tank of the test vehicle. This mixture consisted of one part additive to 1600 parts gasoline with the following composition denoted 5/77:

Ferrous sulfate: 0.16 g
Picric acid (trinitrophenol): 2.8 g
Toluene: 2.7 kg
Isopropyl alcohol: 0.9 kg
Nitrobenzene: 0.13 g
Water: Balance

For both tests, the baseline fuel used was Texaco's "lead-free" gasoline.

Test Procedure Description

The two 1975 cold start emission tests were performed in accordance with Federal Register Volume 41, Number 146. Deviations from this procedure included use of Natural Resources Guardianship International's in-tank fuel supply for both the baseline and device tests, and the calculation of carbon dioxide mass emissions for use in determining fuel economy.

The test vehicle was delivered to Scott's Plumsteadville, Pa., facility by 1600 hours on May 3, 1977, with the initial "cold soak" beginning by 1700 hours. The following morning the dynamometer was warmed up with a non-test vehicle and the load set at 14.7 RHP at 50 miles per hour (the vehicle was equipped with factory air conditioning). The dynamometer inertia was fixed at 5,000 pounds. The baseline emission test (stock condition, no device) was begun at 1032 hours and completed by 1112 hours.

Following the baseline test, several additional emission tests were performed on the test vehicle including one 1975 Federal Cold Start Test (Scott Reports SET 1620-01-0577 and SET 1620-02-0577) and several 1972 "Hot-Start" emission tests (Scott Report SET 1620-03-0577).

On May 16 and 17, 1977, Scott personnel blended intank fuel (1 part MSX Mix additive to 1600 parts Texaco lead-free gasoline) then accumulated 500.7 miles on the vehicle. (Mileage start: 25871.8; mileage end: 26372.5). The "cold soak" period began at 1715 on May 17, 1977, and was terminated at the beginning of the 1975 "Cold-Start" Test No. 3 at 0927 hours on May 18.

The basic equation used to calculate the fuel economy of a vehicle, in miles per gallon, from the mass emission data gathered during a 1975 Federal Emission Test is as follows:

$$\text{mpg} = \frac{\text{grams of carbon/gallon of fuel}}{\text{grams of carbon in exhaust/mile}}$$

SUMMARY OF RESULTS

The data presented in Table 1 below summarizes the vehicle exhaust emission and fuel economy tests performed. The exhaust emissions are presented in grams per mile for total hydrocarbons, carbon monoxide and oxides of nitrogen. Fuel economy measurements are shown in miles per gallon. Also included are the applicable 1976 Federal Exhaust Emission Standards for light duty vehicles.

In comparing the two sets of test results, use of the MSX Mix additive mixed with the in-tank fuel reduced carbon monoxide and hydrocarbons while increasing oxides of nitrogen emissions. In addition, fuel economy improved from 8.72 MPG to 10.65 MPG.

TABLE 1

Data Summary - 1975 Federal Exhaust Emission Tests

Test Date	Test Description	CO g/mi.	THC g/mi.	NO_x g/mi.	Fuel Economy (miles per gallon)
May 4, 1977	Baseline - Stock Condition	16.6	0.60	1.69	8.72
May 18, 1977	MSX Mix Additive - In-Tank Blending	9.4	0.46	2.32	10.65
	(Federal Standards 1976 LDV)	15.0	1.50	3.10	—

EXAMPLE 3

In the same manner as the procedure utilized in Example 2, another series of tests utilized the MSX additive designated 7/77. This additive had the composition per U.S. gallon as follows:

Ferrous sulfate: 1.36 grams

Picric acid: 45.36 grams
Toluene: 2.38 kg
Isopropyl alcohol: 1.02 kg
Nitrobenzene: 2.72 grams
Long chain amine; e.g., tertiary dodecylamine: 1.66 grams
Water: Balance

and the following results were obtained as shown in Table 2.

TABLE 2

TESTS USING ADDITIVE OF 7/77
Data Summary - 1975 Federal Exhaust Emission and Fuel Economy Tests
(Performed by Scott Environmental Technology, Inc.)

		CO	THC	NO_x	Fuel Economy miles per gallon	
		g/mi.	g/mi.	g/mi.	Urban	Highway
1976 Chevrolet Caprice	Baseline - stock condition without Additive	4.1	.61	3.18	9.85	18.26
1976 Chevrolet Caprice	With 7/77 Additive	2.3	.49	3.79	12.55	27.73
1976 Chevrolet Caprice	% increase or (decrease)	(44)	(20)	19	27	52
1975 Pontiac Astre	Baseline - stock condition without Additive	40.4	2.62	1.23	15.45	not completed
1975 Pontiac Astre	With 7/77 Additive	27.1	2.30	1.40	19.62	not completed
1975 Pontiac Astre	% increase or (decrease)	(33)	(12)	14	27	not completed
	Federal Standards 1976 LDV	15.0	1.50	3.10	—	—

EXAMPLE 4

An ASTM D-13-56 Copper Strip and Stainless Steel Corrosion Test was effected using the 7/77 additive formulation (see Example 3) comparing various inorganic metal salts with ferrous sulfate. This test was made for 3 hours at 212° F.

Salt	ASTM D-13-56 Results
Ferrous sulfate	No. 1 (Pass) (No change)
Nickel sulfate	No. 2 (Dark tarnish, multicolored, peacock)
Nickel nitrate	No. 3 (Magenta, light gray)
Cadmium sulfate	No. 3 (Magenta, brown)

A vapor phase corrosion test was made where vapors were utilized for 30 minutes at 300° to 500° F. In this case the iron salt showed slight discoloration whereas the other metal salts blackened with slight pitting. Both stainless steel and copper strips were used in this test.

I claim:

1. A fuel additive for internal combustion and diesel engines consisting of an active ingredient formulation comprising a mixture of picric acid and ferrous sulfate in a relationship of picric acid:ferrous sulfate of about 2:1 to about 550:1 in a mixed solvent of lower alcohol, toluene, and water.

2. The additive according to claim 1 wherein the additive is in atomized form for introduction into the engine.

3. The additive according to claim 1 which additionally contains a minor amount of nitrobenzene as a solvent.

4. The additive according to claim 1 which additionally contains a minor amount of tertiary dodecylamine as a particulate reducer.

5. An additive for direct bulk addition to gasoline and diesel fuel containers which comprises in one U.S. gallon:

Ferrous sulfate: 0.08–1.4 g
Picric acid: 2.8–45.0 g
Toluene: 2.4–1.0 kg
Isopropyl alcohol: 1.0–2.4 kg
Nitrobenzene: 0.08–2.7 g
Tertiary dodecylamine: 0.2–1.7 g
Water: Balance.

6. The additive according to claim 5 wherein the preferred amount in one U.S. gallon is:

Ferrous sulfate: 1.4 g
Picric acid: 45.0 g
Toluene: 2.4 kg
Isopropyl alcohol: 1.0 kg
Nitrobenzene: 2.7 g
Tertiary dodecylamine: 1.7 g
Water: Balance.

7. The additive according to claim 1 wherein the dosage utilized for addition to fuel is 1:1,000 to 1:2,000 additive to fuel.

8. The additive according to claim 1 wherein the dosage utilized for addition to fuel is about 1:1600 additive to fuel.

9. A method for treating fuels for gasoline and diesel engines which comprises adding thereto to each U.S. gallon an additive/fuel comprising a mixture of picric acid and ferrous sulfate in a relationship of picric acid:ferrous sulfate of about 2:1 to about 550:1 in a mixed solvent of lower alkanol, toluene, and water in a dosage of about 1:1,000 to 1:2,000 additive to fuel.

10. The method according to claim 9 wherein the dosage is about 1:1600 additive to fuel.

11. The method according to claim 9 wherein the additive is in atomized form for introduction into the engine.

12. The method according to claim 9 wherein the additive additionally contains a minor amount of nitrobenzene as a solvent.

13. The method according to claim 9 wherein the additive additionally contains a minor amount of tertiary dodecylamine as a solvent.

14. An additive for use in bunker and residual fuels which has the following ingredients per U.S. gallon:

Ferrous sulfate: 4–5.6 g
Picric Acid: 8–12 g
Toluene: 4–5.6 kg
Isopropanol: 0.8–1.2 kg
Tertiary dodecylamine: 0.2–1.7 g
Water: Balance.

15. The additive according to claim 14 wherein the ingredients have preferred values per U.S. gallon as follows:

Ferrous sulfate: 4 g
Picric Acid: 8 g
Toluene: 4 kg
Isopropanol: 0.8 kg
Tertiary dodecylamine: 0.2 g
Water: Balance.

16. The additive according to claim 14 wherein the dosage is in the ratio of 1:1,000 to 1:2,000 additive to fuel.

17. The additive according to claim 14 wherein the dosage is in the ratio of about 1:1600 additive to fuel.

* * * * *

Evaluation of XRG #1 a Fuel Additive

by

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February 1980

Test and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Environmental Protection Agency

Background

The Environmental Protection Agency receives information about many systems which appear to offer potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems because of the obvious benefits to the Nation from the identification of systems that can reduce emissions, improve fuel economy, or both. EPA invites developers of such systems to provide complete technical data on the system's principle of operation, together with available test data on the system. In those cases for which review by EPA technical staff suggests that the data available shows promise, attempts are made to schedule tests at the EPA Motor Vehicle Emission Laboratory at Ann Arbor, Michigan. The results of all such test projects are set forth in a series of Test and Evaluation Reports, of which this report is one.

In February of 1978 the EPA tested NRG #1, a fuel additive developed and marketed by NRG International, Inc. of Clayville, New York. Contrary to NRG's claims, the test results showed, "neither a general increase in fuel economy nor a decrease in emissions associated with the addition of NRG #1 to the fuel." (1)(Evaluation of NRG #1, A Fuel Additive, TAEB Report 77-19, February 1978).*

In response to a request from the Federal Trade Commission for more in-depth information on NRG #1 (now referred to as "XRG #1") (2) this new series of tests was performed.

The conclusions drawn from the EPA evaluation tests are necessarily of limited applicability. A complete evaluation of the effectiveness of an emission control system in achieving performance improvements on the many different types of vehicles that are in actual use requires a much larger sample of test vehicles than is economically feasible in the evaluation test projects conducted by EPA. For promising systems it is necessary that more extensive test programs be carried out.

The conclusions from the EPA evaluation test can be considered to be quantitively valid only for the specific test cars used; however, it is reasonable to extrapolate the results from the EPA test to other types of vehicles in a directional manner, i.e., to suggest that similar results are likely to be achieved on other types of vehicles.

Summary of Findings

There was no significant change in emissions or fuel economy through the use of XRG #1 for the group of vehicles tested.

For individual vehicles, the Citation showed a 2% fuel economy improvement on the FTP and 4% fuel economy improvement on the HFET. There was no significant increase or decrease in fuel economy for the Dart and Fairmont for either the FTP or HFET.

* Numbers in parenthesis designate references at the end of this report.

Description

XRG #1 is a fuel additive developed and marketed by XRG International, Inc., (formerly NRG International) of Clayville, New York.

XRG #1 is recommended by the manufacturer for use "with all grades of gasoline and diesel fuel used in internal combustion engines." It is mixed directly with fuel in the vehicle's tank in a ratio of 1:1600 (0.08 fl. oz. additive per gallon fuel). The following benefits are claimed by the manufacturer when the additive is used in an automotive gasoline engine (3):

- Increased fuel economy of 10-25%.
- Decreased exhaust emissions.
- Increased engine power.
- Decreased starting time in cold weather.
- Decreased dieseling tendency.
- Decreased carbon buildup inside engine.

The manufacturer claims these benefits occur over a period of time of continued usage. That is, there are some immediate benefits from usage of the fuel additive but full benefits are obtained only after several tankfuls of the XRG #1 additive doped fuel. In addition, to retain these benefits, XRG #1 usage must be continued.

Test Vehicle Description

The three test vehicles used in this study were:

A 1980 Chevrolet Citation equipped with a 2.8 litre V-6 engine and an automatic transmission. This vehicle used EGR, an oxidation catalyst, and pulsating air injection for emission control.

A 1975 Dodge Dart equipped with a 225 cubic inch inline 6-cylinder engine and an automatic transmission. This vehicle was calibrated to meet the 1975 California emission standards. This vehicle used an air pump, EGR, and an oxidation catalyst for emission control.

A 1979 Ford Fairmont equipped with a 140 cubic inch inline 4-cylinder engine and automatic transmission. This vehicle used an oxidation catalyst for emission control.

A complete description of these vehicles is given in the test vehicle description in Appendix A.

Test Procedure

Exhaust emission tests were conducted according to the 1977 Federal Test Procedure (FTP) described in the Federal Register of June 28, 1977, and the EPA Highway Fuel Economy Test (HFET), described in the Federal Register of September 10, 1976. The vehicles were not tested for evaporative emissions.

Prior to baseline testing, each vehicle was given a specification check and inspection. The ignition timing, idle speed, and fast idle speed were checked for agreement with the manufacturer's specifications given on the Vehicle Emission Control Information label affixed to the engine compartment. Each vehicle met its manufacturer's specifications and therefore no adjustments were required.

The vehicles were inspected for engine vacuum leaks, proper connection of vacuum hoses, functioning PCV valve, oil and water levels, and general condition of engine compartment. Each vehicle was in satisfactory condition when initially inspected.

Because the manufacturer's claims for XRG #1 additive included both immediate and long term benefits (3) the test program included testing both immediately after initial additive usage and after-mileage accumulation with the additive. Each vehicle was tested in three different conditions:

1. Baseline - as received.
2. With XRG #1 (vehicle fuel tank drained, refueled with additive doped fuel and prepped before this test).
3. After 500 miles with XRG #1.

At each test condition duplicate FTP and HFET tests were conducted. The accumulation of 500 miles using fuel with XRG #1 consisted of sequences of 10 HFET driving cycles and one LA-4 (the basic FTP cycle) driving cycle. The relatively high average speed of the HFET (48 mph) was expected to minimize the amount of time to achieve those additive benefits that are based on vehicle mileage accumulation. Mileage accumulation was accomplished on a dynamometer.

In addition, one vehicle, that was used in later test programs, received baseline tests after the 500 mile XRG #1 tests.

All testing was performed using the same gasoline batch. Two barrels of the gasoline batch were doped with the XRG #1 at the manufacturer's prescribed doseage of 1600 parts gasoline to one part XRG #1. This XRG #1 doped gasoline was used for all XRG #1 tests and mileage accumulation.

Discussion of Results

General Data Analysis

The objective of this test program was to determine if there was a significant beneficial change in vehicle emissions, fuel economy, or performance through the use of the fuel additive XRG #1.

The results of these tests are summarized in Tables I and II. Results of individual tests are given in Tables V through X in Appendix B. The results of the statistical analysis and actual changes between configurations are shown in Tables III and IV.

Table I

Average Vehicle FTP Emissions
grams per mile

Test Condition	HC	CO	CO_2	NOx	MPG
		Chevrolet Citation - FTP			
Baseline	.35	1.93	450	1.55	19.5
XRG #1	.32	2.03	449	1.62	19.6
XRG #1 @ 500 miles	.33	1.86	440	1.61	20.0
		Dodge Dart - FTP			
Baseline	.63	7.90	568	1.81	15.3
XRG #1	.65	8.64	583	1.72	14.8
XRG #1 @ 500 miles	.48	6.93	563	1.85	15.4
		Ford Fairmont - FTP			
Baseline	.76	8.40	400	1.83	21.3
XRG #1	.71	8.57	402	1.83	21.2
XRG #1 @ 500 miles	.74	7.74	404	1.85	21.2

Table II

Average Vehicle HFET Emissions
grams per mile

Test Condition	HC	CO	CO_2	NOx	MPG
		Chevrolet Citation - HFET			
Baseline	.07	.02	313	1.29	28.4
XRG #1	.06	.00	310	1.25	28.6
XRG #1 @ 500 miles	.07	.00	300	1.47	29.5
		Dodge Dart - HFET			
Baseline	.05	.15	368	2.58	24.1
XRG #1	.04	.11	374	2.17	23.7
XRG #1 @ 500 miles	.04	.10	364	2.41	24.4
		Ford Fairmont - HFET			
Baseline	.15	.63	317	2.48	27.9
XRG #1	.14	.68	320	2.52	27.6
XRG #1 @ 500 miles	.14	.58	313	2.35	28.2

Table III

FTP Change From Baseline Due to XRG #1 Fuel
Expressed in % at Minimum Stated Confidence Level*

Test Condition	HC	CO	NOx	MPG
Chevrolet Citation - FTP XRG #1 at 500 miles	-6%***	-4%***	4% 93% C.L.	2% 99% C.L.
Dodge Dart - FTP XRG #1 at 500 miles	-24%***	-12%***	2%***	1%***
Ford Fairmont - FTP XRG #1 at 500 miles	-3%***	-8% 94% C.L.	1%***	0%
Combined Effect - All Vehicles XRG 31 at 500 miles	***	***	***	***

Table IV

HFET Change From Baseline Due to XRG #1 Fuel
Expressed in % Change at Minimum Confidence Level*

Test Condition	HC	CO	NOx	MPG
Chevrolet Citation - HFET XRG #1 at 500 miles	----	----	14% 99% C.L.	5% 99% C.L.
Dodge Dart - HFET XRG #1 at 500 miles	----	----	-7%***	1%***
Ford Fairmont - HFET XRG #1 at 500 miles	----	----	-5%***	1%***
Combined Effect - All Vehicles XRG #1 at 500 miles	----	----	***	***

* Confidence level from statistical "t" test procedure and direction of change.

C.L. - Confidence Level

**+ indicates increase; - indicate decrease.

*** indicates change not significant at 90% confidence level. That there is no significant change.

Note: The confidence level should not be confused with changes of absolute values but are an indication of the statistical significance of the changes in the values given in Tables I and II.

Note: The confidence level was not calculated for the initial XRG #1 tests.

Note: Percent change not calculated for HC and CO emissions for HFET. See text.

From an initial review of the data given in Tables III and IV, it may appear that use of XRG #1 did cause some small changes in individual vehicle emissions or fuel economy. However, in order to determine whether the apparent differences were statistically significant, a significance test, such as a "t" test must be performed. This technique analyzes the difference due to the subject variable in relation to test to test variability to determine if the difference is real or is due to testing variability. The resultant significance determinations are stated in terms of the minimum percent confidence level that can be ascribed to the observed difference.

The "t" test technique allows the determination of the effect of one variable (use of XRG #1 additive) on a vehicle. The "t" test is also able to indicate how representative the effect of the variable is for a group of vehicles. The resultant levels of significance are stated in terms of percents. This confidence level indicates the probability of assigning differences to the variable (use of XRG #1 additive) being analyzed. With a test program of the size performed, changes with confidence levels below 90% are not significant.

EFFECT OF XRG #1

Federal Test Procedure

The use of XRG #1 did not significantly affect the HC emissions for the Citation, Dart or Fairmont.

The use of XRG #1 caused mixed effects on CO emissions. There was no significant change in the Citation's or Dart's CO emissions. The Fairmont's emissions decreased 8% (at the 94% confidence level).

The use of XRG #1 caused mixed effects on NOx emissions. The Citation's NOx emissions increased 4% at the 93% confidence level. XRG #1 did not significantly affect the NOx emissions on the Dart or Fairmont.

The use of XRG #1 did not significantly affect the fuel economy of the Dart or Fairmont. (The Citation's fuel economy showed a slight improvement, 2% (at 99% confidence level).

When the FTP results were analyzed to determine the effects of XRG #1 on the group of vehicles, the analysis showed that the use of XRG #1 did not significantly affect either HC, CO and NOx emissions or fuel economy.

Highway Fuel Economy Test

The HC and CO emissions for all three vehicles were quite low both with and without use of the additive. HC and CO emissions are usually very low for most vehicles on the HFET. Thus, even a very small change such as .01 grams per mile could appear as a 5% to 30% relative change. Therefore, since the results were low and similar, there was no significant change in HC or CO emissions caused by the use of XRG #1.

The use of XRG #1 caused mixed results on NOx emissions. The Citation's NOx emissions increased 14% at the 99% confidence level. The Dart's and Fairmont's NOx emissions were not significantly affected.

The use of XRG #1 did not significantly affect the fuel economy of the Dart or Fairmont. The Citation's fuel economy showed a slight improvement, 4% at the 99% confidence level.

The analysis of the HFET results to determine the effects of XRG #1 on the group of vehicles showed that the use of XRG #1 did not significantly affect either HC, CO and NOx emissions or fuel economy.

Discussion of Additive Components and Their Effects

According to the manufacturer, XRG #1 is composed mostly of isopropol alcohol and toluene. It also contains a small amount of ferrous sulphate, nitro benzene and water (4). An exact chemical breakdown was not given.

Toluene is a normal component of gasoline. Unleaded gasoline is reported to presently contain 10 to 15% toluene and leaded gasoline 5 to 10% toluene (5). Premium leaded fuel is 6% toluene. Individual gasoline fuel samples have had up to 45% toluene.

Conclusions

Although a few individual tests indicated slight improvements in emissions or fuel economy through the use of XRG #1, several tests indicated small emission or fuel economy penalties. A significant but small improvement in fuel economy was noted on one vehicle for the FTP and HFET. However, for the group of vehicles, XRG#1 showed no significant effect on vehicle emissions or fuel economy.

References

1. Evaluation of NRG #1, a Fuel Additive. TAEB Technical Report 77-19, February 1978.

2. Telephone conversation between Mr. F. Peter Hutchins, Project Manager, EPA and Mr. Brian Boshart, engineer, XRG International Inc., on August 8, 1979.

3. NRG Fuel Additive, product information brochure (Note XRG = NRG).

4. Letter dated September 16, 1977 from Mr. Brian F. Boshart, NRG International to Mr. Craig Harvey, EPA. Subject, NRG contents and previous test program schedule.

5. Telephone conversation between Mr. F. Peter Hutchins, EPA and Mr. William Meyer, Gulf Research and Development, on September 4, 1979. Subject, toluene in gasolines.

Appendix A

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1980 Chevrolet Citation

Vehicle ID - 1X117AW150868

Engine

type	V-6, 4-Cycle
bore x stroke	89 x 76 mm/3.50 x 2.99 in.
displacement	2800 cc/170.9 CID
compression ratio	8.5 to 1
maximum power at rpm	115 hp/85.8 kW
fuel metering	2 Venturi Carburetor
fuel requirement	unleaded, tested with Indolene HO unleaded

Drive Train

transmission type	3-speed automatic
final drive ratio	2.53

Chassis

type	4 door sedan
tire size	P185/80R13
curb weight	2905 lb/1318 kg.
inertia weight	3000 lb.
passenger capacity	5

Emission Control System

basic type	Oxidation catalyst EGR Pulsating air injection

Vehicle Odometer Mileage

6730 miles at start of test program
7480 miles at end of test program

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1975 Dodge Dart
Emission control system - Air Pump, Catalyst EGR
Vehicle I.D. - LH41C5B290359

Engine

type	Inline 6, 4-cycle
bore x stroke	3.40 X 4.125 in.
displacement	225 CID/3687 cc
compression ratio	8.4:1
fuel metering	1 Venturi, carburetor
fuel requirement	unleaded, tested with Indolene HO unleaded

Drive Train

transmission type	3-speed automatic
final drive ratio	2.75

Chassis

type	4 door sedan
tire size	D78 X 14
inertia weight	3500 lb.
passenger capacity	6

Emission Control System

basic type	air pump oxidation catalyst EGR calibrated to 1975 California standards

Vehicle Odometer Mileage

20635 miles at start of test program
21950 miles at end of test program

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1979 Ford Fairmont
Vehicle I.D. 9X92Y175689

Engine

type	Inline 4, 4-cycle
bore x stroke	3.80 X 3.10 in./96.5 X 78.7 mm.
displacement	140 CID/2.3 l
compression ratio	9.0:1
maximum power	92 hp/68.6 k W
fuel metering	2 Venturi, carburetor
fuel requirement	unleaded, tested with Indolene HO unleaded

Drive Train

transmission type	3-speed automatic
final drive ratio	3.08

Chassis

type	4 door sedan
tire size	BR 78 X 14
curb weight	2800 lb/1270 kg
inertia weight	3000 lb.
passenger capacity	5

Emission Control System

basic type	oxidation catalyst

Vehicle Odometer Mileage

10890 miles at start of test program
11525 miles at end of test program

Table V

Chevrolet Citation FTP Emissions
grams per mile

Test Condition	Test #	HC	CO	CO_2	NOx	MPG
Baseline	79-9919	.39	2.29	452	1.54	19.4
Baseline	79-9921	.32	1.66	450	1.56	19.5
Baseline	79-9923	.33	1.73	450	1.56	19.5
Baseline	79-9925	.34	2.03	449	1.52	19.6
XRG (14 miles)	79-9927	.32	2.23	450	1.60	19.5
XRG (55 miles)	79-9929	.31	1.83	447	1.63	19.7
XRG (524 miles)	79-9931	.35	1.87	441	1.57	19.9
XRG (552 miles)	79-9978	.32	1.91	440	1.65	20.0
XRG (591 miles)	79-9980	.32	1.80	439	1.62	20.0

Table VI

Dodge Dart FTP Emissions
grams per mile

Test Condition	Test #	HC	CO	CO_2	NOx	MPG
Baseline	79-9778	.83	9.94	579	1.60	14.9
Baseline	79-9781	.79	8.58	591	1.52	14.6
Baseline (769 miles)	80-0246	.38	6.06	547	1.99	15.9
Baseline (1192 miles)	80-0735	.50	7.00	553	2.11	15.7
XRG (8 miles) 9-12	79-9782	.46	7.00	583	1.72	14.9
XRG (42 miles) 9-13	79-9784	.84	10.27	583	1.71	14.7
XRG (521 miles)	79-9786	.49	6.68	566	1.89	15.3
XRG (554 miles)	79-9788	.47	7.12	562	1.78	15.4
XRG (595 miles)	79-9986	.47	6.99	561	1.87	15.5

Table VII

Ford Fairmont FTP Emissions
grams per mile

Test Condition	Test #	HC	CO	CO_2	NOx	MPG
Baseline	79-9909	.76	8.29	400	1.83	21.3
Baseline	79-9911	.76	8.50	400	1.82	21.3
XRG (5 miles)	79-9913	.72	8.58	403	1.83	21.2
XRG (52 miles)	79-9915	.70	8.56	400	1.83	21.3
XRG (509 miles)	79-9917	.74	7.88	403	1.91	21.2
XRG (540 miles)	79-9984	.74	7.59	404	1.79	21.2

Table VIII

Chevrolet Citation HFET Emissions
grams per mile

Test Condition	Test #	HC	CO	CO_2	NOx	MPG
Baseline	79-9920	.07	.00	311	1.20	28.5
Baseline	79-9922	.07	.05	316	1.35	28.0
Baseline	79-9924	.07	.01	313	1.24	28.3
Baseline	79-9926	.07	.01	310	1.37	28.6
XRG (24 miles)	79-9928	.06	.00	309	1.27	28.7
XRG (66 miles)	79-9930	.06	.00	310	1.22	28.6
XRG (536 miles)	79-9932	.07	.00	301	1.47	29.4
XRG (568 miles)	79-9979	.07	.00	299	1.44	29.6
XRG (608 miles)	79-9981	.07	.00	299	1.50	29.6

Table IX

Dodge Dart HFET Emissions
grams per mile

Test Condition	Test #	HC	CO	CO_2	NOx	MPG
Baseline	79-9779	.05	.09	379	2.02	23.4
Baseline	79-9780	.05	.08	374	2.01	23.7
Baseline (781 miles)	80-0316	.05	.19	356	2.79	24.9
Baseline (1228 miles)	80-0734	.06	.22	362	3.48	24.5
XRG (19 miles)	79-9783	.04	.12	376	2.07	23.6
XRG (53 miles)	79-9785	.04	.09	372	2.27	23.8
XRG (532 miles)	79-9787	.04	.06	364	2.40	24.4
XRG (565 miles)	79-9789	.05	.09	365	2.34	24.3
XRG (606 miles)	79-9987	.04	.14	364	2.48	24.4

Table X

Ford Fairmont HFET Emissions
grams per mile

Test Condition	Test #	HC	CO	CO_2	NOx	MPG
Baseline	79-9910	.14	.55	316	2.50	28.0
Baseline	79-9912	.15	.70	317	2.45	27.8
XRG (24 miles)	79-9914	.14	.68	320	2.44	27.6
XRG (63 miles)	79-9916	.14	.67	319	2.61	27.7
XRG (520 miles)	79-9918	.13	.57	312	2.31	28.3
XRG (551 miles)	79-9985	.14	.59	314	2.39	28.1

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Evaluation of NRG #1, A Fuel Additive

February 1978

Technology Assessment and Evaluation Branch
Emission Control Technology Division
Office of Mobile Source Air Pollution Control
Environmental Protection Agency

Background

The Environmental Protection Agency receives information about many systems which appear to offer potential for emission reduction or fuel economy improvement compared to conventional engines and vehicles. EPA's Emission Control Technology Division is interested in evaluating all such systems, because of the obvious benefits to the Nation from the identification of systems that can reduce emissions, improve fuel economy, or both. EPA invites developers of such systems to provide complete technical data on the system's principle of operation, together with available test data on the system. In those cases for which review by EPA technical staff suggests that the data available show promise, attempts are made to schedule tests at the EPA Motor Vehicle Emission Laboratory at Ann Arbor, Michigan. The results of all such test projects are set forth in a series of Technology Assessment and Evaluation Reports, of which this report is one.

NRG #1 is a fuel additive developed and marketed by NRG International Inc. of Clayville, New York. A representative of NRG supplied EPA with results of tests conducted by Scott Environmental Technology, Inc. which showed that use of the additive resulted in increased fuel economy as well as significant reductions in HC and CO emissions. On the basis of this data, EPA decided to conduct confirmatory tests.

The conclusions drawn from the EPA evaluation tests are necessarily of limited applicability. A complete evaluation of the effectiveness of an emission control system in achieving performance improvements on the many different types of vehicles that are in actual use requires a much larger sample of test vehicles than is economically feasible in the evaluation test projects conducted by EPA. For promising systems it is necessary that more extensive test programs be carried out.

The conclusions from the EPA evaluation test can be considered to be quantitatively valid only for the specific test car used; however, it is reasonable to extrapolate the results from the EPA test to other types of vehicles in a directional manner, i.e., to suggest that similar results are likely to be achieved on other types of vehicles.

Description

NRG #1 is recommended by the manufacturer for use with all grades of gasoline and diesel fuel used in internal combustion engines. It is mixed directly with fuel in the vehicle's tank in a ratio of 1:1600 (0.08 fl. oz. additive per gallon fuel). The following benefits are claimed by the manufacturer when the additive is used in an automotive gasoline engine:

-Increased fuel economy of 10-25%

-Decreased exhaust emissions

-Increased engine power

-Decreased starting time in cold weather

-Decreased dieseling tendency

-Decreased carbon buildup inside engine

Test Procedure

Exhaust emission tests were conducted according to the 1977 Federal Test Procedure (FTP), described in the Federal Register of June 28, 1977, and the EPA Highway Fuel Economy Test (HFET), described in the Federal Register of September 10, 1976. Steady state and Federal Short Cycle tests were also conducted. Evaporative emissions were not tested.

Prior to baseline testing the vehicle, described in Table 1, was tuned to Chevrolet's specifications for ignition timing, idle speed, and spark plug gap. One spark plug was found to be fouled with oil, so it was replaced. Compression in all cylinders was also checked and found to be within specification. To precondition the vehicle, it was driven on the dyno for two cycles of the Urban Dynamometer Driving Schedule (UDDS), one HFET cycle, and another UDDS cycle.

The vehicle was tested in three different conditions:

1) Baseline

2) With NRG #1

3) After 500 miles with NRG #1

At each test condition duplicate tests of each type (FTP, HFET, Steady States, Federal Short Cycle) were conducted. The accumulation of 500 miles was made up of 400 miles AMA durability on a test track and 100 miles of highway driving to and from the test track.

Test Results

Table 2 gives a comparison between average results of baseline (before addition of NRG #1) and final (after 500 miles with NRG #1) test conditions. In general, emission levels remained the same or increased with NRG #1 in the fuel. In particular, use of the additive resulted in the following:

- Increased NOx emissions in all test procedures
- Reduced HC emissions (approximately 15%) for steady state tests at 40 and 50 mph
- Increased HC emissions for all other test procedures
- Increased CO emissions (approximately 23%) for the FTP
- Decreased CO emissions (100%) for the Federal Short Cycle
- No measurable change in CO emissions for other tests

CO emissions for HFET and steady state tests were less than 0.1 gram/mile. This is due to the effectiveness of the catalytic converter once it is warmed up.

Changes in average fuel economy were small. Most tests showed a decrease in fuel economy with NRG #1 in the fuel, but the HFET, 40 mph, and 50 mph tests showed slight (less than 3%) increases in fuel economy with the additive.

Conclusions

Although a few EPA tests of NRG #1 showed slight improvements in either fuel economy or emissions, the majority of tests indicated that use of the additive decreased fuel economy while increasing emissions. This leads to the conclusion that there is neither a general increase in fuel economy nor a decrease in emissions associated with the addition of NRG #1 to the fuel.

Table 1

TEST VEHICLE DESCRIPTION

Chassis model year/make - 1975 Chevrolet Nova
Emission control system - EGR, Catalyst, Air Injection (California calibration)

Engine

type	V-8, OHV
bore x stroke	4.00 x 3.48 in. (101.6 x 88.4 mm)
displacement	350 cu. in. (5735 cc)
compression ratio	9.0
maximum power @ rpm	200 hp @ 5200 rpm (150 kW)
fuel metering	Carburetor, 4V
fuel requirement	Unleaded regular, tested with Indolene HO unleaded 100 octane

Drive Train

transmission type	Automatic 3-speed
final drive ratio	3.08

Chassis

type	Sedan, 2 door
tire size	ER78 x 14
curb weight	3585 lb. (1626 kg)
inertia weight	4000 lb.
passenger capacity	six

Emission Control System

basic type	EGR, Catalyst, Air Injection

Table 2
Comparison of Baseline and Final Test Averages

Test Procedure		Baseline	500 Miles With Additive	% Change
FTP	HC (g/mi)	.62	.81	+ 31
	CO (g/mi)	4.8	5.9	+ 23
	NOx (g/mi)	1.86	2.01	+ 8.1
	F.E. (mpg)	12.7	12.5	- 1.6
HFET	HC	.13	.14	+ 7.7
	CO	0.0	0.0	0.0
	NOx	2.69	2.94	+ 9.3
	F.E.	17.3	17.7	+ 2.3
Steady State 20 mph	HC	.15	.24	+ 60
	CO	0.0	0.0	0.0
	NOx	.30	.32	+ 6.7
	F.E.	20.2	16.2	- 20
30 mph	HC	.09	.11	+ 22
	CO	0.0	0.0	0.0
	NOx	.42	.47	+ 12
	F.E.	19.8	19.3	- 2.5
40 mph	HC	.08	.07	- 13
	CO	0.0	0.0	0.0
	NOx	.88	.97	+ 10
	F.E.	19.7	19.8	+ 0.5
50 mph	HC	.11	.09	- 18
	CO	0.0	0.0	0.0
	NOx	1.74	2.08	+ 20
	F.E.	18.7	19.1	+ 2.1
Idle Neutral	HC (g/hr)	1.31	4.02	+207
	CO (g/hr)	0.0	0.0	0.0
	NOx (g/hr)	2.39	3.36	+ 41
	F.E. (gal/hr)	.74	.86	- 16
Idle Drive	HC (g/hr)	.54	1.08	+100
	CO (g/hr)	0.0	0.1	+infinite
	NOx (g/hr)	2.94	3.06	+ 4.1
	F.E. (gal/hr)	.79	.85	- 7.6
Federal Short Cycle	HC (g/mi)	.21	.29	+ 38
	CO (g/mi)	0.2	0.0	-100
	NOx (g/mi)	.91	1.26	+ 38
	F.E. (mpg)	14.9	14.9	0.0

Table 3
Baseline Tests

Test #	Test	HC (gram/mi)	CO (gram/mi)	NOx (gram/mi)	Fuel Economy (mi/gal)
78-5955	Bag 1	1.63	23.8	2.53	12.0
	Bag 2	.27	0.0	1.23	12.2
	Bag 3	.56	0.7	2.46	14.3
	FTP	.63	5.1	1.84	12.7
78-5960	Bag 1	1.66	20.6	2.64	12.1
	Bag 2	.31	0.1	1.28	12.2
	Bag 3	.38	0.7	2.45	14.1
	FTP	.61	4.5	1.88	12.6
78-5956	HFET	.13	0.0	2.82	17.0
78-5961	HFET	.13	0.0	2.56	17.6
78-5957	Fed. Short	.22	0.2	0.74	14.9
78-5962	Cycles	.20	0.1	1.07	14.9
	Steady States				
78-5958	20 mph	.19	0.0	.34	20.8
78-5963	20	.10	0.0	.25	19.6
78-5958	30	.09	0.0	.45	19.4
78-5963	30	.08	0.0	.39	20.1
78-5959	40	.11	0.0	.82	19.7
78-5964	40	.05	0.0	.93	19.6
78-5959	50	.11	0.0	1.78	18.9
78-5964	50	.10	0.0	1.70	18.5
		(gram/hr)	(gram/hr)	(gram/hr)	(gal/hr)
78-5958	Idle	1.66	0.0	2.14	0.59
78-5963	Neutral	.96	0.0	2.64	0.89
78-5959	Idle	1.08	0.0	3.00	0.81
78-5964	Drive	0.00	0.0	2.88	0.76

Table 4
Tests With NRG #1 Added

Test #	Test	HC (gram/mi)	CO (gram/mi)	NOx (gram/mi)	Fuel Economy (mi/gal)
78-6329	Bag 1	1.70	23.8	2.71	12.1
	Bag 2	.27	0.1	1.25	12.2
	Bag 3	.28	0.4	2.60	14.1
	FTP	.57	5.0	1.92	12.6
78-6367	Bag 1	1.58	19.9	2.75	12.3
	Bag 2	.29	0.0	1.25	12.3
	Bag 3	.35	0.8	2.38	14.5
	FTP	.57	4.3	1.87	12.8
78-6328	HFET	.13	0.0	3.17	16.9
78-6394	HFET	.13	0.1	2.96	17.0
78-6331	Fed. Short	.19	0.0	1.16	16.1
78-6331	Cycles	.20	0.0	1.18	15.8
	Steady States				
78-6327	20 mph	.17	0.0	.29	19.5
78-6333	20	.21	0.0	.25	21.3
78-6327	30	.08	0.0	.45	19.4
78-6332	30	.08	0.0	.43	19.8
78-6326	40	.13	0.0	.85	19.5
78-6395	40	.07	0.0	.91	20.5
78-6326	50	.18	0.0	1.64	17.6
78-6332	50	.13	0.0	1.89	18.2
		(gram/hr)	(gram/hr)	(gram/hr)	(gal/hr)
78-6327	Idle	2.28	0.0	4.80	.86
78-6333	Neutral	2.88	5.6	2.88	.75
78-6333	Idle	1.56	22.9	3.36	.72
78-6395	Drive	1.29	0.0	3.19	.75

Table 5
Tests After 500 Miles With NRG #1

Test #	Test	HC (gram/mi)	CO (gram/mi)	NOx (gram/mi)	Fuel Economy (mi/gal)
78-6379	Bag 1	2.19	27.5	2.89	12.0
	Bag 2	.33	0.1	1.30	12.1
	Bag 3	.32	0.3	2.61	14.3
	FTP	.71	5.8	1.98	12.6
78-6374	Bag 1	2.82	28.2	2.82	11.9
	Bag 2	.42	0.1	1.34	11.8
	Bag 3	.38	0.4	2.73	13.9
	FTP	.90	6.0	2.03	12.3
78-6378	HFET	.13	0.0	2.94	17.7
78-6373	HFET	.14	0.0	2.94	17.6
78-6375	Fed. Short	.25	0.0	1.25	14.8
78-6370	Cycles	.32	0.0	1.26	14.9
	Steady States				
78-6372	20 mph	.32	0.0	.39	12.2
78-6377	20	.15	0.0	.25	20.1
78-6371	30	.12	0.0	.48	19.2
78-6376	30	.10	0.0	.45	19.4
78-6371	40	.07	0.0	.99	19.7
78-6376	40	.07	0.0	.94	19.9
78-6371	50	.09	0.0	2.12	19.0
78-6376	50	.09	0.0	2.04	19.1
		(gram/hr)	(gram/hr)	(gram/hr)	(gal/hr)
78-6372	Idle	4.56	0.0	3.12	.86
78-6377	Neutral	3.48	0.0	3.60	.86
78-6372	Idle	1.20	0.0	3.00	.85
78-6377	Drive	.96	0.1	3.12	.85

ADDITIVE TESTING PROJECT
CONDUCTED FOR
XRG INTERNATIONAL, INC.

AESi

AUTOMOTIVE ENVIRONMENTAL SYSTEMS, INC.

AUTOMOTIVE ENVIRONMENTAL SYSTEMS, INC.

ADDITIVE TESTING PROJECT
CONDUCTED FOR
XRG INTERNATIONAL, INC.

By

Alan D. Jones
Project Engineer

August 1980

AUTOMOTIVE ENVIRONMENTAL SYSTEMS, INC.
7300 Bolsa Avenue
Westminster, California 92683

INTRODUCTION

The testing described in this report was conducted in accordance with United States Environmental Protection Agency procedures and requirements. The tests performed were the Federal Test Procedure (FTP) and the Highway Fuel Economy Test (HFET). Three vehicles received FTP and HFET testing with catalytic converters removed and with and without XRG additive combined with commercial unleaded fuel. Replicate FTP and HFET tests were performed to check data repeatability.

TEST FLEET

The test fleet consisted of the following vehicles:

Vehicle	Year	Make/Model	Odometer Baseline	Odometer W/Additive	Fuel Tank	Engine
CX0051	1979	Chev Monte Carlo	22766	24357	18.1	305 V-8
CX0052	1979	Ford LTD	15684	17424	19.0	302 V-8
CX0053	1979	Buick Regal	18246	19932	18.1	231 V-6

All three vehicles were obtained from a rental agency.

VEHICLE PREPARATION

Each vehicle received the following preparation steps:

1. Flow meter installation (FloScan Model 606). Vehicle CX0052 was equipped with a new style FloScan 606 accurate to three decimal places.

2. Fuel tank drained and fueled to 40% capacity with gasoline.

3. Catalytic converter(s) removed and replaced with straight exhaust pipe welded in for a leak-free system.

4. Exhaust emissions control system and vehicle parameter check.

The vehicle parameters were checked before testing began. These parameters were also checked at the conclusion of testing. All were within manufacturer's specifications. These data are retained by AESi to substantiate the parameter values.

TEST PROCEDURE

All dynamometer tests are based on the Federal Test Procedure and Highway Fuel Economy test procedure as described in the Federal Register, Part 86, Subpart B, and Part 600, Subpart C respectively. All emissions calculations are based on the Federal Test Procedure. The carbon balance fuel economy calculations are based on the Highway Fuel Economy test procedure. The fuel density and carbon weight fractions are taken to be the same for unleaded gasoline as for Indolene HO.

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AESi's testing system is checked daily to ensure continued certification for on-going EPA contract testing.

Prior to testing, all vehicles had their catalytic converters removed as described in the Vehicle Preparation Section. The test sequence began with a baseline Federal Test Procedure (FTP) and Highway Fuel Economy test (HFET). Next replicate FTP and HFET tests were performed to verify data repeatability. Following this the first additive was combined with the commercial unleaded fuel at a ratio of 1 ounce of additive for every 12 gallons of fuel. An FTP/HFET test series was performed and replicate tests followed immediately.

The catalytic converters were welded in position prior to the next test series. Baseline FTP and HFET tests were conducted and replicate baseline tests followed. The same additive used for testing without catalytic converters was then added at the same 12:1 ratio. FTP/HFET testing with additive was performed on all vehicles with replicate tests immediately thereafter.

The catalytic converters were again removed as explained in the Vehicle Preparation Section. Next each vehicle received 400 miles of mileage accumulation using the AESi highway/city mileage accumulation driving schedule. The mileage accumulation was done with XRG additive in the commercial unleaded fuel. The additive used for the mileage accumulation and the tests following mileage accumulation was not the same additive used in the previous test series. All additives were unmarked. After mileage accumulation the vehicles received FTP/HFET series with replicate tests.

Between the baseline FTP/HFET and the mileage accumulation with the second additive the vehicles incurred an average of 1672 miles. The Chevrolet Monte Carlo (#0051) had 1591 miles; the Ford LTD (#0052) had 1740 miles; and the Buick Regal (#0053) had 1686 miles. The miles were accumulated with and without catalytic converters, with commercial unleaded fuel and with commercial unleaded fuel with an additive.

ADDITIVE MIXTURE

The additive was provided to AESi by XRG International, Inc. on June 24, 1980. It was unlabled. The mixing ratio used was 1.0 ounce of additive for every 12 gallons of fuel. For all tests, the fuel used was Mobil unleaded gasoline from a local service station.

RESULTS

A summary of fuel economy data for FTP and HFET testing is presented in Exhibit A. A summary of FTP exhaust emissions data is shown in Exhibit B. Exhibit C is a summary of the HFET exhaust emissions data. A complete listing of FTP and HFET emissions data is presented in Exhibit D.

EXHIBIT A

FUEL ECONOMY SUMMARY*
WITHOUT CATALYST

VEHICLE NO	TEST	W/O ADDITIVE	W/ADDITIVE	% CHANGE
CX0051	FTP	14.439	14.971	+3.7
	HFET	18.933	19.760	+4.4
CX0052	FTP	13.724	14.669	+6.9
	HFET	20.477	22.055	+7.7
CX0053	FTP	14.969	16.159	+7.9
	HFET	19.281	21.185	+9.9
Fleet	FTP	14.359	15.240	+6.1
	HFET	19.542	20.957	+7.2

*Harmonic Mean, $H_n = \frac{1}{\frac{1}{n}\sum_{i=1}^{n}\frac{1}{Z_i}}$ where Z_i = mpg for the ith test, n = number of tests

See "**TEST PROCEDURE**" for unusual test conditions.

AUTOMOTIVE ENVIRONMENTAL SYSTEMS, INC.

EXHIBIT B

FTP EXHAUST EMISSIONS - SUMMARY

VEHICLE	POLLUTANT	W/O ADDITIVE	W/ADDITIVE	% CHANGE
CX0051	HC	1.785	1.647	- 7.7
W/O Cat	CO	51.858	43.941	-15.3
	CO_2	527.256	518.062	- 1.7
	NOxC	1.075	0.996	- 7.3
CX0052	HC	2.625	2.062	-21.4
W/O Cat	CO	35.245	22.665	-35.7
	CO_2	582.425	562.354	- 3.4
	NOxC	5.942	5.441	- 8.4
CX0053	HC	1.233	1.729	+40.2
	CO	29.378	12.955	-55.9
	CO_2	542.350	523.272	- 3.5
	NOxC	2.903	1.205	-58.5
Fleet	HC	1.881	1.813	- 3.6
W/O Cat	CO	38.827	26.520	-31.7
	CO_2	550.677	534.563	- 2.9
	NOxC	3.307	2.547	-23.0

NOTE: All of the above emissions data are mathematical averages in grams per mile of the actual test data obtained.

See "<u>TEST PROCEDURE</u>" for unusual test conditions

AUTOMOTIVE ENVIRONMENTAL SYSTEMS, INC.

EXHIBIT C

HFET EXHAUST EMISSIONS - SUMMARY

VEHICLE	POLLUTANT	W/O ADDITIVE	W/ADDITIVE	% CHANGE
CX0051 W/O Cat	HC	0.417	0.378	- 9.4
	CO	9.524	4.861	-49.0
	CO_2	452.288	439.943	- 2.7
	NOxC	1.338	1.260	- 5.8
CX0052 W/O Cat	HC	1.144	1.021	-10.8
	CO	9.275	4.838	-47.8
	CO_2	414.863	391.249	- 5.7
	NOxC	8.190	7.443	- 9.1
CX0053 W/O	HC	0.209	0.566	+170.8
	CO	7.537	3.563	-52.7
	CO_2	447.425	411.199	- 8.1
	NOxC	3.609	1.222	-66.1
Fleet W/O Cat	HC	0.590	0.655	+11.0
	CO	8.779	4.421	-49.6
	CO_2	438.192	414.130	- 5.5
	NOxC	4.379	3.308	-24.5

NOTE: All of the above emissions data are mathematical averages in grams per mile of the actual test data obtained.

See "TEST PROCEDURE" for unusual test conditions

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EXHIBIT D

FTP AND HFET EMISSIONS DATA
WITHOUT CATALYST

VEHICLE NUMBER	TEST NO.	HC	CO	CO_2	NOxC	MPG	HC	CO	CO_2	NOxC	MPG
Without Additive											
CX0051	1	1.924	56.042	524.828	0.993	14.326	0.428	11.398	460.922	1.341	18.467
	2	1.645	47.674	529.684	1.156	14.554	0.406	7.650	443.653	1.335	19.423
CX0052	1	3.038	38.159	574.890	6.018	13.759	1.146	9.105	411.764	8.433	20.637
	2	2.212	32.330	589.960	5.866	13.690	1.141	9.445	417.962	7.947	20.320
CX0053	1	1.266	30.329	537.881	2.961	15.042	0.183	7.749	449.122	3.788	19.220
	2	1.200	28.426	546.819	2.844	14.897	0.234	7.324	445.727	3.430	19.363
With Additive											
CX0051	1	1.605	41.936	525.383	1.029	14.870	0.392	4.751	440.123	1.244	19.758
	2	1.669	45.946	510.740	0.962	15.074	0.364	4.970	439.762	1.275	19.762
CX0052	1	2.206	22.249	563.865	5.503	14.638	1.010	5.178	391.681	7.456	22.0[illegible]
	2	1.917	23.081	560.843	5.378	14.701	1.031	4.497	390.817	7.429	22.106
CX0053	1	1.618	13.120	533.650	1.213	15.870	0.549	3.713	412.621	1.205	21.104
	2	1.840	12.790	512.893	1.196	16.458	0.583	3.412	409.777	1.239	21.267

NOTE: All emissions data in grams per mile

See "TEST PROCEDURE for unusual test conditions

UNITED ST ES ENVIRONMENTAL PROTECTION AGENCY
ANN ARBOR MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

December 2, 1980

Mr. Brian Boshart
XRG International, Inc.
4125 S.W. Martin Highway
Stuart, Florida 33494

Dear Mr. Boshart:

The EPA Engineering Evaluation Group has completed a review of your application for evaluation of "SYNeRGy-1"/"XRG-1"/"NRG-1" under Section 511 of the Motor Vehicle Information and Cost Savings Act. This review indicated that several areas of the test program conducted at Automotive Environmental Systems, Inc. (AESi) require clarification prior to further processing of your application. These areas are as follows:

- The AESi report does not sufficiently detail the actual test program conducted. Please provide a detailed description of that program to include the amount of mileage accumulated on each test vehicle, the condition of the emission control equipment of each test vehicle during each stage of testing and mileage accumulation, and the number of additives used in the program and when each additive was used.

- Please provide both emissions and fuel economy data on the AESi vehicles with the catalytic converters installed for each additive used.

- Please provide a detailed description of the actual test program for the catalyst equipped vehicles, if that program deviated from that conducted on the vehicles without a catalyst installed.

- Complete descriptions of all engine design parameter settings (air-fuel ratio, ignition timing, etc.), dynamometer settings (power absorber setting, inertia, etc.), ambient conditions during testing and specific emission control system for each vehicle tested at AESi are required.

- Please provide a chemical breakdown by weight of each additive used for the AESi test program and a signed affidavit certifying that the additives used during that program conform with the patent documentation provided with your application, the description of the additive as registered with the EPA in Research Triangle Park, N.C., and assuring the EPA that the additives used during the AESi program are representative of the product being marketed.

Additionally, the product patent documentation references testing conducted at Scott Environmental Technology. Please provide the following information/data relative to that testing:

- Scott reports; SET 1620-01-0577, SET 1620-02-0577, SET 1620-03-0577 and Scott report detailing tests conducted on MSX additive designated 7/77.

- A detailed description of each test vehicle, dynamometer setting used, engine design parameter settings, and all test ambient conditions.

If, after review of the above requested information, the EPA deems it appropriate to conduct confirmatory testing at this facility, a test plan to evaluate "SYNeRGy-1"/"XRG-1"/"NRG-1" will have to be agreed upon and a sufficient quantity of "SYNeRGy-1"/"XRG-1"/"NRG-1" will have to be supplied. In the interest of saving time, the attached proposed test plan is provided for your concurrence. If the proposed test plan is agreeable, please provide sufficient additive with your response to accomplish the total test program. Please be sure to provide a signed affidavit certifying that the supplied additive for evaluation conforms with; 1) the additive description contained in the patent documentation, 2) the additive description on record at the EPA, Research Triangle Park, N.C. facility and 3) the additive is representative of the additive marketed as "SYNeRGy-1"/"XRG-1"/"NRG-1".

Your cooperation in this matter and rapid response are appreciated. I look forward to receipt of the requested information so that we can continue processing your application for evaluation. If you require any further information or assistance, please feel free to contact my office (313-668-4299).

Sincerely,

Merrill W. Korth, EPA Device Evaluation Coordinator
Test and Evaluation Branch

Enclosure

Proposed Test Plan for EPA Evaluation
of "SYNeRGy-1"/"XRG-1"/"NRG-1"

On each of three (3) representative vehicles, performed the following:

1) Three (3) FTP/HFET test sequences with vehicle engine design parameters set to vehicle manufacturer's specifications (baseline).

2) Three (3) FTP/HFET test sequences with vehicle engine design parameters set as in 1) above and fuel additive introduced.

3) Accumulate 500 miles using fuel additive according to the Automobile Manufacturers Association driving schedule and vehicle engine design parameters set as in 1) above.

4) Three (3) FTP/HFET test sequences using fuel additive and vehicle engine design parameters set as in 1) above.

Representativeness of the vehicles means that the vehicles; (1) will have been in consumer use, (2) will reflect a large percentage of the vehicles presently in use and will be neither very new nor very old, (3) will represent a small engine displacement, a medium engine displacement and a large engine displacement and (4) will represent each of the three domestic manufacturers. Additionally, all test sequences and mileage accumulation will be accomplished with commercial grade unleaded fuel.

Concurrence:

Mr. Brian Boshart
XRG International, Inc.

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY

ANN ARBOR, MICHIGAN 48105

OFFICE OF
AIR, NOISE AND RADIATION

March 4, 1981

Mr. Brian Boshart
XRG INternational, Inc.
4125 S.W. Martin Highway
Stuart, FL 33494

Dear Mr. Boshart:

It was good to learn during our telephone conversation on 2/26/81 that you soon will be responding to our letter of 12/2/80. I was sorry to hear that you had recently been ill.

Your application for an EPA evaluation dates well back into 1980 and we are concerned that the evaluation can not progress until we receive the information we have requested. If we do not receive your data by April 1, 1981, we plan to complete our evaluation without it, in which case, we will not be able to conclude that your additive improves fuel economy.

Here at EPA we are in a position to promptly continue our evaluation of "SYNeRGy-1"/"XRG-1"/"NRG-1" as soon as we receive the information that we requested from you. Since you are planning to do this I would like to encourage you to forward the data as quickly as possible.

Sincerely,

Merrill W. Korth

Merrill W. Korth, Device Evaluation Coordinator
Test and Evaluation Branch