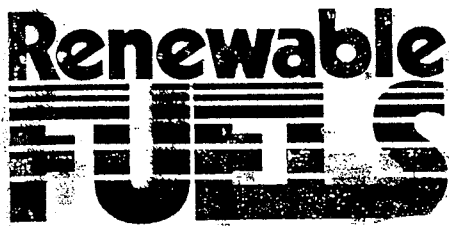


**Gasoline Ethanol Blends
Program Operations Guide**

RFA Recommended Practice # 930601

As recommended by:



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This document is meant to provide information on the many aspects of implementing and maintaining a gasoline/ethanol blending program. Many elements of such programs are company specific. In addition, laws and regulations applicable to gasoline ethanol blending vary from state to state. Those regulations may also change on a frequent basis. While this document should serve as a useful guide in any gasoline/ethanol blending program, it is important to confirm the applicability of its suggestions and recommended procedures with company policies as well as with local, state, and federal regulations.

Introduction

Implementing and maintaining a successful gasoline/ethanol blending program is best achieved by adherence to a number of practices and procedures which have been tried and proven in actual field applications.

Over the years a number of ethanol producers and petroleum companies have prepared guides or manuals covering the details of implementing and maintaining such programs. Many of these guides have proven quite useful in the past. At the same time, some of these guides have been designed with specific types of operations in mind. In other cases, some guides have become outdated due to the rapidly changing nature of gasoline/ethanol blending programs.

As the industry responds to the numerous changes prompted by state and federal regulations and changing industry practices, it is important that a program guide be developed that can change with the times, a so called "living document".

With that in mind, the Renewable Fuels Association has prepared this document, "Gasoline/Ethanol Blends-Program Operations Guide". As a starting point, we have reviewed all of the various program guides that are available. That information has been compiled, condensed, and where necessary, updated. We have attempted to construct the guide in sections which are applicable to various levels of petroleum industry operations. For instance, there is an information section for administrative, terminal level operations, transportation, retail operations, as well as sections on safety/firefighting and technical information.

This information was then reviewed by our technical consultants and representatives of our member companies to ensure its accuracy and the timeliness of information presented.

Perhaps most importantly, this guide was developed to be a living, growing document. Designed in a loose leaf, note book format, this guide can be updated and/or revised as circumstances dictate. As our member companies and their customers, the ethanol blender/retail marketer, identify a need for new information sections, they can be added. This format also allows insertion of company specific information so that the guide can be customized for individual company programs.

While no program guide can be all inclusive for each and every gasoline/ethanol blend program, it is our hope that this guide will serve as a useful tool in the implementation and ongoing operations of your gasoline/ethanol blending program.

By following a few simple procedures and being sure that the proper personnel are informed of their responsibilities, you can ensure that the consumer will be filling their vehicle with gasoline/ethanol blends of the highest quality.

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Company Specific Information

This section is provided for insertion of company specific and/or program specific information.

Realizing that no program guide can anticipate the policies, procedures, or needs of each individual company, this section is provided to allow the insertion of company specific information. This section can be utilized to advise employees of applicable company procedures, regulations, and other information the user feels is necessary to convey accurate and timely information. If you feel certain information in this guide is not applicable to your operations, you may also need to utilize this section to point out those instances and to offer amended information.

Management/Administrative

As mentioned in the introduction section, this guide is designed to provide guidance on the steps necessary to implement and maintain a successful ethanol blending program. The previous section is provided to allow insertion of information that is specific to your company, division, district, etc. The sections following this "Management/Administrative" section are separated to provide guidance at various levels of petroleum operations.

The "Terminal Operations" section covers key considerations for those companies whose blending programs may include equity terminal operations. A "Transportation" section is provided to address issues applicable to transport personnel. A "Maintenance" section is provided to cover issues involving maintenance personnel/maintenance contractors.

The "Safety & Firefighting" section is most applicable to terminal personnel. This section includes "Material Safety Data Sheets" (MSDS) and it may be necessary to issue these to other personnel such as transport drivers and maintenance personnel.

The "Retail" section is by far the most detailed. It is at the retail level that the most important actions are required to ensure a successful ethanol blending program. A "Consumer Information" section is provided to address some of the most frequent questions asked about ethanol. It also includes an appendix with various promotional brochures/pamphlets that have been used at the retail level. If your marketing plans call for such brochures, these might serve as a guide for preparation.

The "Technical Information" section covers the key information on the affect ethanol has on various gasoline properties such as octane, volatility, and oxygen content. It also contains important information for those utilizing more sophisticated blending techniques.

A brief section is also provided on "Quality Assurance" to discuss some of the ramifications of QA programs. Finally, a "Miscellaneous Information" section is provided to allow for compilation and insertion of new and updated data that may become available.

Most sections are supplemented with appendices providing additional details for that section.

The degree to which management/operations personnel need to be familiar with each section will depend on the specific company and the scope of their program. However, it is advantageous for management and operations personnel to be familiar with all aspects of their program. The applicable personnel should therefore be encouraged to review this guide in its entirety. Those involved at the retail level should thoroughly review the "Retail" section.

There are certain aspects of gasoline/ethanol blending program implementation and operations that are usually the responsibility of one or more levels of management within the company. Most often these items include Legal/Regulatory compliance, communications with field/retail personnel and public relations.

Legal/Regulatory Compliance

The legal and regulatory compliance aspects of the petroleum business have grown increasingly complex. In some cases, a portion of these complex laws and regulations may apply to gasoline/ethanol blends. Following are some of the more important items you will need to address.

Terminal Considerations: If you are operating an equity terminal it may be necessary to install or modify/reconfigure tankage. Depending upon the scope of changes, it may be necessary to obtain various permits, prepare a new Spill Prevention Plan (SPP) and verify compliance with fire codes.

Fuel Registration: If you will be the "blender of record", it will be necessary to register with EPA as a fuel manufacturer and to file quarterly reports with the EPA on the product you have blended. The addition of oxygenates to gasoline is regulated by EPA under a series of definitions and waivers. The addition of ethanol to gasoline is limited to a maximum of 10 volume %. The base fuel for a 10% blend must be free of other oxygenates, except, EPA will permit the (unintentional) presence of up to 2 volume % MTBE. If ethanol is being used at lower levels in combination with other oxygenates, the total oxygen level of the blend cannot exceed 2.7 weight %. Certain states may also require that each grade of gasoline be registered with the state. Since gasoline/ethanol blends are a separate or new grade, registration would be required.

Mandatory Oxygenated Fuel Programs: The 1990 Clean Air Act Amendments require that mandatory oxygenated fuel programs be implemented in areas failing to meet the National Ambient Air Quality Standard (NAAQS) for carbon monoxide (CO) (Areas with CO exceedences resulting from a dominate stationary source can be excluded from this requirement). Affected metropolitan areas are required to implement oxygenated fuel programs during certain winter months. The applicable months of the program vary from one area to another depending on when each area has historically experienced CO exceedences. In some cases logistic considerations among interrelated areas have also been considered. The U.S. Environmental Protection Agency (EPA) has developed time frames for these programs to be in effect. Each of the areas will generally fit into one of the following control periods

September 1-February 29

October 1-January 31

October 1-February 29

November 1-February 29

NOTE: Some states may elect to require longer control periods if they so choose.

During the applicable control period, each area will be required to implement a program [1] that requires all gasoline sold during the control period contain 2.7 wt. % oxygen. [2] The exact method of compliance will vary among areas. For instance, some states utilize oxygenate credits trading programs which allow oxygen content of fuels in excess of 2.7 wt % to be credited to gasolines containing less than 2.7 wt.%. Other areas may simply require a 2.7 wt.% minimum in all fuels. During the control period there are also requirements that pumps be labeled to identify that the fuels comply with the program. The specifics of these programs are rather detailed. If your gasoline/ethanol blending program is being implemented to comply with these requirements, you should review the applicable regulations. Technical information regarding oxygen content of gasoline/ethanol blends is provided in the "Technical Information" section of this guide.

- 1 EPA has authority to grant an area up to two one year extensions if oxygenate supplies are inadequate or if there are extraordinary logistic considerations.
- 2 Some areas such as California have indicated that they will utilize a lower oxygen standard and/or implement a maximum oxygen cap below 2.7 wt.%. To do so it will be necessary to demonstrate, to EPA, that these steps are necessary to reduce levels of other controlled pollutants.

Fuel Volatility: As with gasoline comprised solely of hydrocarbons, gasoline/ethanol blends are subject to EPA's Phase II Fuel Volatility requirements. Phase II sets limits on the vapor pressure of gasoline sold (at retail) during a control period from June 1st to September 15th of each year. The maximum vapor pressure permitted is either 9.0 psi or 7.8 psi depending upon the area. During this control period, gasoline/ethanol blends containing 9 to 10 volume % ethanol are allowed to have a vapor pressure up to 1.0 psi higher than the specified limit. During the remainder of the year, there are no federal fuel volatility requirements. Some states also have fuel volatility regulations which include vapor pressure. A portion of these states also place restrictions on distillation characteristics such as T_{50} (the temperature required to evaporate 50% of a gasoline sample). You should ascertain if the states in which you will be selling blended fuels have any such requirements. Also, certain ozone non-attainment areas will implement even more stringent RVP controls beginning in the summer of 1995.

Octane: The FTC requires that an octane decal be posted on each dispenser to identify the octane of the grade being dispensed. If your gasoline/ethanol blends will have an (R+M)/2 (pump octane) different than the grade previously dispensed, it will be necessary to change the octane decal. Some states may also have requirements regarding posting of octane. Information on calculating the octane increase/response resulting from the addition of ethanol is provided in Section IX Technical Information.

Fuel Tax: Gasoline/ethanol blends qualify for special tax treatment under certain considerations. There are various levels of tax incentives available. The federal motor fuel excise tax for gasoline/ethanol blends is reduced dependent upon the ethanol content of the blend as follows:

<u>Ethanol Content</u>	<u>Excise Tax Reduction</u>
10.0%	5.4 cents per blended gallon
7.7%	4.16 cents per blended gallon
5.7%	3.08 cents per blended gallon

In lieu of reductions in the federal motor fuel excise tax, a credit can also be taken under the "blenders tax credit" which allows for a credit of 54¢ per gallon of ethanol used. This credit can be less advantageous than the excise tax credit and requires a higher degree of consideration to determine its usefulness. However it can be utilized for other blend ratios and has been used by some companies. You should have your controller or the appropriate accounting personnel review these regulations for their applicability to your operations as well as compliance with necessary accounting procedures etc. A few states also still offer tax incentives to encourage the sale of gasoline/ethanol blends. You should determine if any of the states in which you are selling blended fuel offer such credits and what is required to take advantage of incentives that are offered.

Pump Labeling: The majority of states require that gasoline containing ethanol be identified by placing decals on the retail dispenser. Requirements vary from one state to the next. The appendix to this section contains requirements of several states that responded to a survey in 1992. You should check with state officials to determine if there are any pump labeling requirements with which you must comply.

Phase Separation: As covered in section VII, page 6, and Section IX, page 7, of this manual, if gasoline/ethanol blends come in contact with excessive levels of water, the ethanol can fall out of the blend resulting in a phase separation. When this occurs, the lower phase is comprised of about 20% water, 70% ethanol and 10% hydrocarbons and must therefore be removed from the tank. Due to the hydrocarbon

content of these "tank bottoms" they will require special handling and fall subject to "Hazardous Waste" requirements. You should be sure that appropriate personnel or contractors are familiar with, and in compliance of, all these requirements. It is recommended that a detailed written procedure (that conforms with your company's policies) be developed to set forth the actions to take if a phase separation occurs.

The proceeding in meant to provide an overview of some of the legal and regulatory considerations involved with gasoline/ethanol blending programs. The applicable laws and regulations, whether federal or state, can change rapidly so you should consult the appropriate regulations.

Operating Procedures

Some aspects of your blending program may require new or modified procedures. At the office level such modifications might be in accounting procedures, tax filings, and legal compliance.

There are also considerations at the transport and retail levels. Examples here would be procedures on how to correct a mis-drop, what to do if a phase separation occurs, and what to do if tank water bottoms are present. Your program will operate a lot smoother if these procedures are established prior to a need for them. Such procedures should be written, include appropriate contact information and be disseminated to the appropriate personnel.

Communications

Your program will be better accepted and operate smoother if all personnel, especially retail employees understand the details.

It is recommended that a store/station operators meeting be conducted to explain why the program is being implemented and what steps will be required for a successful program implementation. The majority of details are covered in the "Retail" section of this guide. However you will also need to discuss company specific information such as the motive for implementing the program, proper accounting procedures, changes in terminology and how to handle public relations issues such as consumer questions.

While no program guide can be all inclusive, it is hoped that this guide will help you develop materials tailored for your specific needs.

Management/Administrative Appendix - Section II

■ State Pump Labeling Information

NOTE: The following pump labeling regulations were in response to a survey conducted in late 1992. You should confirm that these are still the applicable pump labeling requirements. Also, some states may have additional or supplemental labeling requirements for use in conjunction with their oxygenated fuel programs. As an example, some states require labels utilizing wording such as "This gasoline contains oxygenates to reduce carbon monoxide".

Alabama (2-92)

80-1-16-.09 - Labeling Requirements For Motor Fuels
Containing Alcohol

(1) Any dispensing device which is used to dispense gasoline as defined in §8-17-80(a)(1), Code of Alabama (1975), which contains more than one per cent, by volume, of any ethanol or methanol shall also be labeled on both sides of the dispensing device, which face the vehicle, as follows:

- Contains Ethanol, or
- Contains Methanol and Cosolvent

(2) The labeling requirement set out in paragraph No. (1) above shall be composed of black letters with a distinctly contrasting background. The letters appearing on the label shall be a minimum of one-half inch in height with a minimum one-sixteenth stroke.

Alaska

Arizona (2-92)

under regular rules

R4-31-711. Retail oxygenated fuel labeling

A. All dispensers shall be labeled when offering gasoline containing:

- 1. More than 2.75 percent by volume of methanol with an equal amount of co-solvent, or
- 2. More than 5.5 percent by volume of ethanol, or
- 3. More than 11 percent by volume of MTBE, or
- 4. Any other oxygenate at a level that would require a waiver from the Federal Environmental Protection Agency.

B. Notwithstanding the provisions of subsection A, within nonattainment area B from and after September 30 through March 31 of each year all dispensers shall be labeled when offering gasoline containing:

- 1. More than 2.45 percent by volume of methanol with an equal amount of co-solvent, or
- 2. More than 5.1 percent by volume of ethanol, or
- 3. More than 9.6 percent by volume of MTBE.

C. Where labeling is required under Subsections A and B above, identification shall be accomplished by conspicuously posting, on the face of the dispenser, the appropriate following label indicating the maximum volumetric percentage of oxygenate contained in the oxygenated fuel:

- 1. Contains up to % ethanol:
- 2. Contains up to % methanol and % co-solvent;

or

3. Contains up to % ether (MTBE).

D. Any other oxygenate blended with gasoline shall be disclosed in the format as set forth in Subsection C.

E. The posting shall be with block letters no less than one-half inch in height, easily readable and plainly viable to the customer.

under emergency rules

R4-31-711. Retail oxygenated fuel labeled.

A. All dispensers shall be labeled when offering gasoline containing:

- 1. More than 2.45 percent by volume of methanol with an equal amount of cosolvent, or
- 2. More than 5.1 percent by volume of ethanol, or
- 3. More than 9.6 percent by volume of MTBE, or
- 4. Any other oxygenate at a level that would require a waiver from the EPA.

B. Where labeling is required under Subsection above, identification shall be accomplished by posting, on the upper 50 percent of the face of the dispenser, the appropriate following label indicating the maximum percent by volume of oxygenate contained in the oxygenated fuel:

- 1. Contains up to ___% ethanol:
- 2. Contains up to ___% methanol and % co-solvent; or
- 3. Contains up to ___% ether (MTBE).

C. Labels posted on dispensers located in Area A shall comply with subsection B above and also contain a statement that the gasoline is oxygenated and will reduce carbon monoxide emissions from motor vehicles.

D. Any other oxygenate blended with gasoline shall be disclosed in the format as set forth in Subsection B.

E. The posting shall be with block letters no less than one-half inch in height. The label and printing shall be resistant to all petroleum products and weather conditions. The label shall be clean, legible, and visible at all times. Other information may be placed on the label provided the label remains in compliance with this section.

Arkansas (2-92)

Petroleum Inspection Law with Rules and Regulations

(3) All spark-ignition engine fuel kept, offered, or exposed for sale, or sold, at retail containing at least one percent by volume of any oxygenate or combination of oxygenates shall be identified as "with" or "containing" (or similar wording) the specific type of oxygenate(s) in the engine fuel. For example, the label may read "contains ethanol" or "with MTBE/ETBE". This information shall be posted on the upper fifty percent of the dispenser front panel in a position clear and conspicuous from the driver's position, in a type at least 1/2 inch in height, 1/16 inch stroke (width of type).

California (2-92)

§ 13480. SALE, ETC., OF PETROLEUM PRODUCTS FROM UNLABELED CONTAINERS, ETC., UNLAWFUL: VISCOSITY RATING: CONTAINERS WITH NET CONTENT OF GALLON OR LESS

(d) When the product is a motor fuel which contains at least 1 percent by volume ethanol (ethyl alcohol) or methanol (methyl alcohol), or a combination thereof, there shall be conspicuously displayed on the dispensing device at least one sign or label correctly stating the applicable one of the following statements:

- (1) "Contains alcohol (ethanol)."
- (2) "Contains alcohol (methanol)."
- (3) "Contains alcohol (ethanol and methanol)."

Colorado (2-92)

8-20-211.5 Labeling of containers. Throughout the state of Colorado, all visible containers and all devices for drawing motor fuel blends containing class A fuel products and at least two percent by volume of alcohol or at least two percent by volume of methyl tert butyl ether (MTBE) from underground containers at filling stations, garages, or other places where such products are sold or offered for sale shall be stamped or labeled in a visible place with information indicating the presence of alcohol or the presence of methyl tert butyl ether (MTBE) in the motor fuel blend. If the volume of ethanol exceeds ten percent, or if the volume of methanol exceeds two percent, or if the volume of methyl tert butyl ether (MTBE) exceeds eleven percent, the stamp or label shall state the exact percentage. Such information shall appear on the front of the pump in a position clear and conspicuous to the driver's position, in at least one-half inch block letters, with information which identifies the maximum percentage by volume to the nearest whole percent of ethanol or of methanol or of methanol with cosolvents or of methyl tert butyl ether (MTBE).

Source: Amended, L. 89, p. 383, § 1.

Connecticut

Delaware (3-92)

3. "Gasohol" shall be a blend of nine (9) parts unleaded gasoline and one (1) part ethanol and shall be mixed by a distributor at time of delivery to a purchaser. A retail seller shall clearly label all pumps dispensing gasohol as such.

Florida (2-92)

5F-2.003 (7), Florida Administrative Code:

All motor fuel kept, offered, or exposed for sale, or sold, at retail, containing at least one percent by volume of ethanol, methanol, or a combination shall be identified as "contains ethanol," "contains methanol," or "contains ethanol/methanol" on the upper fifty percent of the dispenser front panel in a position clear and conspicuous from the driver's position, in a type at least 1/2 inch in height and 1/16 inch stroke (width of type).

Georgia (2-92)

GUIDELINE FOR ETHANOL GASOLINE BLENDS

- 2) Upon blending, the finished material must be labeled. A suitable label for example for a 90% unleaded gasoline mixed with 10% Ethyl Alcohol would be UNLEADED WITH 10% ETHANOL. Product identification will be clarified at the time of registration.
- 4) "WITH 10% ETHANOL" can be no less than 1/2 the size of the name of gasoline it is blended with.
- 5) All pump identification is located such that it is readily visible by the purchaser.
- 6) The concentration of Ethanol shall be within 0.5% of the concentration labeled.
- 15) Gasoline-ethanol blends containing 1% or more ethanol must be labeled at the pump.

Hawaii

Idaho (2-92)

6a.2 PUMP LABELING REQUIREMENTS

1. All distributors, retailers and other persons receiving, storing, selling or distributing gasoline, leaded or unleaded, in this State that contains one percent (1%) by volume or more ethanol, methanol, cosolvent alcohol, or any combination thereof, shall label each retail pump from which such product is dispensed.

2. The labels shall be furnished by the retail owner or operator.

6a.3 ALCOHOL CONTENT LABELS

1. The label shall state the type and percent of alcohol and the type and percent of cosolvent.

2. The label shall have letters in bold face block not less than one inch (1") high. The lettering shall be in black on a

contrasting background. Both colors shall be non-fade. The illustration appearing at the end of this section is a prototype label that demonstrates the proper wording and layout.

3. The label shall be displayed on both faces of the dispenser on the upper one-third of the dispenser as near the unit price display as practical.

Illinois (2-92)

1704.1. Gasoline containing ethanol or methanol-Notice of percentage-Federal requirements

§4.1. (a) Upon any retail motor fuel dispensing device which is used to dispense a motor fuel containing at least 1% by volume of ethanol, of methanol, or of a combination thereof, there shall be displayed a label which identifies the maximum percentage by volume, to the nearest whole percent, of ethanol, of methanol, and of co-solvent contained in the motor fuel. Such labeling shall be done in contrasting colors with block letters at least 1/2 inch in height and 1/4 inch in width, and not more than one inch in height and 1/2 inch in width, and shall be visible to customers. Devices used to dispense only motor fuels which contain a total of less than 1% by volume of methanol and ethanol need not be so labeled.

Indiana (unverified)

P.L. 103-1984

[H. 1401. Approved February 24, 1984]

An Act to amend the Indiana Code concerning petroleum products.

Be it enacted by the General Assembly of the State of Indiana:

SECTION 2. IC 16-6-11-5.5 is added to the Indiana Code as a NEW section to read as follows: Sec. 5.5. (a) A retail service station merchant may not sell or dispense a petroleum product that contains ethanol (ethyl alcohol) or methanol (methyl alcohol), or both, unless he complies with subsection (b).

(b) Whenever any petroleum product contains at least one percent (1%), by volume, ethanol or methanol, or both, the merchant shall place a notice in a conspicuous place on each dispenser that supplies a petroleum product containing ethanol or methanol, or both.

(c) The notice required by subsection (b) shall be designed by the department. The notice that is placed on a particular dispenser must list:

(1) the name of each alcohol; and

(2) a percentage (to the nearest whole percent) that identifies the maximum percentage of each alcohol; that is contained in the petroleum product supplied by that dispenser.

(d) A merchant who:

(1) receives from his supplier the information required by section 5.2 of this chapter; and

(2) fails to comply with this section; commits a Class A infraction.

Iowa (2-92)

85.48 (10) All motor vehicle fuel kept, offered or exposed for sale or sold at retail containing over 1 percent ethanol shall be identified as "Containing ETHANOL" or "ethanol blend" in black lettering no less than 1/2" in height, 1/8" in stroke, to be placed 10" to 40" above driveway level on the front of the pumps. Additional wording or statements may be allowed upon submission to and approval by the department. Approval shall be based upon factual information or scientific data provided by the applicant and a determination that the wording is not misleading to consumers.

85.48 (11) All motor vehicle fuel kept, offered, or exposed for sale at retail containing over 1 percent methyl tertiary butyl ether shall be identified as "contains MTBE" or "MTBE blend" in black lettering no less than 1/2" in height, 1/8" in stroke, with directly below "METHYL TERTIARY BUTYL ETHER" in black lettering no less than 20-point type size to be placed 30" to 40" above driveway level on the front of the pumps.

Additional wording or statements may be allowed upon submission to and approval by the department. Approval shall be based upon factual information or scientific data provided by the applicant and a determination that the wording is not misleading to consumers.

Kansas (2-92)

No. 91-06 PMEP

LABELING AND POSTING

2) Gasoline-alcohol blends - all motor fuel kept, offered for sale, or sold at retail containing at least one percent (1%) by volume of any alcohol shall be identified as such using the words "contains" or other wording approved by the secretary, in conjunction therein, the maximum volume percentages to the nearest whole percent and the name of each alcohol additive on the upper fifty percent (50%) of the dispenser panel in a position clear and conspicuous from the driver's position in a type at least one-half inch (1/2") in height, one-sixteenth inch (1/16") stroke (width of type).

Kentucky (3-92)

No statutes which require labeling.

Louisiana

Maine (2-92)

2.20. Gasoline-Oxygenate Blends.--

2.20.1. Method of retail sale.-- All spark ignition engine fuel kept, offered, or exposed for sale, or sold, at retail containing at least one percent by volume of any oxygenate or combination of oxygenates shall be identified as "with" or "containing" (or similar wording) the specific type of oxygenate(s) in the engine fuel. For example, the label may read "contains ethanol" or "with MTBE/ETBE." This information shall be posted on the upper 50 percent of the dispenser front panel in a position clear and conspicuous from the driver's position, in a type at least 1/2 inch in height, 1/16 inch stroke (width of type).

(Added 1984; Amended 1986 and 1991)

Maryland (2-92)

R61-940-04 Labels. All motor fuel kept, offered or exposed for sale or sold containing at least one percent by volume methanol or ethanol must be labeled in a prominent, conspicuous manner, "% METHANOL" or "% ETHANOL."

A. Letters on the label must be at least 1 inches high and in contrasting colors.

B. Labels must be located on the face of each dispenser near the area designating the grade of the product.

Massachusetts (2-92)

(5) Display of Alcohol Content Signs. The main display panels of each pump or other dispensing device, including computing pumps, from which motor fuel, blended or mixed with more than one percent alcohol is sold at retail, shall have affixed thereon, one sign made of waterproof material showing the ethanol, methanol and cosolvent content of the motor fuel. Such sign shall look like the illustration appearing at the end of this section.

Such signs shall be as follows:

- (a) Layout. The sign shall be 5" wide by 6" long with a 1/8 black border.
- (b) Type size. Block letters and numerals shall be used on the signs. The words "ALCOHOL CONTENT" shall be in letters 1/2" high and 3/8" wide. All other letters and numerals shall be at least 1/4" high and 1/8" wide.
- (c) Colors. Such signs shall be in black print on a yellow background. Both colors shall be non-fade.

Michigan

Regulation 562 (effective Sept. 22, 1987)

Gasoline that contains ethanol, methanol, or another co-solvent in the amount of 1% or more by volume must be labeled at the pump in Michigan. If the additive is methanol, the notice shall state: "CONTAINS ALCOHOL: METHANOL _____%"

If an additive is ethanol or another alcohol other than methanol and is used as a co-solvent, the notice shall state: "CONTAINS _____". For example, "CONTAINS ETHANOL 10%" is acceptable.

A notice is not required when the gasoline contains MTBE.

Minnesota (2-92)

No labeling beyond Federal requirements.

Mississippi (2-92)

Section 13. (§75-55-22). Alcohol Blended Fuel.

All gasoline, leaded or unleaded kept, offered, or exposed for sale, or sold, at retail containing one percent (1%) or more volume of ethanol, methanol, or an ethanol/methanol mixture shall be identified as "with" or "containing" (or similar wording) "ethanol", "methanol" or "ethanol/methanol" on the upper fifty (50) percent of the dispenser front panels in a position clear and conspicuous from the driver's position, in a type at least one-half (1/2) inch in height, one sixteenth (1/16) inch stroke (width of type). All letters shall be black with a contrasting background.

Missouri (2-92)

Title 2-Department of Agriculture
Division 90-Weights and Measures
Chapter 90-Petroleum Inspection
2 CSR 90-30.040 Quality Standards For Motor Fuels

(2) Method of Sale of Gasoline-Alcohol Blends.

(A) Method of Retail Sale. Notwithstanding any rule to the contrary, all motor fuel kept, offered, or exposed for sale, or sold at retail containing at least one percent (1%) by volume of any alcohol shall be identified as such using the word "contains" or other wording approved by the director, in conjunction therein, the maximum volume percentages to the nearest whole percent and the name of each alcohol additive on the upper fifty percent (50%) of the dispenser front panel in a position clear and conspicuous from the driver's position, in a type at least one-half inch (1/2") in height, one-sixteenth inch (1/16") stroke (width of type).

Examples:

CONTAINS 10% ETHANOL
CONTAINS ALCOHOL
5% METHANOL
5% TERTIARY BUTANOL

Montana (2-92)

The Weights and Measures Bureau has for years used NIST Handbook 130 as its guideline for labeling of retail gasoline dispensers. The Bureau intends to formally adopt the requirements sometime this summer, depending on available funding.

Nebraska (2-92)

66-1214. Motor fuel dispensers; label requirement; penalty. Commencing January 1, 1986, motor fuel dispensers shall be labeled on both faces with the product identity using the most descriptive terms commercially practicable. In addition, all alcohol-blended fuel dispensers shall have a label stating: With or containing ethanol, methanol, or ethanol and methanol or with similar wording if the motor fuel being dispensed contains one percent or more by volume of alcohol. Any person who owns or controls such a motor fuel dispenser and does not attach the notice required by this section shall be guilty of an infraction.

Source: Laws 1985, LB 346, § 6.

Nevada (2-92)

ADOPTED REGULATIONS OF THE STATE SEALER
OF WEIGHTS AND MEASURES

LCB File No. R057-91

Authority: NRS 590.100

Sec. 3. 1. The octane rating number of the gasoline from the proof of transfer must be posted on the pump or other device for dispensing the gasoline unless the gasoline contains ethanol. If the gasoline contains ethanol, the pump or device must be posted with the statement "Gasoline Containing Ethanol".

New Hampshire

New Jersey (3-92)

No labeling is required.

New Mexico (4-92)

57-19-13. Labeling.--

A. Except as otherwise provided in this section, it is unlawful for any person to sell, offer for sale, assist in the sale of, permit to be sold or offered for sale, or deliver or offer for delivery any petroleum product referred to in the Petroleum Products Standards Act (57-19-1 to 57-19-22 NMSA 1978) at any place where petroleum products are kept or stored for sale, unless and until there is firmly attached or painted upon each container, receptacle and pump, from which or into which such product is drawn or poured out for sale or delivery, a sign or label plainly visible consisting of the name of such product including in the case of gasoline and diesel fuel the grade or brand name designation, if any, in letters not less than one-half of an inch in height, together with the brand name, trademark or trade name of such product, which word or words shall also be in letters of not less than one-half of an inch in height.

January 22, 1990 Memorandum from Frank A, DuBois, Director/Secretary to Gasoline Retailers, Wholesalers, Jobbers and Repairman on Labeling of Alcohol-Blended Fuels (SCS 90 E-13)

To comply with the above sections of the Petroleum Products Standards Act, whenever an alcohol-blended fuel is offered for sale, a label in letters not less than one-half of an inch in height, indicating the type of alcohol used in the blend shall be conspicuously displayed on both sides of the dispenser.

Letter from New Mexico Dept. of Agriculture, Division of Standards and Consumer Services, April 6, 1992

...the county of Bernalillo and the city of Albuquerque work in concert on a mandated oxygenated fuel program from November to March, and they have their own labeling requirements.

New York

North Carolina (2-92)

Section .0400-DISPENSING DEVICES AND PUMPS

.0401 LABELING OF DISPENSING DEVICES

(a) For the purposes of product identity, each dispensing device used in the retailing of any motor fuel shall be plainly and conspicuously labeled with the following:

(3) for gasoline-oxygenate blends containing at least one percent by volume of ethanol, methanol, or combination, the registered brand name plus an additional label which states that the blend "contains alcohol", "contains ethanol," "contains methanol," or "contains ethanol/methanol." The label shall be composed of letters at least one inch in height, minimum one-eighth inch stroke, which contrast distinctly with the label background and shall be affixed to the dispenser front panel in a position clear and conspicuous from the driver's position. Exceptions to this Rule are:

(A) for fuels not covered by an EPA waiver, the additional label shall identify the percent by volume of ethanol and/or methanol in the blend.

(B) for such fuels meeting the EPA's "Substantially Similar" rule and which do not contain ethanol or methanol, no additional label is required.

Oklahoma

North Dakota (2-92)

- a. All gasoline or gasohol sold or offered for sale containing ethanol, methanol or cosolvent alcohol, or any combination thereof, shall be labeled with the conventional name or names of the alcohol contained in the gasoline or gasohol if the gasoline or gasohol consists of one percent or more by volume of any alcohol or combination of alcohols. The label must be on any price advertising and the dispenser's front panel in a position that is clear and conspicuous from the driver's position.
- b. Maximum percentage of methanol and cosolvent alcohol must both be conspicuously displayed or labeled if the product contains three percent or more by volume of methanol.

Ohio

As described in the Ohio Revised Code, at 109:4-3-18

(C) It shall be a deceptive and unfair act or practice in connection with a consumer transaction, when ethanol, methanol or co-solvent, or any combination thereof, is blended or mixed into gasoline in quantities greater than three-tenths of one percent by volume and sold or offered for sale to the public, for a retail dealer to fail to disclose:

- (1) The fact that the gasoline contains ethanol, methanol, or co-solvent;
- (2) The maximum percentage to the nearest tenth of a percent of any ethanol, methanol, or co-solvent contained in the gasoline.

The disclosure required by this paragraph shall be made by printed sign or label affixed to the retail dispensing pump. The printed sign or label shall be visible and legible to the purchaser and shall be displayed in a clear, conspicuous and prominent manner. The word "Contains" shall be in block letters not less than one-half inch in height.

(D) It shall be a deceptive and unfair act or practice for a person who transfers the possession of gasoline at wholesale, which may affect a consumer transaction, to fail to deliver to a buyer, before or at the time of the transfer of possession of the gasoline, a written notice identifying the gasoline transferred, including any ethanol, methanol, or co-solvent...

Oregon (2-92)

(Statutory Authority)

Trade Regulations and Practices

646.915 Retail sale; disclosure required; signs. (1) A retail dealer of gasoline who knowingly sells or offers for sale gasoline that is blended with ethanol, methanol, co-solvent or a combination thereof in quantities greater than one percent by volume, must disclose:

(a) That the gasoline contains ethanol, methanol, or co-solvent; and

(b) The percentage to the nearest one half of one percent of ethanol, methanol, or co-solvent contained in the gasoline.

(2) The disclosure required by this section shall be made by affixing two signs, one to each side of each pump that dispenses gasoline blended with ethanol, methanol, or co-solvents. The following apply to the signs required by this section;

(a) Each sign shall be at least one and three-fourths inches in width and shall have printed on the top in block letters at least one-fourth inch in height and on-sixteenth in stroke the words "contains alcohol".

(b) If the gasoline contains ethanol, the signs shall have printed below the words "contains alcohol" the word "ethanol" and the percentage disclosure required by sub-section (1) of this section. The word "ethanol" and the numerals shall be in block letters not less than three-sixteenths of an inch in height and one-sixteenth of an inch in stroke.

(c) If the gasoline contains methanol and co-solvents, the signs shall have printed below the words "contains alcohol" the words "methanol" and "co-solvents" and the percentage disclosure required by sub-section (1) of this section. The words "methanol" and "co-solvent" and the numerals shall be in block letters not less than three-sixteenths of an inch in height and one-sixteenth of an inch in stroke. [1985 c468 §3 (1), (2)]

(Current /Oregon Regulations/Guidelines)

2.20.0 Gasoline-Alcohol Blends.-

2.20.1 Method of retail sale. -- All motor fuel kept, offered, or exposed for sale, or sold, at retail containing at least one percent by volume of ethanol, methanol, or a combination shall be identified as "with" or "containing" (or similar wording) "ethanol", "methanol", or "ethanol/methanol" on the upper 50 percent of the dispenser front panel in

a position clear and conspicuous from the driver's position, in a type at least one half inch in height, 1/16 inch stroke (width of type).

South Carolina

- 2.20.2. Documentation for dispenser labeling purposes. -
 - The retailer must be provided, at the time of delivery of the fuel, on an invoice, bill of lading, shipping paper, or other documentation, the presence and maximum amount of ethanol, methanol, or any combination of ethanol/methanol (in terms of percent by volume) contained in the fuel. This documentation is only for dispenser labeling purposes; it is the responsibility of any potential blender to determine the total oxygen content of the motor fuel before blending.
- (Added 1984, amended 1985, 1986)

South Dakota

Pennsylvania (2-92)

Act 1987-24 Laws of Pennsylvania
SB 29

Section 1. Definitions

"Gasoline additives." Methanol, ethanol, or cosolvent in concentrations above 1% by volume.

Section 2. Posting of gasoline additive information

(b) Pump signs.-

- (1) The manufacturers also shall provide anyone who purchases the gasoline for resale to the public or to retail service station dealers with pump signs meeting the following criteria:
 - (i) The pump sign shall indicate that the gasoline dispensed from that pump contains gasoline additives and shall set forth the maximum percentage by volume, to the nearest whole percent, of each gasoline additive.
 - (ii) This information shall be set forth in block lettering which is at least one-quarter inch in size.
- (2) When providing pump signs to purchasers of its gasoline who intend to resell the gasoline to the public or to retail service station dealers, the manufacturer shall provide an adequate number of the signs for the purchaser or retail service stations to whom the purchaser sells, to meet the requirements of this act.

Rhode Island (5-92)

Letter from Lynda Maurer, Supervising Metrologist, Metrology Laboratory, R.I. Dept. of Labor:

The State of Rhode Island adopted in August 1980 the method of Sale of Commodities regulation section of NIST Handbook 130. To my knowledge this is the only place where the labeling of oxygenated fuels is addressed.

Tennessee (2-92)

47-26-247. Petroleum products containing ethanol or methanol.- (a) Any person who shall sell or deliver a petroleum product containing ethanol (ethyl alcohol) or methanol (methyl alcohol), or both, to a person other than a retail consumer, shall place on the instrument evidencing the sale or delivery of the petroleum product, the name of each alcohol, and the percentage by volume of each alcohol, contained in the petroleum product being sold or delivered.

(b) Any retail service station merchant who shall sell or dispense a petroleum product containing by volume at least one percent (1%) ethanol (ethyl alcohol) or methanol (methyl alcohol), or both, shall affix a notice to a conspicuous area of each dispenser which supplies a petroleum product containing ethanol or methanol, or both.

(1) Such notice shall contain the name ethanol or methanol, or both, whichever is contained in the petroleum product supplies by such dispenser.

(2) Such notice shall contain the name and maximum percentage to the nearest whole percent, of ethanol, or methanol, or both, contained in the petroleum product supplies by such dispenser.

(c) Any person who shall violate any of the provisions of this section shall be guilty of a misdemeanor and subject to a fine of not less than one hundred dollars (\$100) nor more than one thousand dollars (\$1000) or imprisonment for not more than six (6) months, or fine and imprisonment in the discretion of the court. [Acts 1985, ch. 70 § 1.]

0080-5-9-.03 (19) Gasoline-Alcohol Blends

B. Rules.

For purposes of this regulation, the following rules shall apply:

- 1. Any petroleum dispensing device distributing a petroleum product containing at least one percent (1%) etha-

nol (ethyl alcohol), methanol (methyl alcohol), or cosolvent, must be labeled with the type alcohol (ethanol, methanol, cosolvent, or any combination thereof) and the maximum percentage by volume of each.

- a. These labels shall be located on the upper one-third (1/3) area of the dispensing device and as near as possible to the price per unit of the alcohol blended fuel.
 - b. Labels must be affixed to each side of the petroleum dispensing device where a prospective purchaser may dispense or receive an alcohol blended fuel.
 - c. If dispenser design or installation prohibits labels from being affixed as specified in subsections A and B, they shall be affixed in such a manner as to be readily observed by a prospective purchaser. In addition, labels shall be subject to approval by the Commission.
2. Two separate but similar labels not less than 1 3/4 inch in height and 2 3/4 inch in width shall be used to designate petroleum dispensing devices containing ethanol, methanol, or both. The words "CONTAINS ETHANOL" or "METHANOL" shall appear in block letters not less than one-fourth (1/4) inch in height and one-sixteenth (1/16) inch in width and appear at the top of the label.
- a. For petroleum products containing ethanol, the following shall apply: Below the words "CONTAINS ETHANOL" the label shall contain the word "ETHANOL" and the required disclosure.
 - b. For petroleum products containing methanol, the following shall apply: Below the words "CONTAINS METHANOL" the label shall contain the word "METHANOL" and "COSOLVENT" and the required disclosure.
- The words "ETHANOL", "METHANOL", "COSOLVENT", and the required disclosures shall be in block letters not less than 3/16 inch in height and 1/16 inch wide. (See illustrations 1 and 2 for examples).
- c. No additional wording, graphics, or information shall be included upon the label. The label shall not be displayed in a manner calculated or tending to mislead, confuse, or deceive an actual or prospective purchaser.
3. Labels must consist of black letters and numbers on a white background and be constructed of a durable water-proof material.
4. The Department shall, when it deems necessary, test or cause to be tested, any petroleum product either in the

retail or wholesale chain for alcohol content to determine accuracy of above mentioned labeling.

5. Every manufacturer, distributor, wholesaler, or blender of alcohol blended petroleum products shall furnish to the Department within 60 days of the approval of this regulation, the company name, company mailing address, street address (if different), and telephone number, of retail service stations to which they distribute alcohol blended petroleum products. Thereafter, the Department shall be notified within seven (7) days when retail establishments not previously selling or receiving alcohol mixtures, are added to or deleted from these listings.
6. Unlabeled petroleum dispensing devices distributing an ethanol or methanol blended fuel shall conform to all labeling requirements within sixty (60) days following final approval of these rules and regulations.
7. Ethanol/methanol content and percentage labels presently appearing on petroleum dispensing devices distributing an ethanol or methanol blended fuel will be acceptable until January 1, 1987, at which time they must be replaced by labels conforming to the above rules and regulations. Any existing ethanol/methanol content labels must comply with the basic intent of T.C.A. Section 47-26-247 and pursuant rules and regulations and shall be subject to approval by the Commissioner.

STATUTORY AUTHORITY: T.C.A. Section 43-26-207.

Texas (2-92)

House Bill 504

Section 3. POSTING NOTICE OF SALE OF ALCOHOL AND MOTOR FUEL MIXTURE.

(a) A motor fuel dealer in this state may not sell or offer for sale any motor fuel from a motor fuel pump that is supplied by a storage tank into which motor fuel containing ethanol in a mixture in which one percent or more of the mixture measured by volume is ethanol or into which motor fuel containing methanol in a mixture in which one percent or more of the mixture measured by volume is methanol has been delivered within the 60-day period preceding the day of sale or offer of sale, unless the dealer prominently displays on the pump from which the mixture is sold a sign that complies with the regulations of Subsection (b) of this section.

(b) (1) The sign required under Subsection (a) of this section must be displayed on each face of the motor fuel pump on which the price of the motor fuel mixture sold from the pump is displayed. The sign must state "Contains Ethanol" or "Contains Methanol", as applicable. The sign must appear in contrasting colors with block letters at least one-half inch in

height and one-fourth inch in width and shall be displayed in a clear, conspicuous, and prominent manner, visible to consumers using either side of the pump.

(2) In addition to the requirements of Subsection (b) (1) of this section, if a motor fuel is supplied by a storage tank into which motor fuel containing 10 percent or more ethanol by volume or five percent or more methanol by volume has been delivered within the 60-day period preceding the day of the sale or offer of sale, the sign shall state the percentage of ethanol or methanol by volume, to the nearest whole percent, of the motor fuel having the highest percentage of ethanol or methanol delivered into that storage tank within the 60-day period. This subsection does not prohibit the posting of other alcohol or additive information, the information and posting being subject to regulations by the commissioner of agriculture.

Utah

Vermont

Virginia (2-92)

§ 59.1-167.1. Labeling of motor fuels; notification to reseller.-
A. Every dispensing device used in the retail sale of gasoline shall be plainly and conspicuously labeled with the brand name or trade name of the gasoline, and if the product contains 1.0% or more of ethanol or methanol, a label identifying the kind of alcohol and the percentage of each shall be posted in letters not less than one inch in height.

Washington (2-92)

NEW SECTION
WAC 16-657-040 POSTING OF ALCOHOL BLEND GASOLINES. (1) All retail motor fuel devices dispensing alcohol blend gasolines shall state on the face of the device that alcohol ingredients are contained therein. The statement shall disclose what alcohol products are included, i.e. methyl alcohol, ethyl alcohol, and the percentage of alcohol that is contained therein. The statement shall be conspicuously posted in gothic letters at least one inch in height in contrasting letters, in a location as to be easily seen by consumers and in the following format:

CONTAINS _____% ethyl/methyl ALCOHOL

(2) The percentage of alcohol disclosed on the dispensing device shall be the ratio between the amount of ethyl alcohol, or methyl alcohol including co-solvents or proprietary inhibitors, or any other alcohol, to the total product volume.

SUBSTITUTE HOUSE BILL NO. 1668

State of Washington 48th Legislature 1984 Regular Session

by Committee on Transportation (originally sponsored by Representatives Isaacson, Ellis, Hankins, Walk, Barnes, Clayton, Bond, Egger and Zellinsky)

Read first time February 3, 1984

AN ACT Relating to motor vehicle fuel containing alcohol; adding a new section to chapter 19.94 RCW; and prescribing penalties. BE IT ENACTED BY THE LEGISLATURE OF THE STATE OF WASHINGTON:

NEW SECTION. Sec. 1. There is added to chapter 19.91 RCW a new section to read as follows:

It is unlawful for any dealer or service station, as both are defined in RCW 82.36.010, to sell ethanol and/or methanol at one percent, by volume, or greater in gasoline for use as motor vehicle fuel unless the dispensing device has a label stating the type and maximum percentage of alcohol contained in the motor vehicle fuel.

Violation of this section is a misdemeanor.

West Virginia

Wisconsin (2-92)

(b) A device that dispenses a gasoline-ethanol fuel blend for sale at retail shall be marked or labeled with the percentage of ethanol, using one-half inch high letters with a stroke of not less than one-eighth inch in width, at all times when the product is offered for sale. The label shall be on the front or side of the upper half of the dispensing device and shall be conspicuous and legible to a customer when viewed from the driver's seat of a motor vehicle that is located within 6 feet of the dispensing device. The device may also be marked or labeled with any product grade specifications prescribed under s. 168.04.

Wyoming (2-92)

Section 3. Products to be Labeled. All products must be sold under their true name and grades, respectively, and such names and grades must be impressed or otherwise

plainly marked upon the container, can, barrel, vessel, or dispensing device in or through which the product is stored, sold, offered or exposed for sale.

District of Columbia

Terminal Operations

Introduction

Considerations at the terminal level will vary depending on the blending program selected as well as the specifics of the terminal.

Traditionally, the most common blend ratio for ethanol blending programs has been a blend of 90% gasoline/10% ethanol. However, programs which utilize ethanol for its oxygen value may also utilize blends containing either 5.7% ethanol or 7.7% ethanol. The 5.7% ethanol level equates to approximately a 2.0% oxygen level which is the minimum level stipulated for reformulated gasoline (as well as the minimum level for oxygenated fuel programs). The 7.7% ethanol level equates to approximately a 2.7% oxygen level which is the average amount specified for oxygenated fuel programs. A level of 10% ethanol equates to an oxygen level of approximately 3.5 weight %. These blend levels and corresponding oxygen content are recapped in the chart below.

<u>Volume % Denatured Ethanol in Fuel</u>	<u>Approximate Oxygen Content</u>
10.0% by volume	3.5% by weight
7.7% by volume	2.7% by weight
5.7% by volume	2.0% by weight

NOTE: When utilizing ethanol to comply with the oxygen requirements for oxygenated fuel programs, very specific methods for calculating oxygen content apply. Company management should ensure that these requirements are adhered to.

Storage Requirements

The blend levels selected (i.e. 10%, 7.7%, or 5.7%) will obviously affect storage requirements. When determining storage requirements, consideration should also be given to the method employed to deliver ethanol to the terminal. Terminals receiving product by transport truck will be able to work off of smaller inventories. Those receiving product by rail or barge will need to consider both the larger minimum shipment requirements and less predictable arrival times, possibly necessitating greater storage capability. In addition to being utilized to meet mandated oxygen levels, ethanol blends qualify for certain tax incentives based on strict content requirements. Therefore it is extremely important that even short periods of product outage be avoided.

Tanks selected for ethanol storage must meet certain requirements and must be properly prepared. The American Petroleum Institute (API) has guides for tank cleaning and preparing. Space for insertion of these guides is provided in the appendix to this section.

Blending Equipment Requirements

There are a variety of ways to blend ethanol at the terminal including different variations of splash blending as well as in-line blending.

Splash Blending: Splash blending (also called top-off blending) refers to the practice of loading gasoline and ethanol into the transport tank compartments separately and allowing the blending to occur

in the transport. This requires no special equipment other than the additional loading arm and meter for the ethanol. However this procedure leaves the responsibility for accurate blend ratios in the hands of the transport driver. Please note that API recommends adding gasoline to the transport before the ethanol to ensure that vapors in the compartments are above the upper flammability limits.

Until the late 1980's, splash blending was the typical method employed by most blenders. With the increase in market share and involvement of major oil companies, as well as more complicated blend ratios, the trend today is to employ either sequential splash blending or in-line (injection) blending. Most terminals implementing new ethanol blending programs view splash blending only as an interim measure until more sophisticated blending equipment can be installed.

Sequential Splash Blending: This procedure removes the control of the blend ratio from the transport driver. Gasoline and ethanol are both metered through the same loading arm and meter, one following the other. The percentage of each product is usually determined by computer or preset metering devices. Sequential splash blending ensures accurate blend ratios and eliminates the need to connect to a second loading arm to fill the transport compartment. This is still considered a form of splash blending since blending occurs in the tank compartment.

In-line Blending: In-line blending refers to the practice of the ethanol and gasoline being blended by injection into product pipes prior to the metering process. This method results in the product being blended prior to the meter. Only one loading arm is used and only one meter ticket is necessary. Blend ratios are controlled by computer or pre-set blending equipment.

Additional Reference Sources

Appendix III-1 contains additional information on terminal preparation and blending equipment. The following items or space for their insertion are provided in the appendix to this section.

- Storage & Handling Ethanol & Gasoline Ethanol Blends at Distribution Terminals & Service Stations - API Recommended Practice 1626 (April 1985) (space provided for insertion)
- Cleaning Petroleum Storage Tanks - API Publication 2015 (September 1985) (space provided for insertion)
- Flow Forum (Gate City newsletter on additive injection)
- Gate City Blending Systems - Technical description
- Waugh Control Blending System information
- Daniel Flow Products Inc. Gasoline Blending System
- Blackmer Vari-Flo pumps for variable capacity liquid transfer and proportioning applications

NOTE: Data on blending equipment is provided for informational purposes and does not constitute an endorsement of any equipment or its manufacturer.

Other Considerations: If any actions taken at the terminal require EPA or other permits or filings, these should be obtained and kept on file. Also if total tankage is changed or products are altered, it may be necessary to update the terminal's Spill Prevention Plan (SPP).

Specifications and operating requirements for the terminals evaporative emissions system should be checked to ensure that they are adequate to handle any new products and/or resulting increased volumes.

Finally, if the terminal utilizes a color coding system such as the API Color Code or other product identification system, you should ensure that the appropriate changes are made to reflect any product changes. Space is provided for the appropriate information to be inserted in the appendix to this section.

Operations

Most of the aforementioned information deals with preparing a terminal for an ethanol blending program. Once equipment is selected and prepared/installed, it is necessary to ensure that terminal personnel are oriented not only to the new equipment but any new safety and operational procedures that result.

First it is necessary to familiarize the terminal personnel with any new equipment and its operation. This information will be company, terminal, and equipment specific. Additionally any new or modified company procedure such as accounting changes should be covered.

Safety and firefighting information should be covered and Material Safety Data Sheets (MSDS) should be posted or issued to each employee. These issues along with an MSDS are covered in the "Safety & Firefighting" section of this manual.

Information on the proper procedures for receiving ethanol should be thoroughly covered. Instructions for properly unloading rail cars and tanker trucks of ethanol as recommended by ADM are included in the appendix of this section. Procedures for receiving marine shipments are not covered since such procedures are company specific and may involve various cargo inspection procedures.

In order to ensure product quality, many companies require that product be checked for "proof" and visual clarity. Information on determining proof of denatured alcohol is also provided in the appendix. Some companies may also require testing product with a hand held refractometer. Information on use of a hand held refractometer is included in the appendix to this section. Company procedures regarding retention of samples should also be covered. Product specifications are generally provided by your ethanol supplier. A space is provided at the end of this section for insertion of product specification sheets from your ethanol supplier(s).

It should be noted that some terminals have experienced frequent filter/strainer plugging when converting to ethanol for the first time. This will depend largely on the condition and cleanliness of tanks and lines, but the appropriate personnel should be advised that such occurrences are possible. Neat ethanol does have a solvency effect and can loosen deposits in the product system. Once the system is relatively clean from the initial conversion, you should not experience any additional incidence of filter plugging or slow down.

Ethanol may loosen system deposits, that have built up over the years. It is recommended that affected meters be tested and/or recalibrated after the first 10 to 15 days of use to ensure accuracy of product delivery.

By following a few simple procedures and properly orienting terminal personnel, you should not encounter any problems at the terminal level. To aid you in covering these items with appropriate personnel, a brief checklist concludes this section.

Terminal Personnel - Orientation Check List

- 1. Equipment orientation
- 2. Cover new or modified procedures (accounting etc.)
- 3. Cover safety and firefighting information
- 4. Issue/post MSDS
- 5. Cover product receipt procedure
- 6. Cover any procedure regarding product inspection and/or sample retention
- 7. Advise maintenance personnel of conversion and potential for filter/screen plugging
- 8. Test affected meters and recalibrate if needed (10 to 14 days after initial conversion)

Terminal Operations Appendix - Section III-1

- Storage & Handling Ethanol & Gasoline Ethanol Blends at Distribution Terminals & Service Stations - API Recommended Practice 1626 (April 1985) (space provided)
- Cleaning Petroleum Storage Tanks - API Publication 2015 (September 1985) (space provided)
- API 1637 or other product identification guidelines
- Flow Forum (Gate City newsletter on additive injection)
- Gate City Blending Systems - Technical description
- Waugh Control Blending System information
- Daniel Flow Products Inc. Gasoline Blending System
- Blackmer Vari-Flo pumps for variable capacity liquid transfer and proportioning applications
- Unloading Instructions for Tank Cars of Ethanol
- Handling & Unloading Procedures for Tank Trucks of Ethanol
- Methods of Determining Apparent Proof of Ethanol
- Use of Hand Held Refractometer
- Product specification sheets-ethanol

Space provided for insertion of:

**Storing & Handling Ethanol & Gasoline-Ethanol
Blends at Distribution Terminal & Service Stations**

API Recommended Practice 1626 - April 1985

Space provided for insertion of:

Cleaning Petroleum Storage Tanks

API Publication 2015 - September 1985

Space provided for insertion of:

Product Identification Guidelines

API Recommended Practice 1637 or Appropriate Substitution

Recap of API Color Code for Ethanol Blends

The API color codes for gasolines extended with ethanol are the same as the base gasoline except the background color in the fill cap circle is encircled with the color used in the cross.

Unleaded regular with ethanol is a white background with a black cross encircled in black.



Unleaded midgrade with ethanol is a blue background with white cross encircled in white.



Unleaded premium with ethanol is red background with white cross encircled in white.



Terminal signage, fill box inserts, and tankage/piping identifications use markings similar to those above.

Flow Forum™

News and Notes on Additive Injection

ILTA Trade Show

Welcome to the 1992 ILTA Edition of the *Flow Forum™* Newsletter. This year's ILTA annual conference and trade show will be from June 22 through June 25. The trade show will be open on Wednesday, June 24, from 9:00 AM to 5:00 PM and on Thursday, June 25, from 9:00 AM to 1:00 PM.

Gate City will exhibit in our traditional area, booth numbers #101 and #103. This year's show will feature our revolutionary *Blend-Pak™* Injector. Shown as a prototype at last year's show, the *Blend-Pak* Injector has been performing reliably in the field for the last four months at several locations. Additionally, several major oil companies are now evaluating this unit.

Featured with the *Blend-Pak* Injector will be radio communications. This option allows the *Blend-Pak* Injector to communicate through its modem with any computer system without expensive communication wiring and conduit. A complete demonstration of this technology will be available at our booth.

On the same injection rack will be Gate City's reliable *Gate-Pak®* Injector and the remark-

able *ABC™* Injector. All are working models and will give our visitors an excellent opportunity to compare all three styles of injectors.

Displayed for the first time at Gate City's booth, will be a new HV style master meter. Tests run in April produced excellent results as compared to a traditional horizontal master meter. Come by the booth to see the vertical meter and learn about the results.

Also exhibited, will be the *Wild Stream™* WB-1190 *Oxygenate Blender* configured as a three stream unit. Our design can easily accommodate any number of streams based on your requirements. This skid mounted blending system is easy to install at your terminal site and will handle any currently approved oxygenate. The November 1, 1992 deadline for oxygenates in the non-attainment areas is close. Stop and see if this simple, flexible system will meet your oxygenate needs.

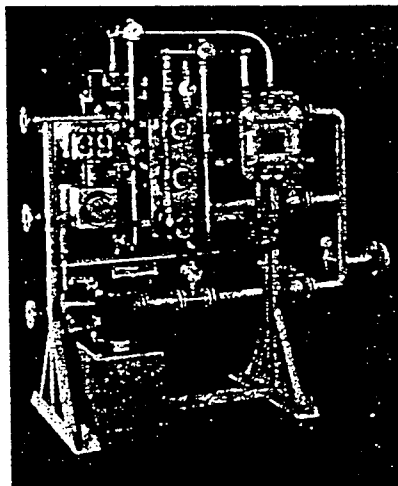
Finally, a mag drive, dual pump assembly will be displayed. This assembly will contain our PS-1
(continued on page 3)

Wild Stream™ Oxygenate Blender

On November 1, 1992, the Clean Air Act covering carbon monoxide (CO) emissions will become active. Any area, which is in violation of the federal CO air quality standards, will have to use oxygenated gasoline. Oxygenated gasoline will have an oxygen content of 2.7% by weight. Forty-one metropolitan areas are currently covered by this portion of the Clean Air Act.

Implementation of this act raises two obvious questions. First, which approved oxygenate should a company use? Second, how does a company implement oxygenated gasoline in its terminals and retail outlets?

A number of factors influence the choice of an oxygenate. Local availability and cost are two



Wild Stream Oxygenate Blender

important considerations. It is likely that the answer for these questions will differ according to location. Another factor may be local legislation that requires the use of a specific oxygenate within that state.

Blending the oxygenate into the gasoline can also raise several questions. First, where is the blending to be done? Choices for the blending include at the refinery, in the terminal storage area, or while loading individual trucks. Blending while loading trucks is preferred as it will reduce

inventory costs and minimize the amount of costly oxygenated gasoline sold during non-regulated periods. Another consideration is what equipment is suitable for each company at all its terminals?

(continued on page 2)

Oxygenate Blender

(continued from page 1)

Gate City's *Wild Stream*™ WB-1190 Oxygenate Blender is the ideal system for oxygenate blending. First, the WB-1190 is compatible with all current approved oxygenates as defined by the EPA. This will allow standardization on one blending system at all the company's terminals while still allowing the use of different oxygenates. If for any reason a change in oxygenates is required, the only adjustment needed is to enter the correct blend ratio.

Installation of this *Wild Stream* blender is easy and inexpensive. All that is needed is space near the rack for the blender, connect the inlet and outlet piping, hook up the electronics, and the system is ready to run. Also, our system can accommodate any number of loading racks. Typical systems are designed to blend into three to five loading positions.

Available as an option is our 'Clean Start' feature. 'Clean Start' allows the main product to flush out the line while still blending the correct amount of oxygenate into the product. This control procedure blends more oxygenate at the beginning of the load, such that at the end of the load the correct blend ratio will be present. Use of this feature can be very important in terminals that supply retail outlets in both regulated and non-regulated areas.

Accuracy of the blend ratio is also important. If the oxygenate blend ratio is too low, that load of gasoline will be out of compliance. If the ratio is too high, expensive oxygenate will be given away. The WB-1190 Countmaster™ controller monitors the blend ratio. If the ratio falls outside the predefined limits, the Countmaster controller shuts down that loading arm.

Additional information on the *Wild Stream* WB-1190 Oxygenate Blender is available in Gate City's Blending Systems brochure and in a product sheet. Please contact your Gate City representative or Gate City for additional information.

EZ Inject™ System

(continued from page 4)

One possible application is as an emergency additive system. If for any reason, a terminal's gasoline loading or additive system is out of commission, the EZ Inject System connected to a portable additive storage tank can be used to load additive into the truck's compartments. Once the additive has been loaded, untreated gasoline can be loaded and the product integrity will be maintained.

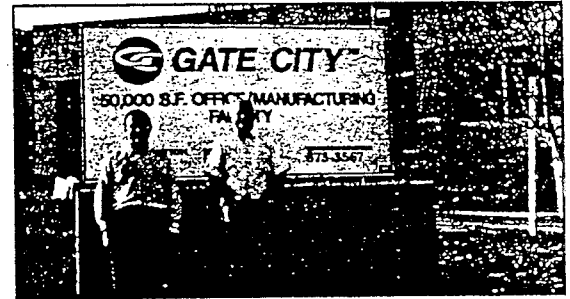
For more information on the EZ Inject System or to discuss your application idea, please feel free to call Gate City at (404) 475-1900.

Distributor Highlight

As a regular feature, this column will profile one of our excellent distributors. Distributors are extremely important to Gate City as they are a valuable extension of our sales and marketing efforts. Caltrol, our largest distributor for 1991, will be profiled.

Caltrol joined Gate City's distributors network early in 1991. Thanks to efforts from Milt Blevins, Jerry Long, Kathy West, and Warren Davis, Caltrol sales of Gate City equipment topped one million dollars.

In the flow product area, Caltrol represents Gate City, Smith Meter and Emco Wheaton. Fisher Controls is also a major supplier. For Gate City, Caltrol's geographic responsibility is southern California, Arizona, and parts of New Mexico and Nevada.



Milt Blevins and Jerry Long at Gate City's new facility

Caltrol employs 195 people with sales of \$60 million. Caltrol is employee owned with headquarters in Glendora, CA. Other offices are in Bakersfield, Signal Hill, San Diego, Phoenix, and Tucson.

Sales responsibility is divided geographically with emphasis on major contractors and end users. Sales coverage is enhanced by two technical support groups; process instrumentation and flow products.

If you are interested in talking to Caltrol about Gate City's equipment, please feel free to call them at (818) 963-1010.

Blend-Pak Upgrades

(continued from page 4)

limitation is allowing the unit enough time to complete the injection and prepare for the next cycle. Also, a smaller gallon per cycle setting will decrease the solenoid valve's life as more injection cycles will be run.

Lastly, the protocol to allow the automation system to set the injection rate has been developed. This effectively allows for 'infinite' injection rates as the terminal system could set a rate for each load. For example, incorporating this communication protocol into the terminal system would allow the terminal system to set additive rates for you company, exchange customer #1, exchange customer #2, 'Clean Start', etc.

All these upgrades are in 'beta testing'. Commercialization of the above upgrades should be late summer or early fall. Please feel free to contact Gate City for additional information.

Flow Forum™

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Additives and Communications

by Patrick Hayden, Product Manager

Today's gasoline requires the addition of sophisticated additives to provide both the performance required by today's consumer, and the reduction in emissions required by the EPA. Under forecasted legislation requiring additive use, the burden of proving that the additives are correctly injected is placed on the oil companies. This "burden" can become a cost and quality advantage if a monitoring system is implemented and tracked properly. The advantage comes from several factors including:

- Increased product quality by insuring the proper dosage of additive
- Reduction in additive usage by tracking and correcting overdosing systems
- Individual injector problems identified rather than "system wide" problems

Several of our customers have indicated a reduction in the additive amount used by 1% to 2% can result in savings approaching hundreds of thousands of dollars per year.

Our Gate-Pak Injector requires the least amount of maintenance of truck terminal equipment. Today the additive injection system has taken on a whole new importance. With that new found importance comes the requirement for additive system data. In the near future, we anticipate the EPA will require that the amount of additive delivered be included on the Bill Of Lading. Gate City is currently working with several major oil companies to help provide them with the data required to meet these coming requirements.

Communications with the additive system can take on several meanings, with the entire Gate City Injector product line being able to provide the information that will be necessary to meet coming requirements.

Gate-Pak™ Injectors can provide information to monitoring systems by means of our magnetically operated piston switch. When an injection is completed, our piston switch sends a signal to the monitoring system which receives and interprets that signal into a known volume. The sending and receiving of the signal becomes a form of communication, and when coupled with the right monitoring system can provide very accurate additive usage reports. As an alternate means, a metering device (typically an oval gear type meter) fitted with a transmitter can be placed in each injector additive stream. This method provides information to the monitoring system by means of a pulse output (typically 240 pulses per gallon), which can then be interpreted to determine actual additive usage.

ABC™ Injector systems provide an internal monitoring system, which provides an alarm output when an injection error is detected. Automation system communications are provided by means of a factored pulse output that is a mirror image of the additive injected by the ABC Injector. The factored pulse output may then be used by the automation system to interpret the amount of additive and provide reporting capabilities.

Blend-Pak™ Injectors offer the most flexibility when your requirements include two-way communications. Our standard unit includes RS232 serial communications. With our RS232 serial interface card, your Blend-Pak Injector system operates as a multi-drop network providing easy installation and user communications. The Blend-Pak is also available with RS485 communications to meet your communication requirements.

The Blend-Pak Injector features a simple and user friendly interface that is accessible using any communications software. Alarm outputs are internally determined as critical and non-critical, and two separate Form C relay outputs are provided. Alarm output relays may be tied to permissive or indicator systems. The Blend-Pak Injector keeps track of all alarms internally and provides a report of alarms to the operator.

With an ever increasing awareness of the important role that additives play in providing quality products, and the requirement to verify proper additization, also comes the knowledge that the entire Gate City product line can provide you with the equipment and the solution. Contact your Gate City representative to discuss your company's requirements and interest in communications.

Employee Profile

In the normal course of business, most contact between a company and its customers is done over the telephone. This regular column highlights one or a specific group of employees at Gate City.



Profiled this issue is Tom Gyde, Gate City Operations Manager and chief troubleshooter. Operations Manager, Tom is responsible for manufacturing, warehousing, purchasing, and shipping departments. When wearing his troubleshooting hat, Tom travels worldwide working systems and new product start-ups. Tom recently celebrated his 19th year with Gate City. He moved to Atlanta in 1971 while employed with A. Smith's Meter Division. Tom grew up in Idaho and moved to Milwaukee after high school where he studied electronics at the Milwaukee School of Engineering and then joined A.O. Smith.

When not working at Gate City, Tom enjoys traveling. His recent pleasure trips have been to Egypt ("once is enough!"), Australia, and his favorite area, the Orient. Tom has two remaining goals for his traveling. One is to fly around the world in one trip. Considering his Gate City travels, this probably will be accomplished sooner than he would expect. The second is to fly on the Concorde. He also enjoys all water activities, especially jet skiing.

ILTA Booth

(Continued from page 10)

control sequencer. Under normal operating conditions, the PS-1 will automatically sequence the use of each pump, thus ensuring proper operation of both pumps. Additionally, when the flow rate demand on the operating pump exceeds the pump capacity, the PS-1 will bring on line the second pump.

This system allows for the most cost efficient use of pumps when compared to installing a larger pump sized to handle the maximum flow rate. The dual assembly also acts as its own spare allowing preventive maintenance on one pump while maintaining operations. Preventive maintenance on a larger pump would shut down the terminal, a costly, second larger spare pump was installed.

If you have any questions or needs, the Gate City booth will be manned during all the trade show hours. We look forward to seeing you at the show.

Inject™ System

Gate City is proud to announce another new injection system, the EZ Inject™ System. In the gasoline market, product differentiation is supporting brand identity. Product differentiation of gasoline is accomplished by the additive used by that company.

A problem maintaining that identity arises when the company's additive can not be loaded into the tank. This can occur when that grade of gasoline is out of inventory, whether in your terminal or exchange location.

The EZ Inject system only loads additive into the compartment based on the driver's input on how much gasoline will be loaded into that compartment. When the additive is loaded, the driver can travel to the gasoline source and load that volume of gasoline. The final result is a load of gasoline that maintains the product identity of that company.

A complete package, the EZ Inject consists of a flow displacement meter complete with a pulse transmitter, an electronic control system mounted in an intrinsically safe enclosure, stainless steel hose connected to an Emco Wheaton J451 coupler, and a hose reel. All is mounted on a mounting rack complete with a holder for the J451 coupler (so the coupler is not left on the ground).

(continued on page 2)

Blend-Pak™ Installation & Upgrades

The first installation of the Blend-Pak™ Injector started up in early March and continues to run well. This Atlanta installation of four panels replaced a Gate-Pak™ Injector rack. Communications to the Blend-Pak are via short range radio transmission. This saved approximately \$3,000 in costs as an underground communication conduit did not need installation. A Blend-Pak interface card is attached to the radio so each Blend-Pak Injector can be communicated with individually.

A new upgrade to the Blend-Pak is password protection. This upgrade will give your company the ability to enter its own password, thus allowing only authorized personnel to make changes in the Blend-Pak settings. Gate City will have a password that will allow authorized use in case your password is lost.

Also added is RS485 interface communications protocol. This option was requested by several companies during the initial demonstration of the Blend-Pak. RS232 will continue to be the standard communications protocol.

Again through customer comments, the 'Unable to complete injection' error is being changed. This error was originally designed to report any cycle where the correct amount of additive was not injected for any reason. Now it will compare the final total of additive injected versus the theoretical total of additive injected and determine if it falls within customer defined limits. For example, if the actual total of additive injected is 959 cc's versus a theoretical amount of 1000 cc's and the user defined limits are 90% and 110%, no error is recorded. If the parameters were 96% and 105%, then an error would be recorded and announced.

Traditionally, an injection occurs every 40 gallons of product. Now the Blend-Pak can be set by the customer to any injection cycle. This could be a number from 10 gallons per injection to 100 gallons per injection. The only

(continued on page 2)



Gate City Equipment Company, Inc.
Office Box 93099
Atlanta, GA 30377 - 0099

this Issue
ATA Trade Show
Oxygenate Blenders
Communications
Control
Employee Profile

Mr. Robert Reynolds
Downstream Alternatives Inc.
P.O. Box 190
Bremen, IN 46506-0190

Printed on recycled paper



Your Subscription Enclosed

GATE CITY BLENDING SYSTEMS

TECHNICAL DESCRIPTION



Quality since 1955

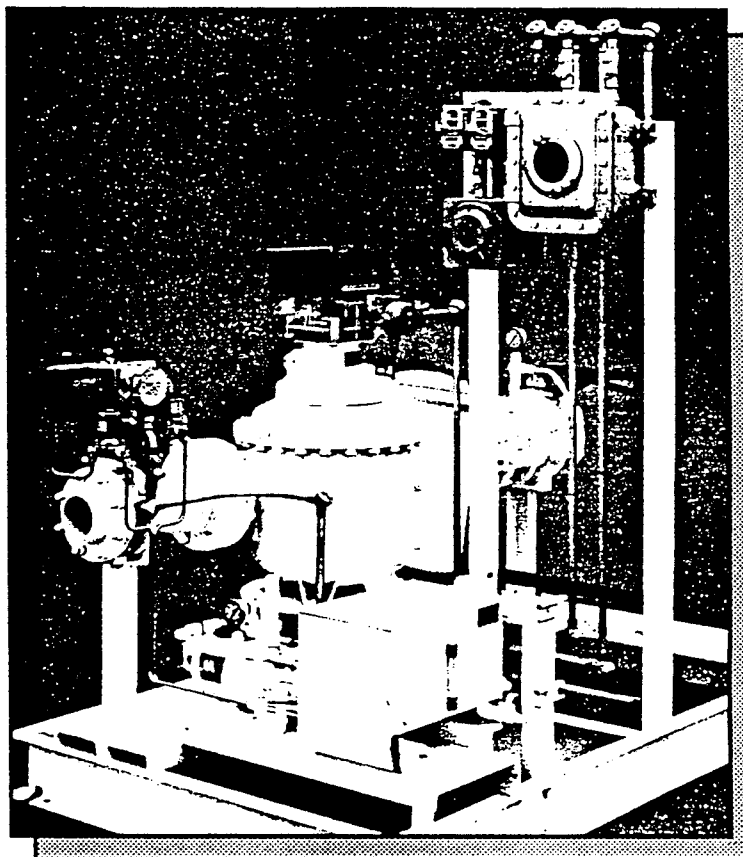
Introduction

Gate City blending systems are designed for simplicity and durability. A wide variety of available systems insures compatibility with your existing loading rack equipment, with minimal changes required. Over 10 years of direct field experience in multiple product blending enables our engineering staff to design a blending system to meet your special requirements.

Countmaster blending systems feature *ADC - Advanced Digital Control*, and are available for either hazardous or non-hazardous environments. Every blending system goes through a fully operational test procedure, which incorporates all of the components of the system. All Countmaster blending systems allow for the adjustment of blend ratio by field personnel.

Countmaster blending systems are used by many of the major oil companies, and are used to blend a wide variety of products, including: alcohol-gasoline; gasoline-gasoline; kerosene-fuel oil; MTBE-tolulene-gasoline; oil-oil.

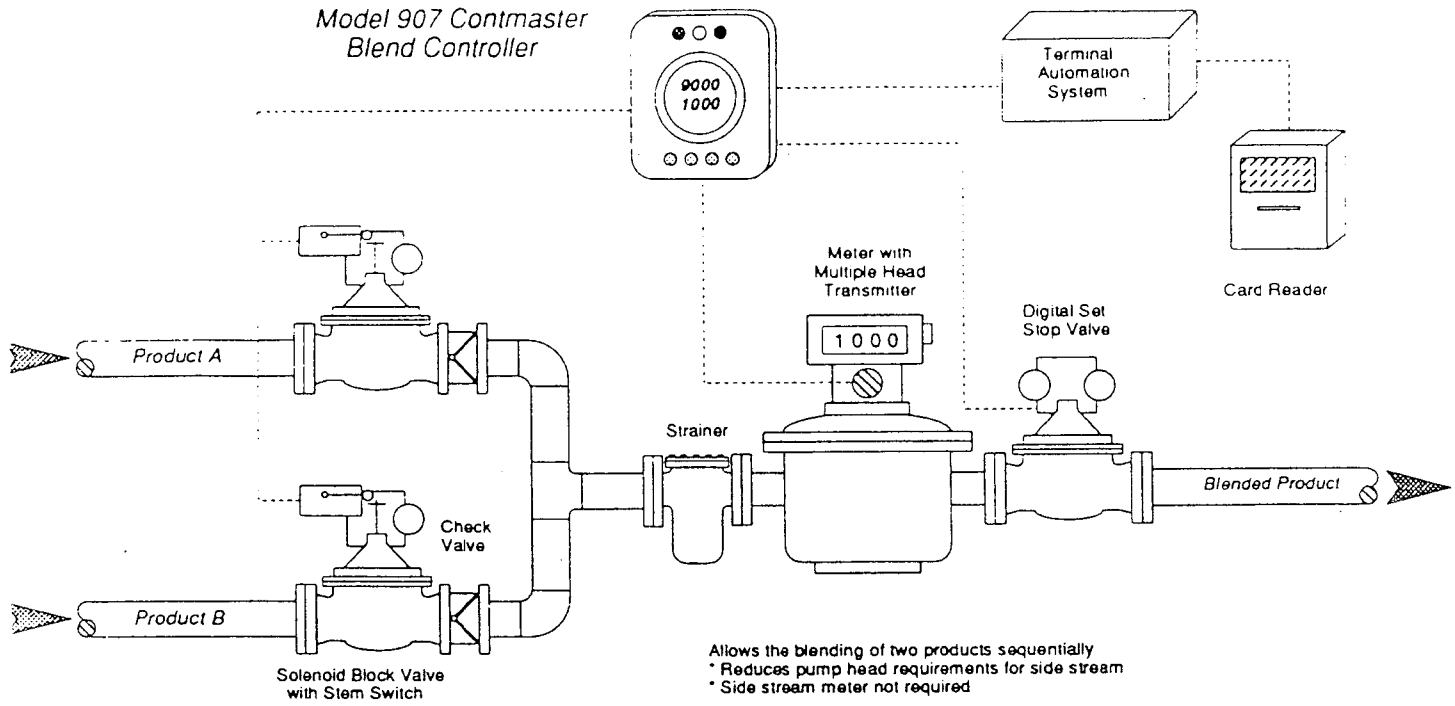
All Countmaster blending systems are backed by Gate City's 35 years of experience in the petroleum industry.



FEATURES:

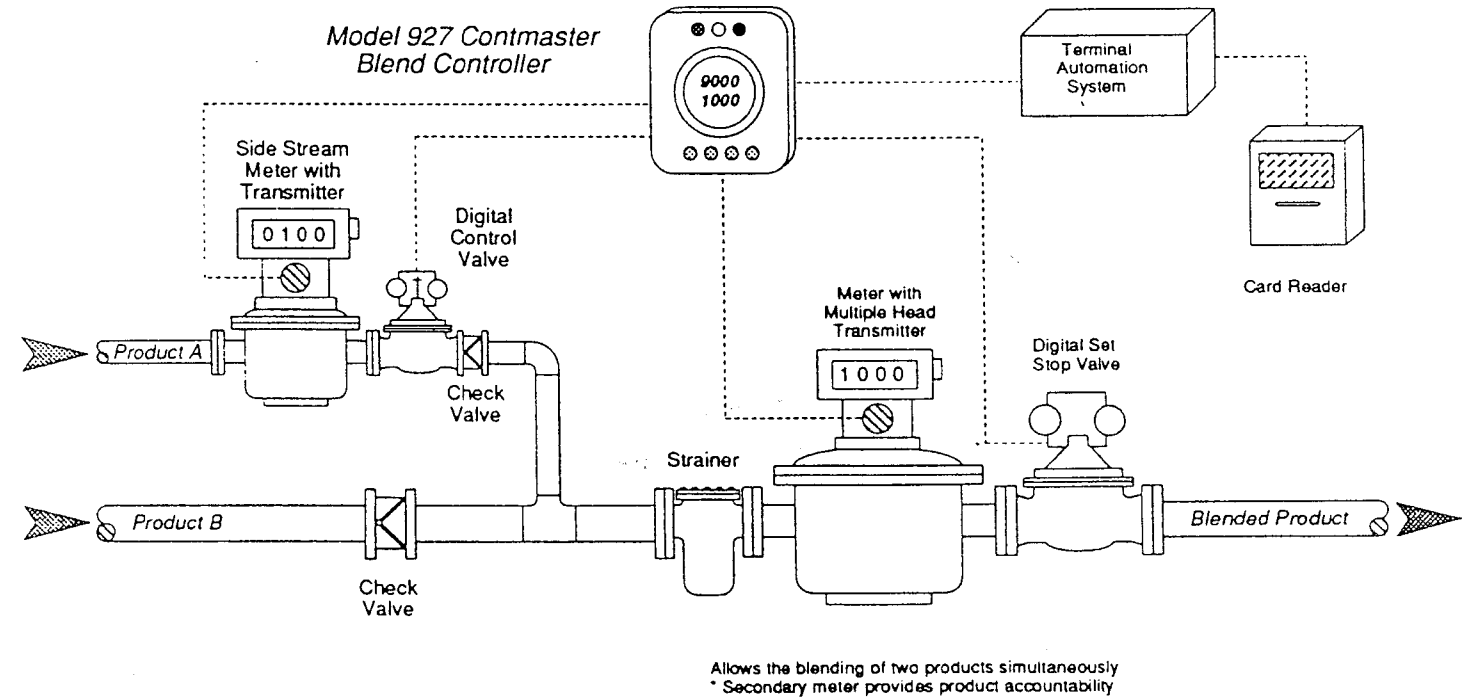
- * Several models to choose from
- * Durable design uses proven components with *ADC- Advanced Digital Control*
- * Certain designs allow the ability to supply more than one metering position
- * Over 10 years of direct experience with multiple product blending systems
- * Easily adaptable to your metering system
- * Complete system tested for reliability

Model 907 Contmaster Blend Controller

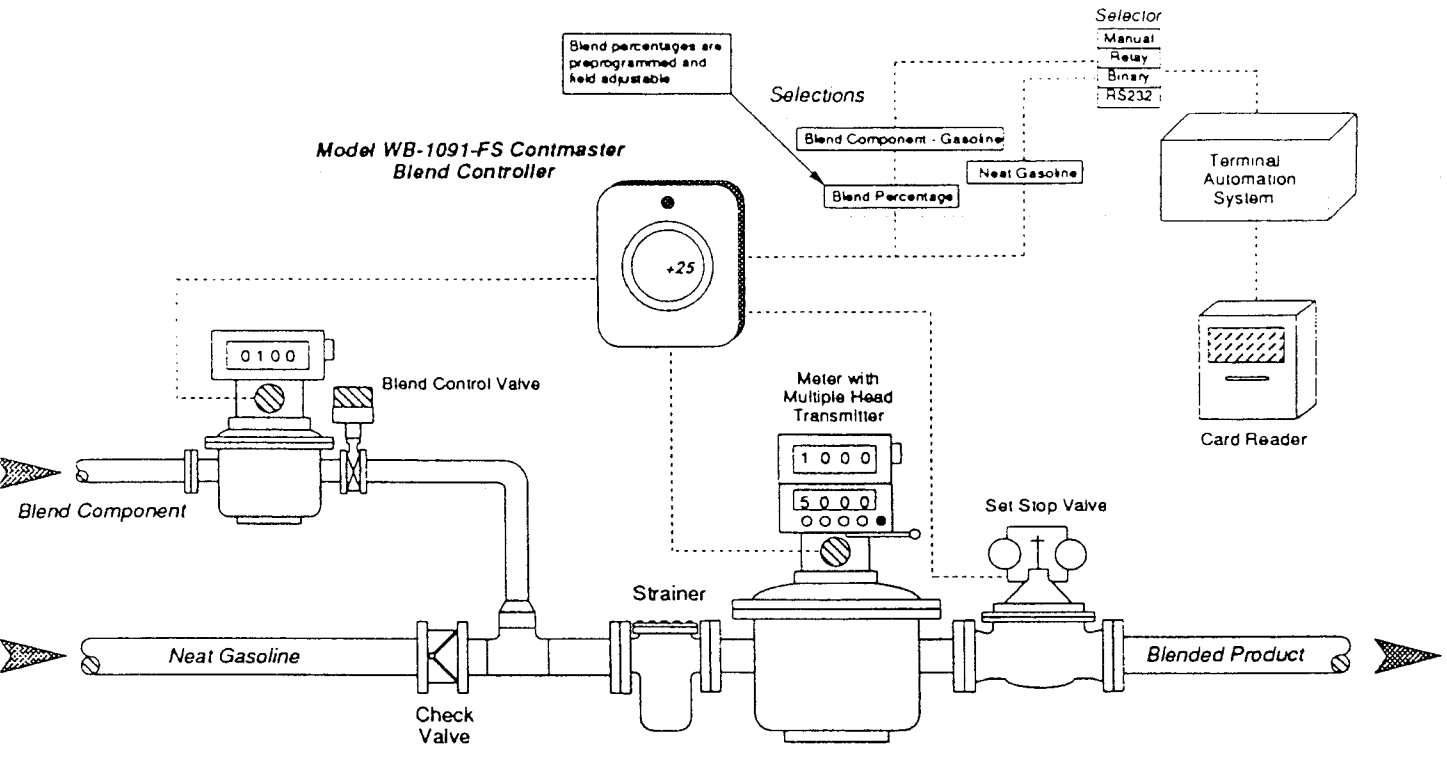


Model 907 Sequential Blender

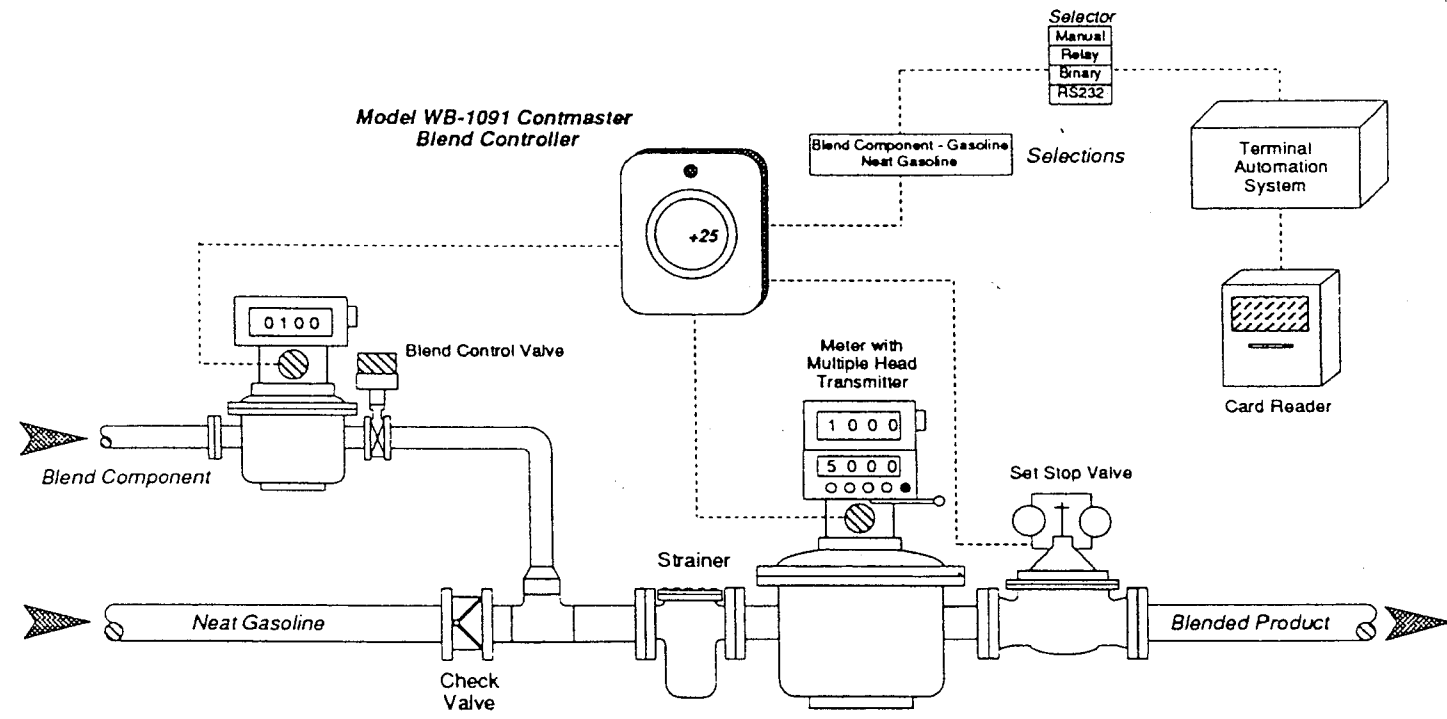
Model 927 Contmaster Blend Controller



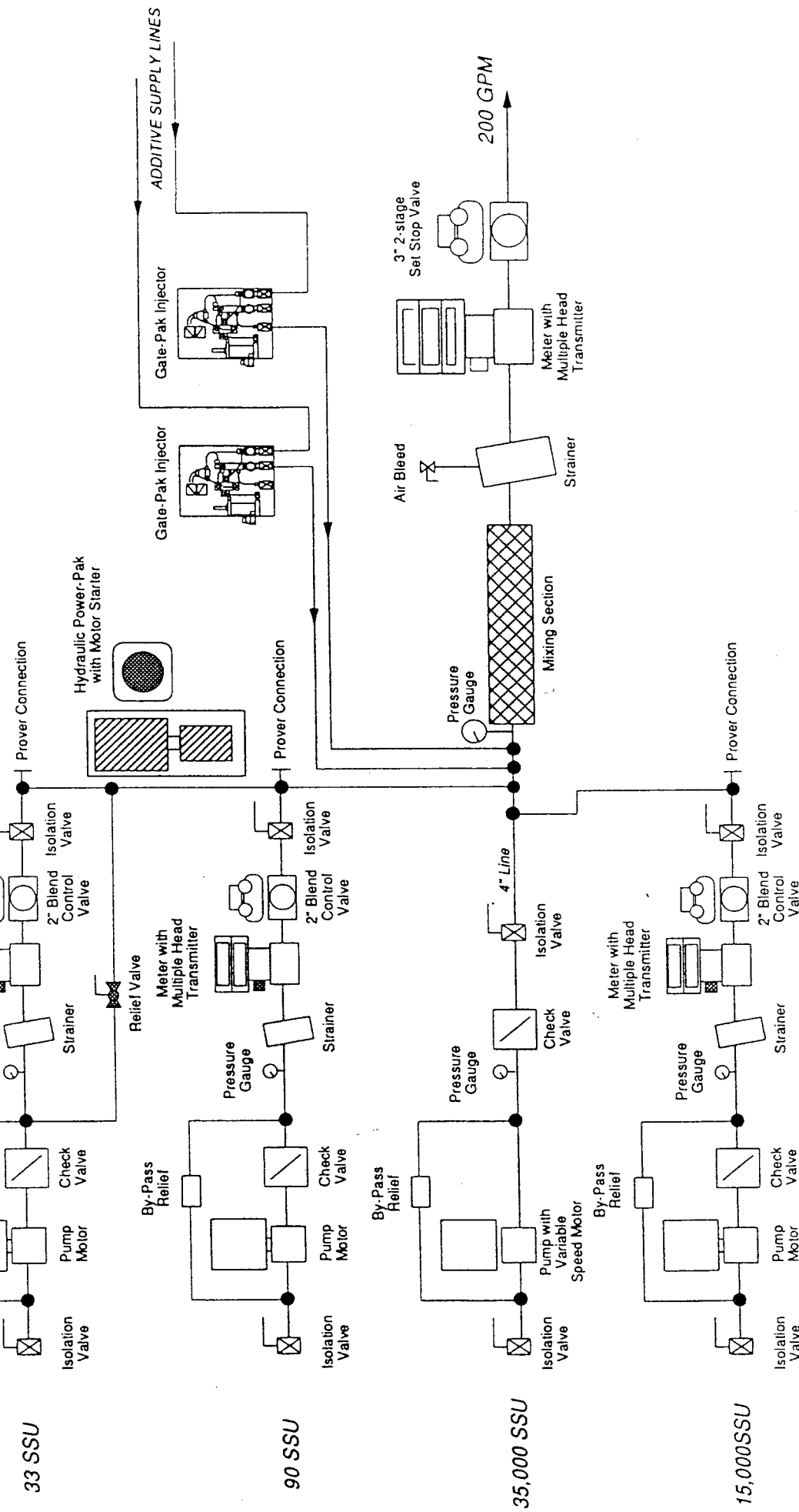
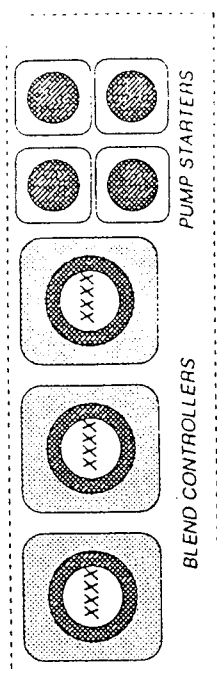
Model 927 Selectable Dual Preset Blender



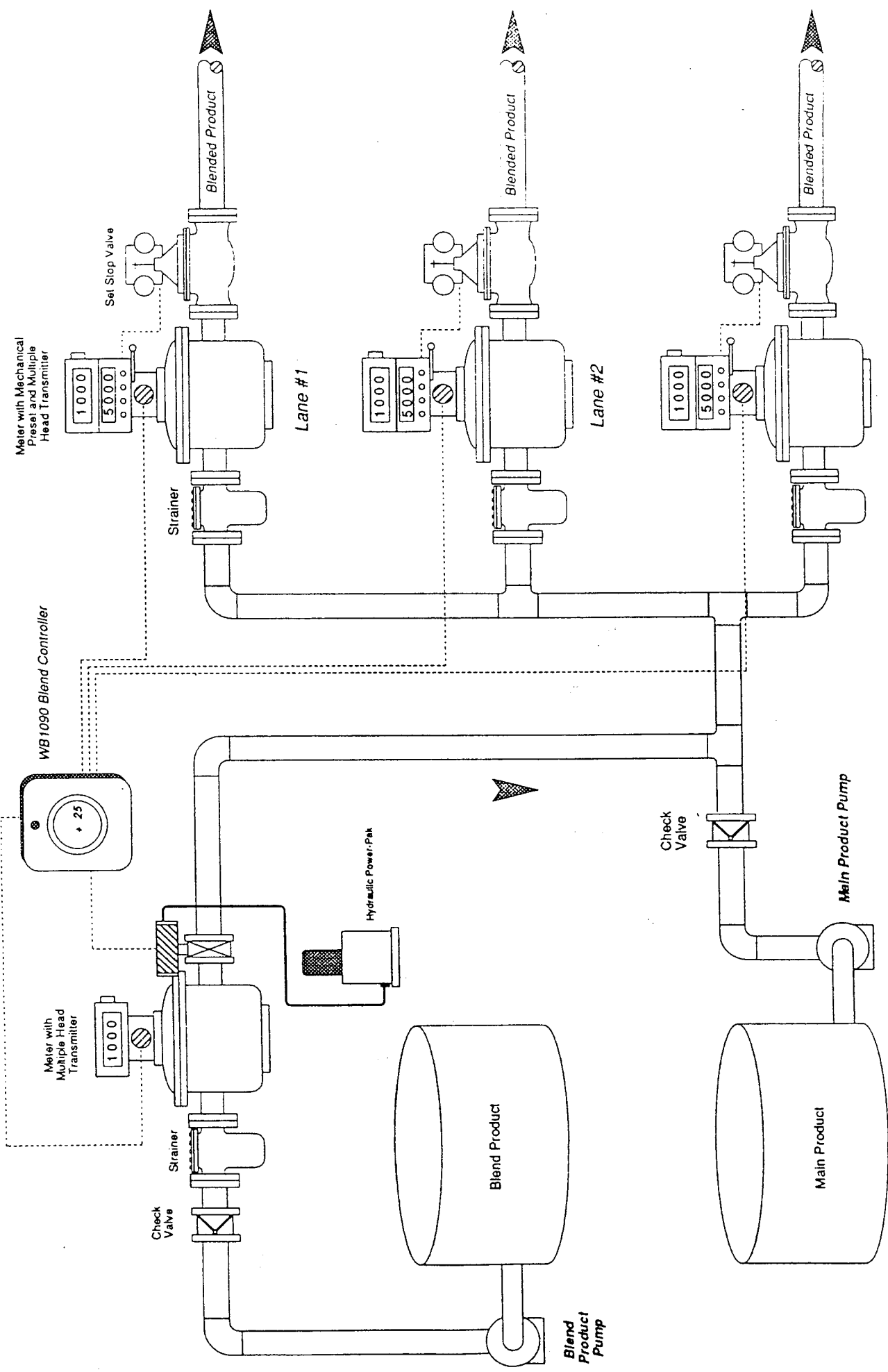
WB1091-FS Factor Selectable Wild Stream Blender



WB1091 Single Stream Wild Stream Blender



Multiple Product Wild Stream Blending with Additive Injection

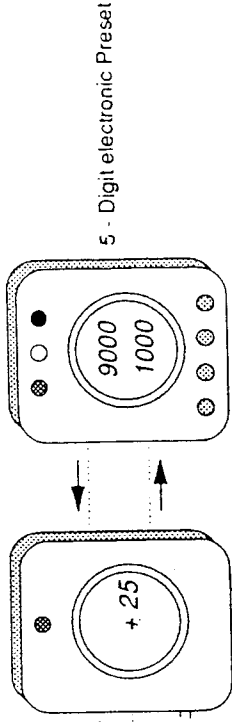


* Minimal Changes to existing load rack equipment
 * Continuous blending (non-selectable)

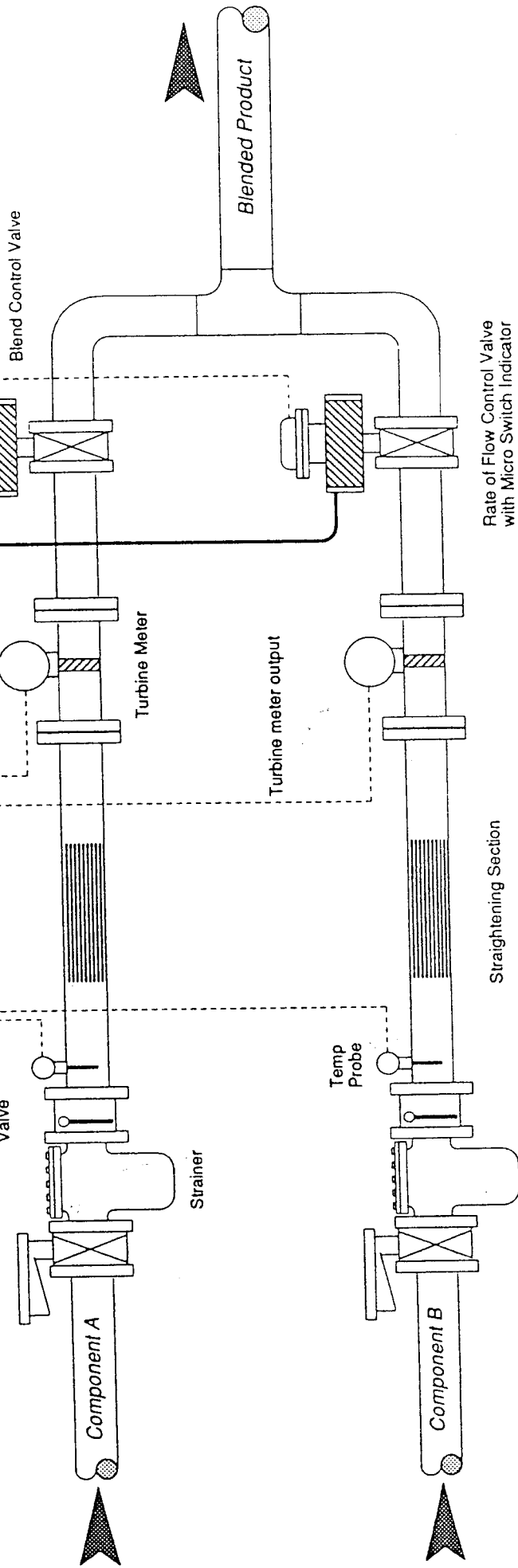
140 Series Countmaster
Electronic Preset

WB1090 Countmaster
Blend Controller

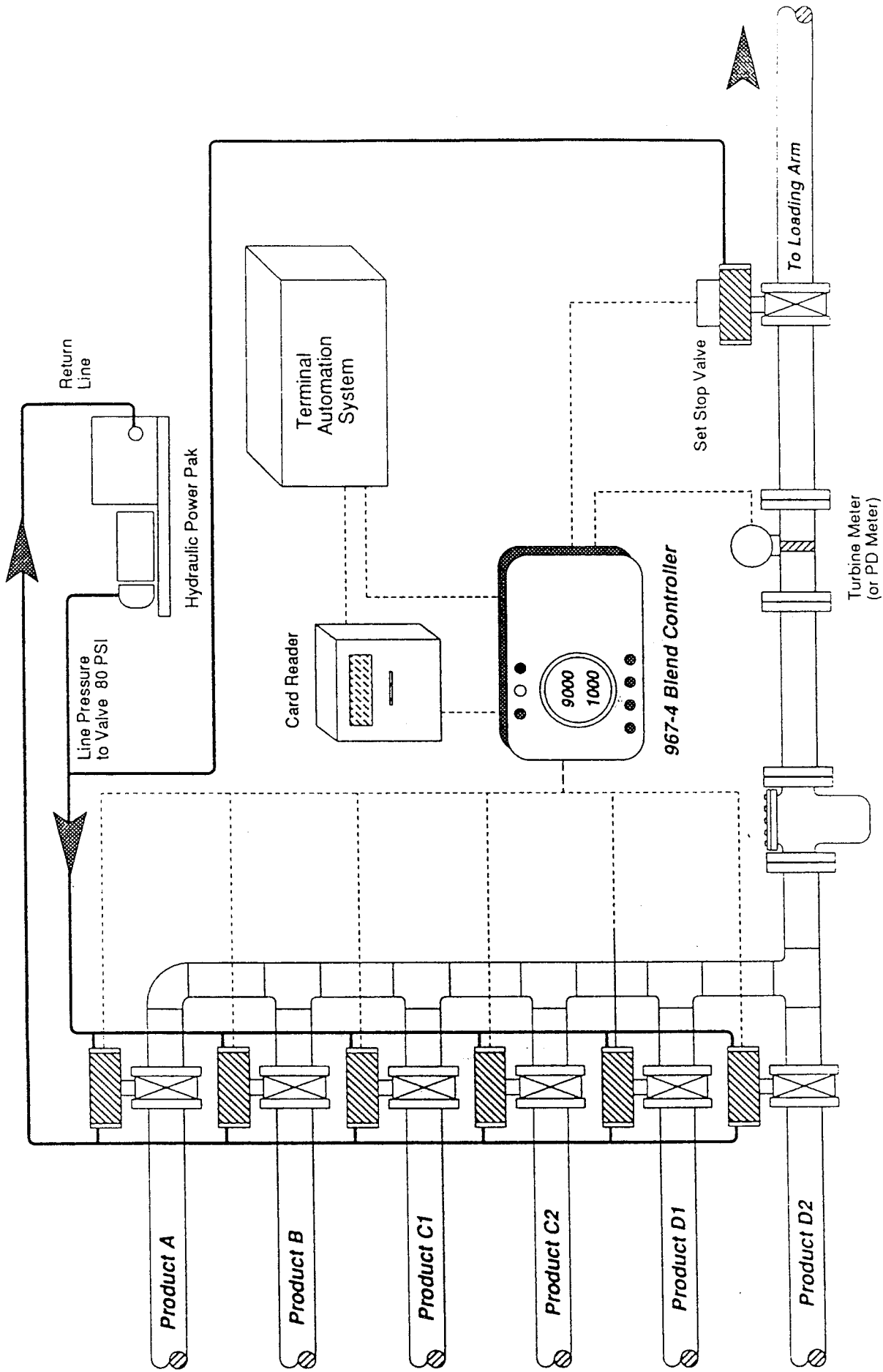
Malfunction Alarm
Pulse per unit volume Product A
Pulse per unit volume Product B
Pulse per unit volume A + B



Hydraulic Power-Pak



Wild Stream Tank/Barge Blending System



Model 967-4 Sequential Blender allows blending of 4 different products from a menu selection of up to 32 "recipes", and selecting from up to six different streams.

Model 967-4 Multiple Product Sequential Blender

Models Available:

907 Sequential Blender
927 Simultaneous Blender
937 Simultaneous Blender
967 Sequential Blender
967 - 4 Sequential Blender
WB1090 Wild Stream Blender
WB1090 FS Wild Stream Blender
WB1091 Wild Stream Blender
WB 1091 FS Wild Stream Blender

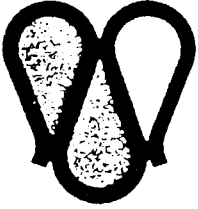
Features and Options:

- * Blending percentage selection
Preprogrammed - field adjustable
- * Temperature compensation
- * Multiple meter factor
- * Remote ticket printer
- * Turbine meter interface with meter factor adjustment
- * Display totalizer with battery back-up
- * Gate-Pak Injectors for low percentage rates
- * Manual entry and display
0 - 32 menus - 5-bit binary - RS 232
- * Hydraulic Power-Pak complete with reservoir and manifold

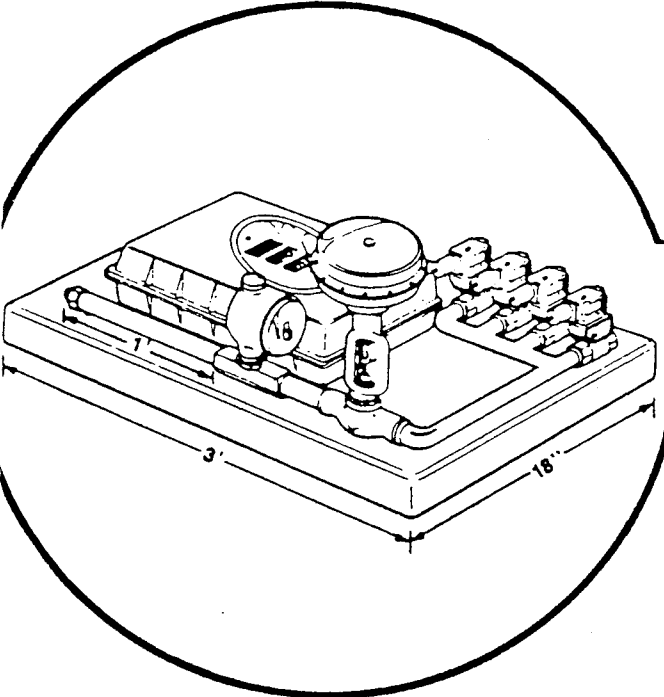
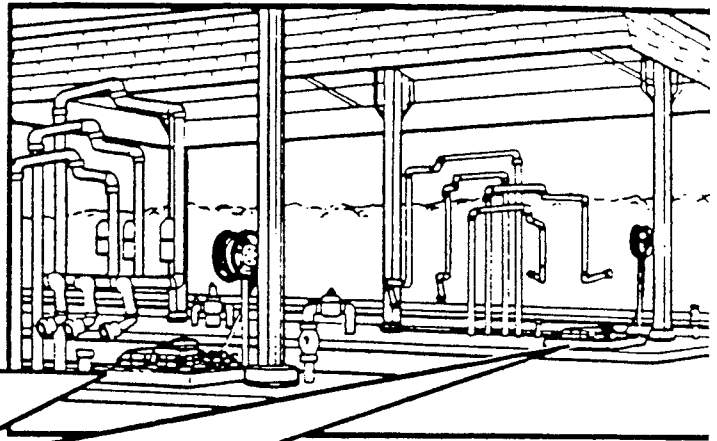
Your Gate City Representative:

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P.O. Box 93099
Atlanta, GA 30318
U.S.A.
Phone: 404-794-8275
Fax: 404-799-5722
Telex: 54-2327

Waugh Controls



**IN-LINE BLENDING + ETHANOL =
 LOADING RACK PROFIT.**



the gasoline streams and connecting signal and 120 VAC power wiring. Only one PetroBlend system is required per loading rack bay.

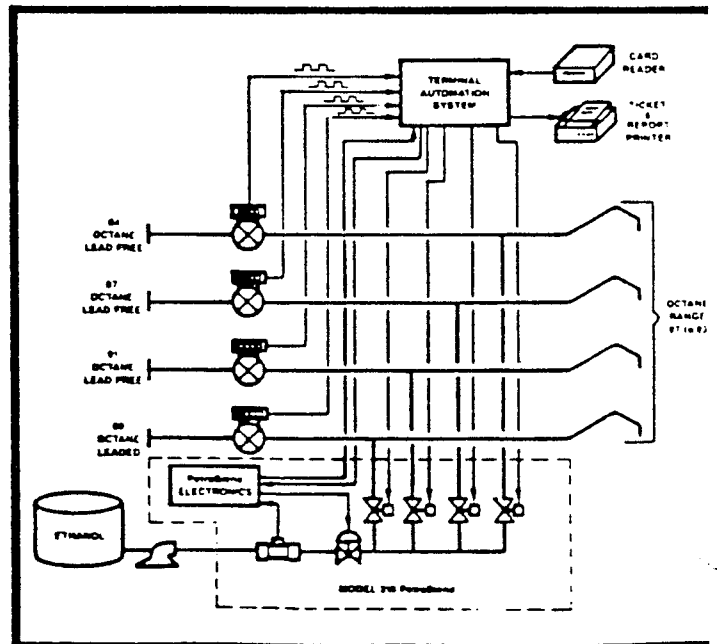
The PetroBlend accepts pulse inputs from the selected gasoline flow meter via the terminal automation system. It employs a flow meter for measurement of ethanol. It automatically regulates its control valve to maintain ethanol flow rate at a precise 10% ratio. The PetroBlend package provides a non-reset accumulated total of both ethanol and gasoline delivered. A second counter is provided for inventory control of ethanol and to test ratio accuracy. A pulse signal representing ethanol flow can be connected to the terminal automation system to obtain separate or combined delivery tickets.

**MODEL 316
 PetroBlend
 GASOLINE / ETHANOL
 BLENDER**

The PetroBlend System provides the loading rack operator with a small, low cost, in-line blending package that's simple to install, operates automatically and requires no operator adjustments. The PetroBlend can be set up to blend 0% ethanol into as many gasoline streams as desired, thus allowing rack menus to be expanded without adding gasoline storage tanks.

At automated terminals, the operator need only select the desired product with a card or key, the rest is totally automatic. As soon as gasoline flow occurs, the PetroBlend system will automatically blend in ethanol, precisely and continuously at a 10% ratio with .05% ratio accuracy, until gasoline flow ceases. An optional feature allows setting ratios other than 10%.

Because the PetroBlend's small size and Class I, Group D, Division I construction, it can be installed in any location at the terminal, even at the loading rack. Installation consists of connecting the inlet to an ethanol supply, the outlets to





Waugh Controls Corporation

9001 Fullbright Avenue • Chatsworth, CA 91311 • (818) 998-8281 • TLX 69-6171 • FAX (818) 407-1

LOADING RACK IN-LINE BLENDING REPORT

Blending multiple products at the time of delivery at your loading rack is now economical with the new Waugh Controls Model 316 and 326 PetroBlend Systems.

Several approaches are available to the loading rack operator, ranging from a simple single run Ethanol additive unit to an ID card-access system which blends up to six different products from three base stocks.

ETHANOL AND SUB-OCTANE BLENDER

The Waugh PetroBlend System presently operating at the Hartford Wood River Terminal in Alton, Illinois is an outstanding example of an explosion-proof, low cost, hi-tech product now available to produce a variety of gasoline blends as they are loaded into trucks at the terminal.

The Hartford Terminal PetroBlend System, shown in the Figure 1 sketch and photograph, automatically and continuously blends Ethanol (typically 10%) and/or a sub-octane gasoline at 10-30% into either a regular or no lead gasoline stream.

The installation of this system was simple and cost was reduced by using the existing regular or no-lead loading meter to meter the total blend flow.

A 6-position selector switch allows the operator to select from one of the following gasoline blends:

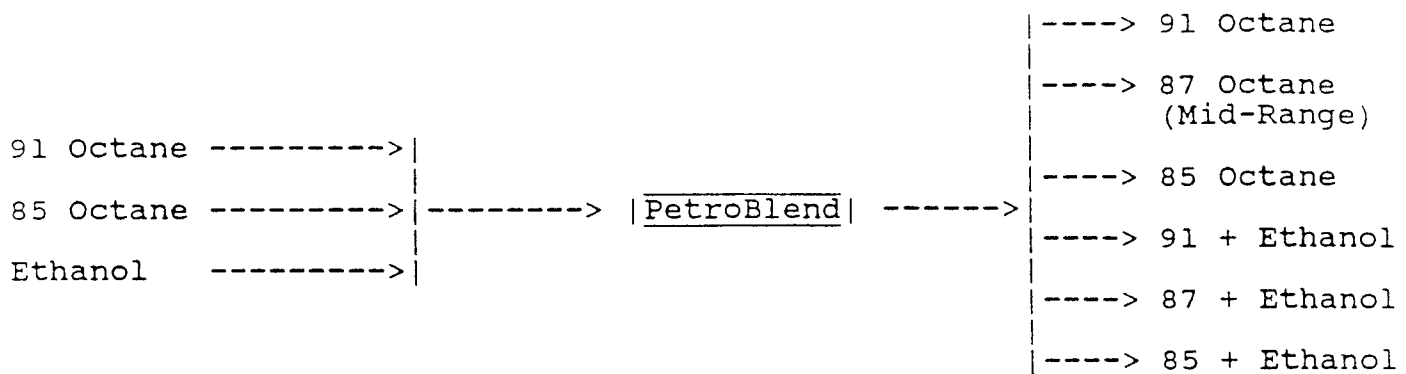
- Regular Gasoline only
- Unleaded Gasoline only
- Regular & Ethanol
- No Lead & Ethanol
- Regular & Ethanol & Sub-Octane Gasoline
- No Lead & Ethanol & Sub-Octane Gasoline

Each PetroBlend System can service one truck with any one of the above blends. The Hartford Terminal Facility uses two PetroBlend units, which allows them to load two trucks simultaneously. Each truck can be loaded with a different blend, if desired.

The PetroBlend System is a complete skid-mounted unit, including the built-on, explosion-proof PetroBlend electronics enclosure. Estimated price for the PetroBlend System shown in Figure 1, not including the two main line meters shown as existing, is \$28,000.00.

BLEND TWO MAJOR GASOLINES PLUS ETHANOL

Figure 2 shows a system designed to not only blend Ethanol into gasoline, but to also blend two grades of gasoline to create an intermediate octane. In this configuration the Model 326 PetroBlend provides the capability to produce 6 products from the 3 base stocks as shown below. The 4" valves shown are used for 100% loading of 91 or 85 octane product through the larger main line meter.



A 6-position switch allows the operator to select the blend of his choice.

Estimated price for the complete skid-mounted PetroBlend System shown in Figure 2, not including the main line flow meters, shown as existing, is \$34,000.

TERMINAL AUTOMATION BLENDING SYSTEM

The diagram in Figure 3 illustrates how the PetroBlend System, shown in Figure 2, can be upgraded to provide unattended terminal loading capabilities.

The PetroBlend System in Figure 3 functions as follows:
(All operator entries are English language prompted on the CRT display)

- * Tanker truck driver inserts his ID card in the card reader. If it is a valid card, the computer monitor display requests the driver to input his personal ID number on the keyboard.
- * If his personal ID matches with his ID card he is allowed to select via the keyboard the type and amount of product he is authorized to receive.
- * The driver inserts a ticket in the ticket printer and proceeds to fill his truck.
- * The computer informs the PetroBlend unit what product to blend and deliver.
- * When the selected quantity has been delivered, the computer will shut off the pumps and the PetroBlend and print out a delivery ticket for the driver.

Price for the PetroBlend and Card Reader/Computer System illustrated in Figure 3, less the 4" flow meters shown as existing, would be approximately \$68,000. Additional PetroBlend units could be hooked to this computer system for terminals which require simultaneous loading of various products in multiple truck bays.

In addition to controlling truck loading, the computer system can provide daily, weekly and monthly delivery and inventory reports.



Waugh Controls Corporation

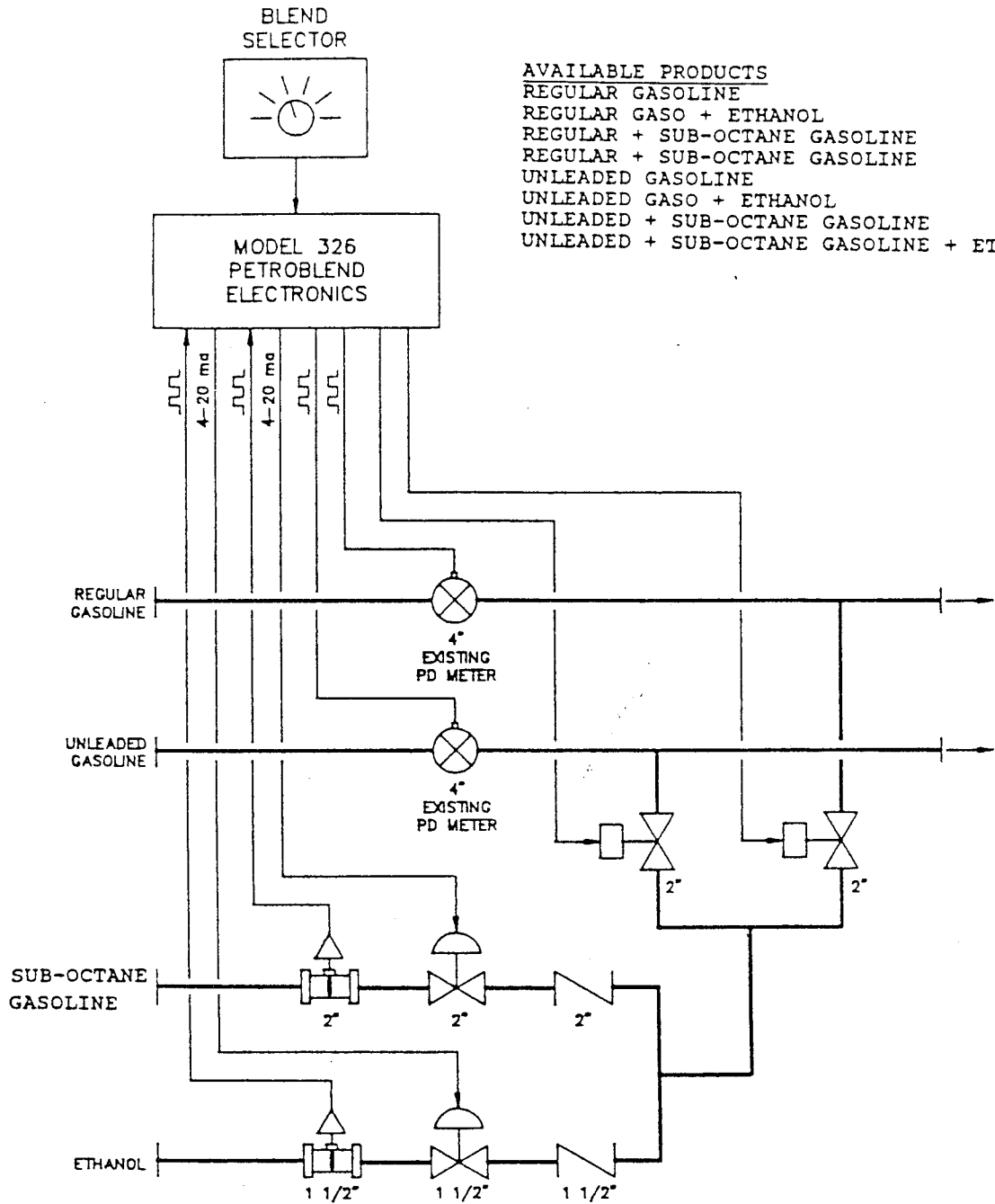
9001 Fullbright Avenue • Chatsworth, CA 91311 • (818) 998-8281 • TLX 69-6171 • FAX (818) 407-1:

All estimated pricing shown includes electronics and skid-mounted field controls fully assembled and tested at the factory. Transportation to the site and installation costs are not included. Estimated pricing assumes instrument air is available on site. If not, prices would be slightly higher.

For applications in which more than three products are to be blended together, or where multiple 2, 3, 4 or more component blenders are required, Waugh Controls offers its 2300 Process Management System. The 2300 can be configured to handle up to (12) 2-component blenders or (8) 3- component blenders or any other combination of blender configurations utilizing up to a maximum of (24) flow loops. Batch control, report printout, Host Computer I/O and an extensive array of other features are also provided by the 2300. A bulletin detailing the capabilities of the 2300 Process Management System, is available from your Waugh Controls Representative.

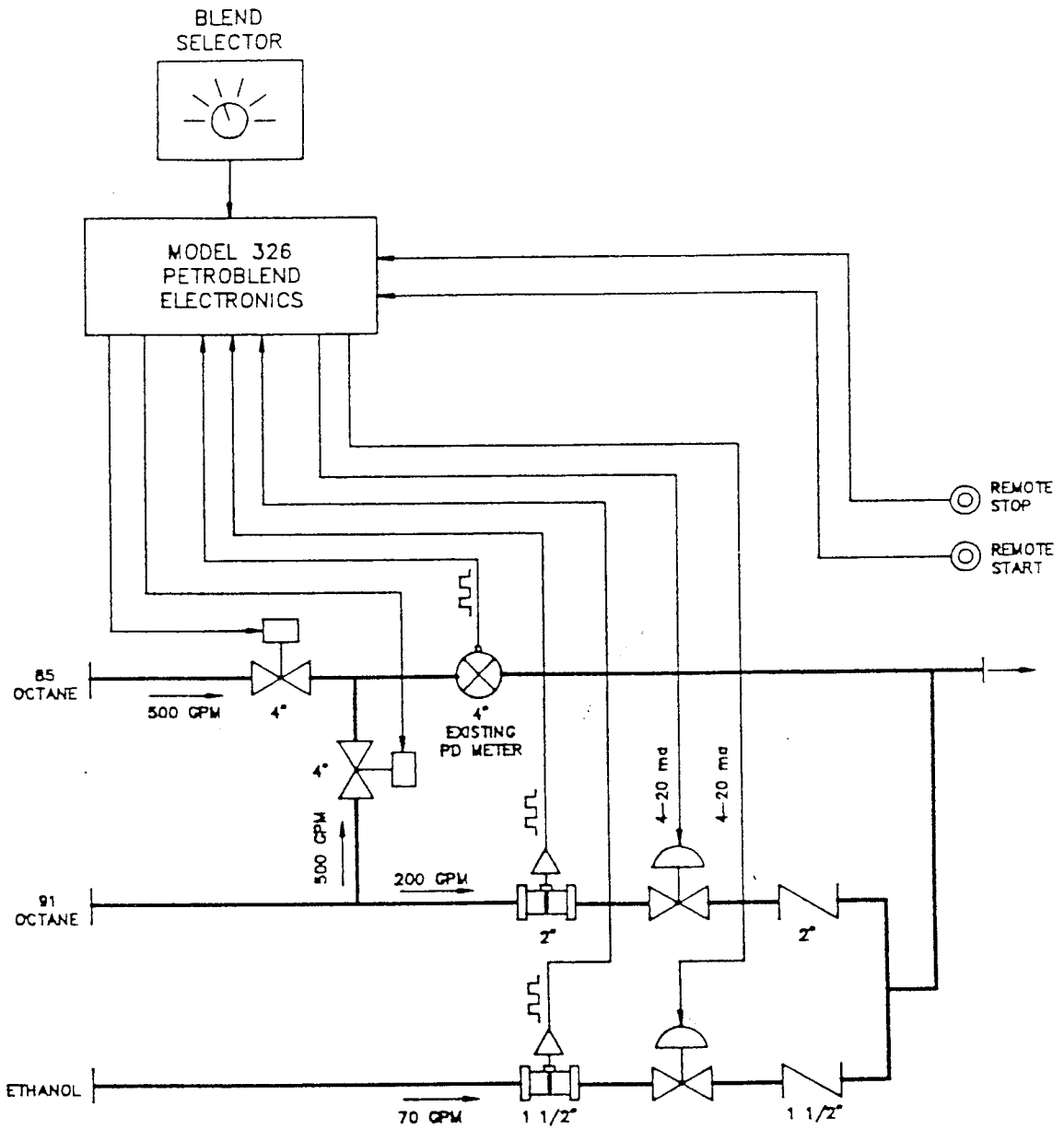
For a detailed analysis of your application and a written quote, contact the Waugh Controls Representative in your area or the Waugh Controls factory directly. A list of Waugh Controls Representatives is attached.

Enclosures: Figure 1, Ethanol and Sub-Octane Terminal Blending System
Figure 2, Two Major Gasolines Plus Ethanol Terminal Blending System
Figure 3, Terminal Automation Blending System
2 each Photographs of Hartford, Woodriver Terminal Skid Assemblies
2 each Photographs of PetroBlend Electronics Enclosure
Bulletin D2005, Waugh Controls Engineering Representatives



- AVAILABLE PRODUCTS
- REGULAR GASOLINE
 - REGULAR GASO + ETHANOL
 - REGULAR + SUB-OCTANE GASOLINE
 - REGULAR + SUB-OCTANE GASOLINE
 - UNLEADED GASOLINE
 - UNLEADED GASO + ETHANOL
 - UNLEADED + SUB-OCTANE GASOLINE
 - UNLEADED + SUB-OCTANE GASOLINE + ETHANOL

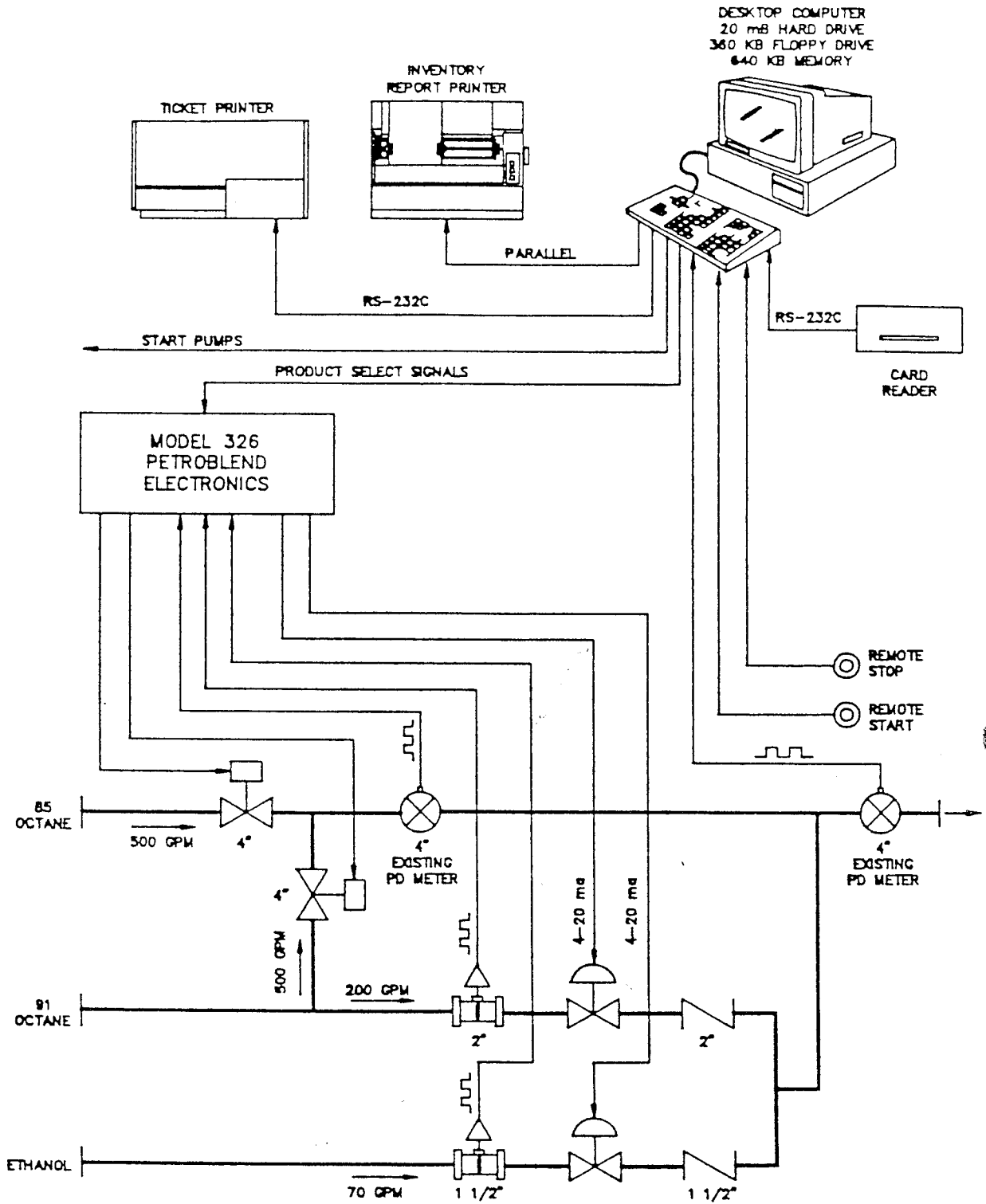
CONTRACT NO _____		Waugh Controls			
APPROVED _____ DATE _____		ETHANOL AND SUB-OCTANE TERMINAL BLENDING SYSTEM			
DR _____					
CHK _____					
APPD _____	DATE _____	SIZE	CODE	IDENT NO.	FIGURE 1
APPD _____	DATE _____	SCALE	NOBEL	BASIC	SHEET OF



AVAILABLE PRODUCTS

- 91
- 85
- 91 + 85 = 87
- 91 + E
- 85 + E
- 91 + 85 + E = 87 + E

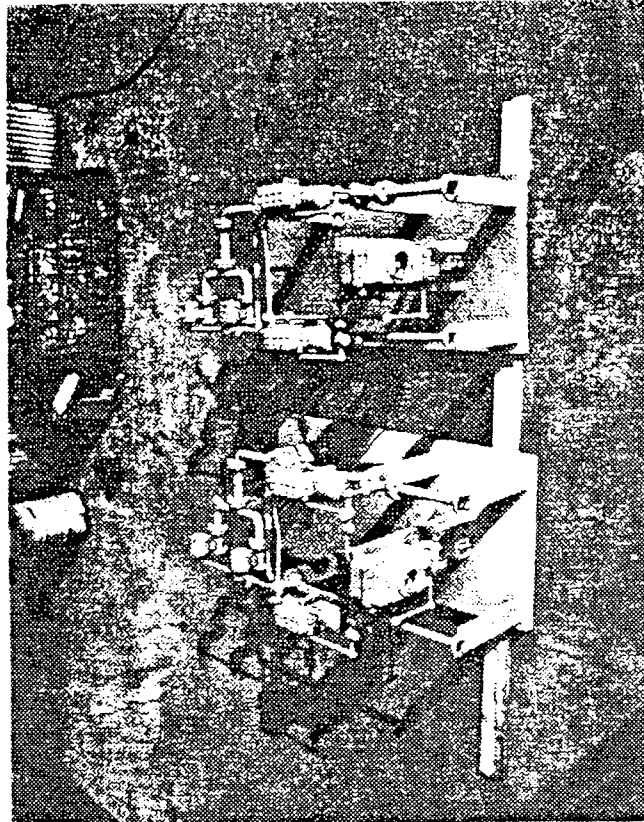
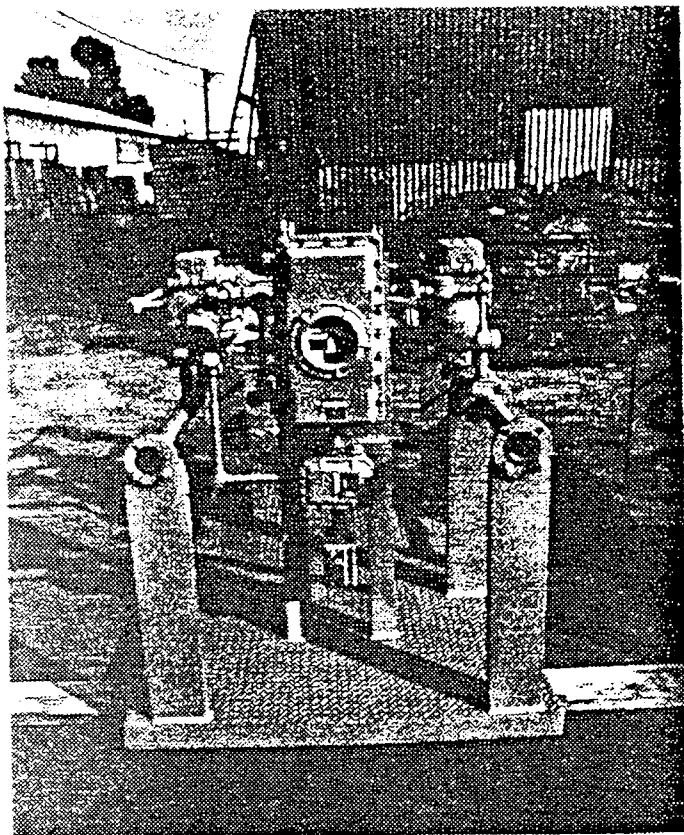
CONTRACT NO _____		Waugh Controls			
APPROVED _____ DATE _____		TWO MAJOR GASOLINES PLUS ETHANOL TERMINAL BLENDING SYSTEM			
DR _____	DATE _____	SIZE _____	CODE _____	FIGURE 2	
CHK _____	DATE _____	SCALE _____	REVISION _____	SHEET _____	PAGE _____
APP'D _____	DATE _____				
APP'D _____	DATE _____				



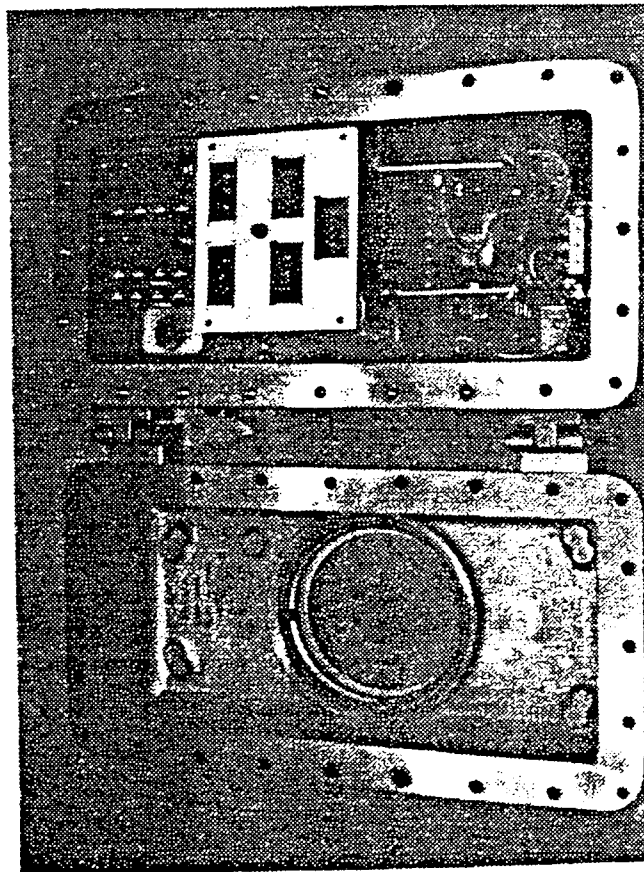
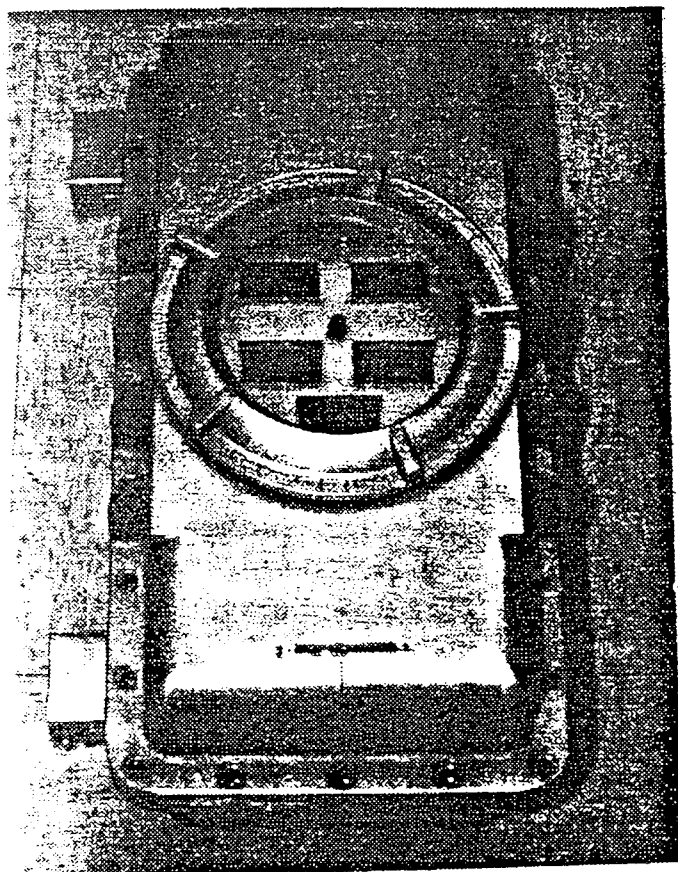
AVAILABLE PRODUCTS

- 91
- 85
- 91 + 85 = 87
- 91 + E
- 85 + E
- 91 + 85 + E = 87 + E

CONTRACT NO _____		Waugh Controls			
APPROVED _____ DATE _____		TERMINAL AUTOMATION BLENDING SYSTEM			
BY _____					
CHEK _____					
APPD _____ DATE _____	DATE _____	SIZE _____	CODE IDENT NO. _____	FIGURE 3	
APPD _____ DATE _____		SCALE _____	REVISION _____	DATE _____	SHEET _____ OF _____



HARTFORD WOODRIVER TERMINAL
PETROBLEND SKID ASSEMBLIES



PETROBLEND EXPLOSION-PROOF
ELECTRONICS ENCLOSURE



Waugh Controls

MODELS 310, 320, 330, 340 IN-LINE BLENDING CONTROLLERS

Bulletin PB-300-2

DESCRIPTION — Waugh Controls Model 300 Series in-line blending systems provide precise ratio control of liquid or solid materials to form a blended product. A complete blending system consists of a blend controller, a flow sensing element and a flow regulating element in each stream to be blended. The 300 series includes models capable of blending up to four streams simultaneously. The specific model number describes the number of controlled streams. For example, Model 330 has 3 controlled streams and one master station. Larger systems requiring more than four streams utilize the Model 2200 microprocessor-based blend controller.

Waugh Controls offers the blend controllers alone, or complete systems including flowmeters, control valves and other accessory hardware.

Flow of each material is controlled by a component station in the blender, at which the operator sets the desired percentage of that material to the total. A master station in the blend controller provides a pacing signal to each single component station which is divided according to the ratio of the particular component to the total. The divided signal serves as a set point for a digital flow controller which compares the set point with the actual flow signal. Controller output positions a valve or other flow regulating element to maintain flow at the required amount. Alternatively, the pacing signal may be derived from an uncontrolled stream flowmeter (e.g., Model 1310).

TYPICAL APPLICATIONS

Petroleum — Widely used to control blending of gasoline, fuel oils, lube oils, phthalts, solvents, either directly to transport vehicles or to intermediate storage.

Chemical — Liquid fertilizers, aerosol propellants and industrial alcohols are examples of bulk materials handled with ease by this versatile system. In chemical processing, feeds to a reactor may be controlled more accurately, improving quality and yield, with smoother start-ups as well.

Beverages — Soft drinks, wine, tomato paste, sugar syrups and many others can be blended economically and accurately.

Plastics — Quality and yield of urethane foam is improved and set-up time is minimized when these systems are put to work.

Cement — Provides superior control for feeding of dry material in cement plants.

SYSTEM FEATURES

Integrated Circuits — Exclusive use of integrated circuits provides superior reliability. Due to the quality of the integrated circuits themselves, and to a large reduction in number of soldered connections, further improved reliability is achieved.

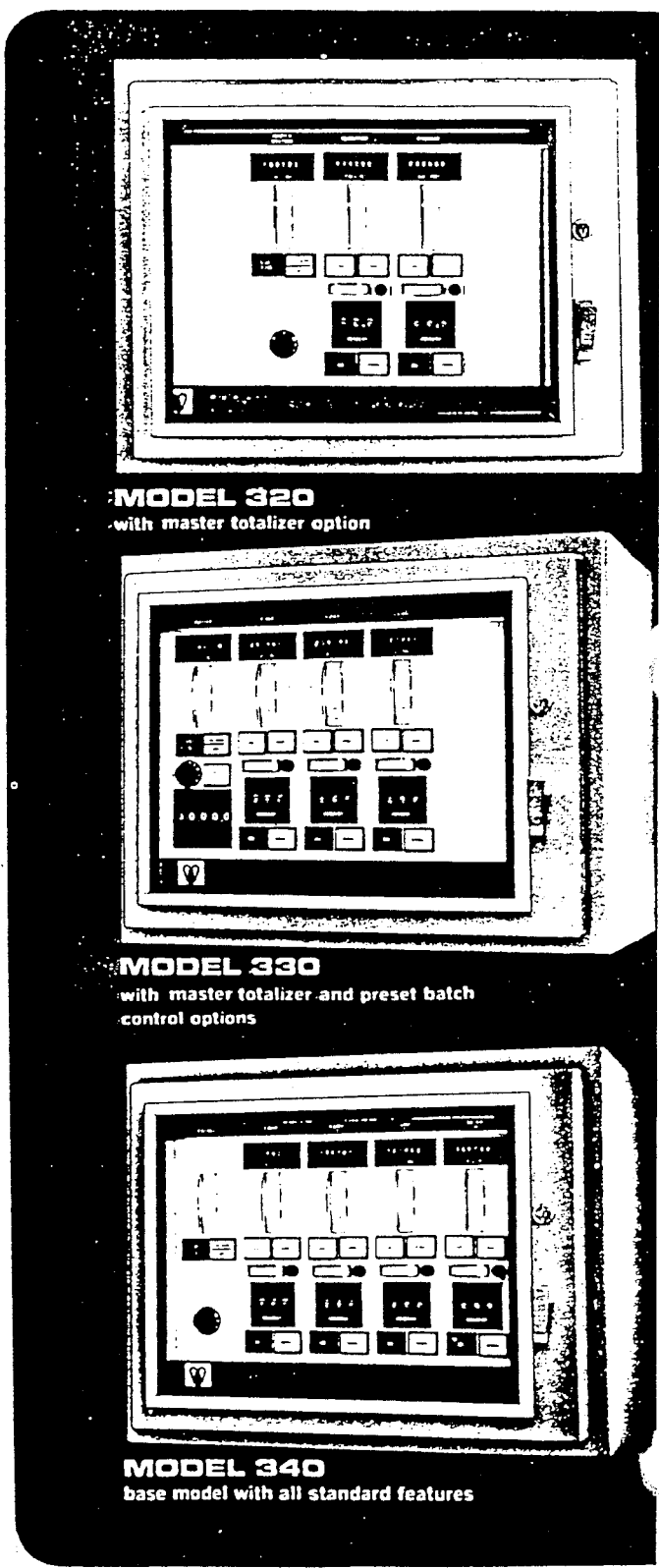
Fast Lock Control — Another exclusive feature, this mode of control initiates corrective action faster and holds instantaneous blend ratios more accurately, outperforming all other blend control systems.

Automatic Rate Control — If one or more of the component stations fail to maintain the correct ratio, this feature nudges the master signal up or down to maintain overall blend accuracy. If the condition persists, automatic shutdown results.

Low Rate Indicator — Important to check for operation of all flow meters within their linear range, this feature is standard in all Waugh systems.

Plug-in Circuit Modules — All individual circuit modules are replaceable in no time at all. Commonality greatly minimizes cost of maintaining spares, with only four modules required to provide a complete spare backup for any standard model blend controller.

Versatility — Many optional features, including electronic temperature compensation, preset batch control, analog flow meter input and others are available to allow these systems to perform almost any liquid or solid flow blending operation required.



MODEL 320
with master totalizer option

MODEL 330
with master totalizer and preset batch control options

MODEL 340
base model with all standard features

WAUGH CONTROLS CORPORATION

3001 Fullbright Avenue • Chatsworth, California 91311 • (213) 998-8281 • Telex 69-617

Model 300 Series Dimensions

Housing — Weather proof, aluminum die cast, finished with clear anodized aluminum.

Size — 20" wide, 16" deep.

Weight — 10 lbs. net, 15 lbs. shipping.

Field Connections — Two terminals inside housing, three conduit fittings through front face of housing.

REPEATABLITY —

Accuracy — 1% or better in blend control. Total system accuracy 0.05% to 0.1% depending on type of flow meters used and control system used.

Repeatability — 1% or better, depending on flow meters.

Dynamic Response — Time from zero start to steady control at set rate of flow, based on flow meter, depending on valve speed.

ENVIRONMENT

Temperature — 0°F to 130°F.

Electrical Classification — Suitable with optional air purge for Class 1, Group D, Division 1 hazardous areas.

Mounting — Weather proof housing, suitable for outdoors mounting.

OPERATING CONTROLS, MASTER STATION

Flow Totalizer — Six digit resettable E/M. or optional LED counter.

Total Blend Flow Rate — Vertical scale 2 1/2" meter, 0-100% scale, indicates total flow rate set point, or pacing stream flow rate, or actual total flow (if total flow signal provided).

Start Blend — Lighted push on — push off switch to start and stop blend.

Shutdown — Alarm light to indicate shutdown due to error.

Limit — Alarm light to indicate total flow rate is being altered by action of one or more component stations.

Total Flow Set Point — Single turn knob for setting of total blend flow rate.

Shutdown Delay — Behind panel. Trimpot adjustment to set time delay between limiting action and final shutdown, 1 to 90 seconds.

OPERATING CONTROLS, EACH COMPONENT STATION

Flow Totalizer — Six digit resettable E/M. or optional LED counter.

Flow Rate Indicator — Vertical scale meter, 2 1/2", 0-100% scale.

Limit Lights — High and Low, indicate station is either raising or lowering total blend flow rate.

Valve Position Indicator — Edgewise meter, 1 1/2", 0-100% scale.

Manual Valve Loader — Single turn pot, operable when station is in Manual mode.

Percent Set — Three digit thumbwheel switch, to set percentage of component to total.

On/Off — Lighted push on-push off switch.

Auto-Manual — Lighted push on-push off switch transfers control from automatic to manual.

Gain Adjust — Behind panel. Single turn pot, adjustable from .01 to .5 gain.

Reset Adjust — Behind panel. Single turn pot, adjustable from 1.5 to 45 repeats per minute.

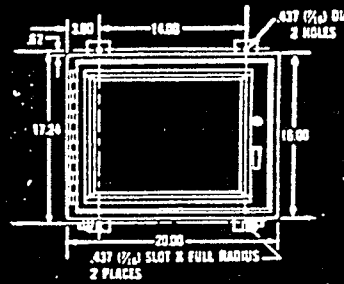
ELECTRICAL

Signal Input — Pulse from turbine meter pre-amplifier or displacement meter pulser is standard. Analog input is optional.

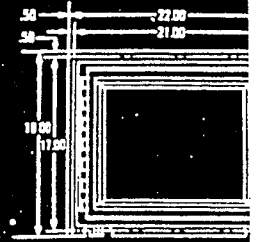
Valve Output — 4-20 ma into 0-600 ohms.

Optional External Connections — Remote interlock on start blend signal. Remote shutdown switch. Outputs to signify start blend or shutdown. Total flow pulse output. (Specify when ordering).

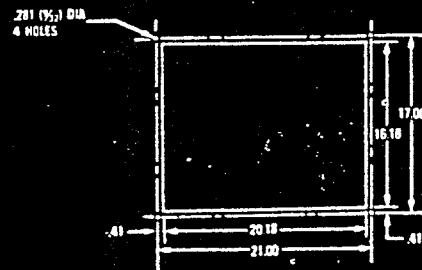
Wall Mount (standard)



Panel Mount (option)



Panel Cutout Dimensions



OPTIONS

1. **Master Totalizer** — Provides a resettable totalizer at the master station to read blend total when a displacement type meter is provided in the total blended stream.
2. **Blend Total from Component Meters** — Provides a resettable totalizer at the master station, together with combinator circuits which sum the scaled outputs from individual component meters to provide a blend total.
3. **Pacing Totalizer** — Provides a resettable totalizer at the master station for totalizing an uncontrolled pacing stream flowmeter.
4. **Analog Input, Linear** — Permits blender to accept 4-20 milliamperes (or other process standard) analog input in lieu of pulse input. Specify for each station as required.
5. **Electronic Temperature Compensation** — Corrects flow meter input to standard temperature, per ASTM Petroleum Measurement Tables. Specify for each station as required.
6. **Preset Batch Control** — Provides a 5 digit preset counter at the master station with automatic shutdown of the blender when the set quantity is delivered. Requires a total flow signal.
7. **Mass Flow** — Provides totalization, flow indication, and ratio control in mass units (Weight x Speed).
8. **Air Purged** — Per ISA Standard S12.4, for Class 1, Group D, Division 1 or 2 (specify).
9. **LED Totalizers** — Seven digit, resettable LED counters are available instead of 6-digit electro-mechanical.
10. **Pump Start Relay** — Provides a maintained single pole contact, 115 volt, 1 ampere capacity, wired to terminals, to actuate remote motor starter when blend is initiated. Specify for each station as required.
11. **Flush Panel Mounting** — Provides a flange to allow the controller to be mounted in a control panel (standard is wall-mount).
12. **230VAC Power** — Provides for operation from 230 VAC, 50/60 Hz power source instead of 115VAC, 50/60 Hz (standard).

Specifications Subject to Change Without Notice

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GASOLINE BLENDING SYSTEMS

from

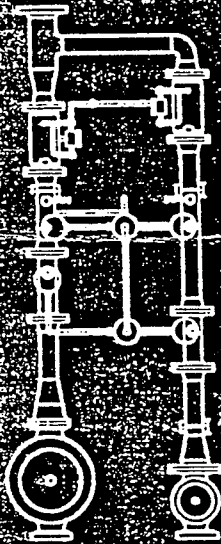
DANIEL

Automation

Flow Products, Inc.

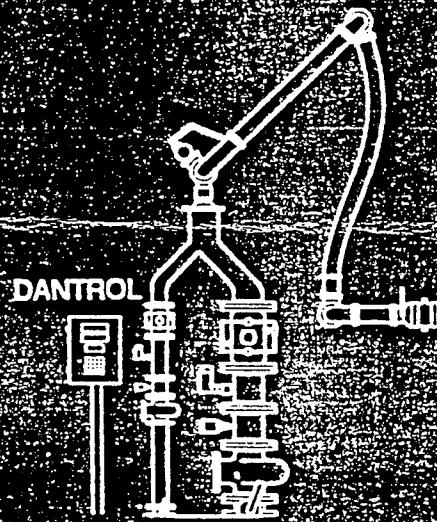
MIDGRADE BLENDING SKID

Blends high and low unleaded octanes to produce a mid-octane product

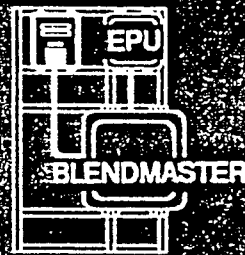


RACK BLENDER

Danload Batch Blending System provides customer selectable blend percentages



DANTROL



DANTROL

- * In-line proportional blending insures homogenous blends
- * Mounts in tank farm or at load rack to fit your application
- * Available skid-mounted or as individual components for customer installation

WHY BLEND?

State regulations require the use of oxygenated fuels in certain areas. Blending unleaded midgrade gasoline at the terminal saves money in both refining and product-storage costs.

Daniel "in-line" blenders are specifically designed to provide precise control of component mixing. The in-line blender is superior to traditional sequential blending systems because it provides a true, accurate product mixture in accordance with adjustable blend percentages. Available in ship-loose components or as turnkey skid-mounted units, Daniel blenders provide a flexible solution to bulk terminal blending requirements.

WHY A MIDGRADE BLENDING SKID?

Our skid-mounted blender, an efficient approach in providing a blending system, comes self-contained complete with all components necessary to accommodate your blending needs. This unit is shipped ready for flanged mounting to your plant piping. Also, a skid-mounted blending approach allows you to eliminate your midgrade tank while still supplying product to dedicated midgrade meters at the rack.

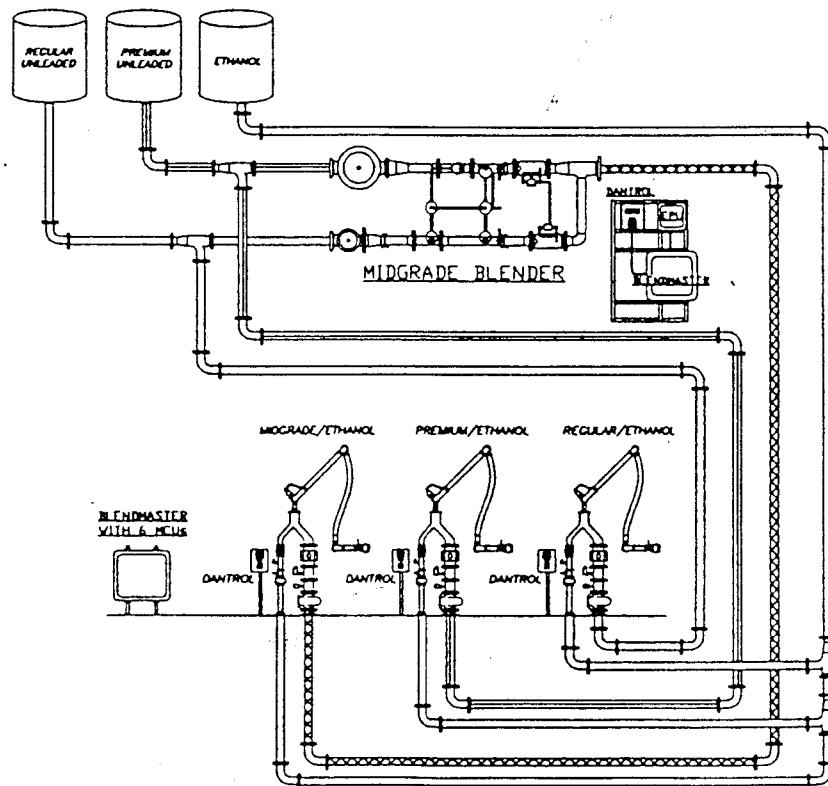
WHY BLEND AT THE RACK?

Rack blenders represent a smaller investment than midgrade blending skids. The clean line start and flush characteristics of the blend program allow loading of the blended product as well as the unblended primary component through a single loading arm. The ship-loose components are supplied for customer mounting, on-site, with minimal field piping changes.

WHY BUY FROM DANIEL?

A leader in the flow measurement industry for over 60 years, Daniel Flow Products provides turnkey solutions to your blending problems. A skilled staff of hardware, software, and mechanical engineers provides the design and support capabilities necessary to meet the needs of the dynamic blending market. Daniel's reputation of reliability, manufacturing excellence and competitive pricing is recognized throughout the world.

For a real-time solution to your real-world needs, contact the flow measurement experts at Daniel.



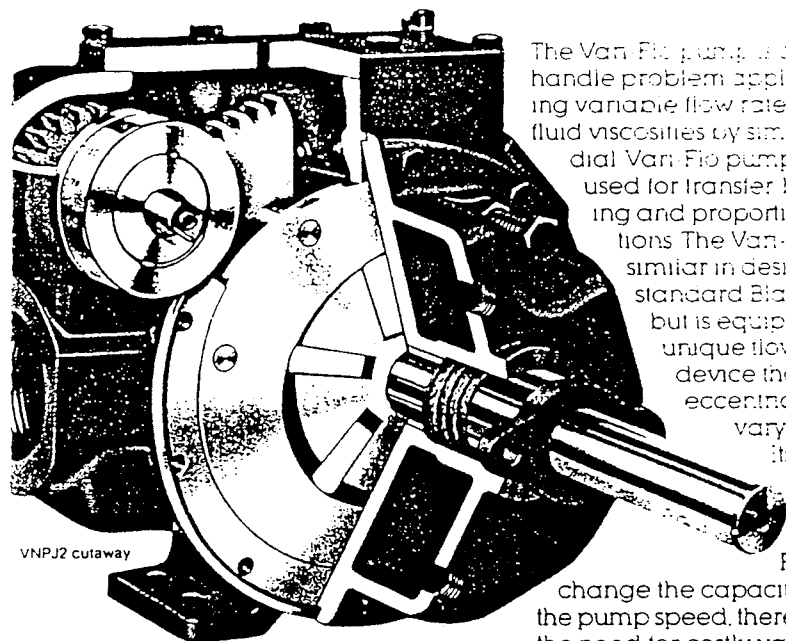
James Bell

DANIEL Automation
Flow Products, Inc.

PO Box 19097
Houston TX 77224
(713) 467-6000

VNP(J) VARI-FLO PUMPS

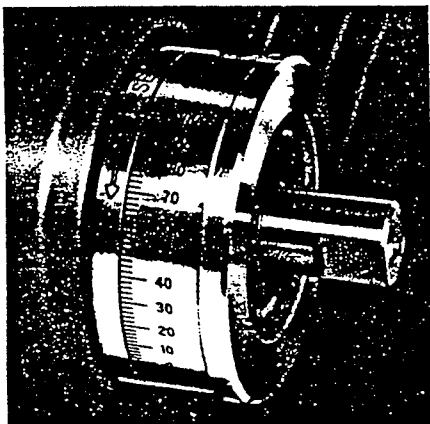
VARIABLE CAPACITY PUMPS FOR LIQUID T.



VNPJ2 cutaway

The Vari-Flo pump is designed to handle problem applications involving variable flow rates or varying fluid viscosities by simply turning a dial. Vari-Flo pumps are typically used for transfer, batch processing and proportioning applications. The Vari-Flo pump is similar in design to other standard Blackmer pumps but is equipped with a unique flow-changing device that rotates an eccentric casing liner to vary displacement. Its operation is shown in Figure 9.

With a Vari-Flo pump you change the capacity setting, never the pump speed, thereby eliminating the need for costly variable speed drives or complicated controls. One pump using a conventional drive and motor can cover an infinite variation in delivery, from zero to full flow, simply by manual adjustment of its control dial with an ordinary wrench. In fact, by rotating the control dial far enough, flow can actually be reversed to evacuate discharge lines after shutoff.



Capacity easily changed by rotating dial

The 2-inch proportioning pump shown in Figure 10 consists of two supply pumps and two Vari-Flo pumps of liquid motors. It can pump out two different liquids. A single Vari-Flo pump and a fixed displacement pump can also be used. By adjusting the flow rate of the Vari-Flo, precise proportioning of the flow through both lines can be achieved. And because each revolution of a Blackmer pump displaces the same volume of fluid — regardless of speed variations — proportioning remains accurate even if the pump speed fluctuates.

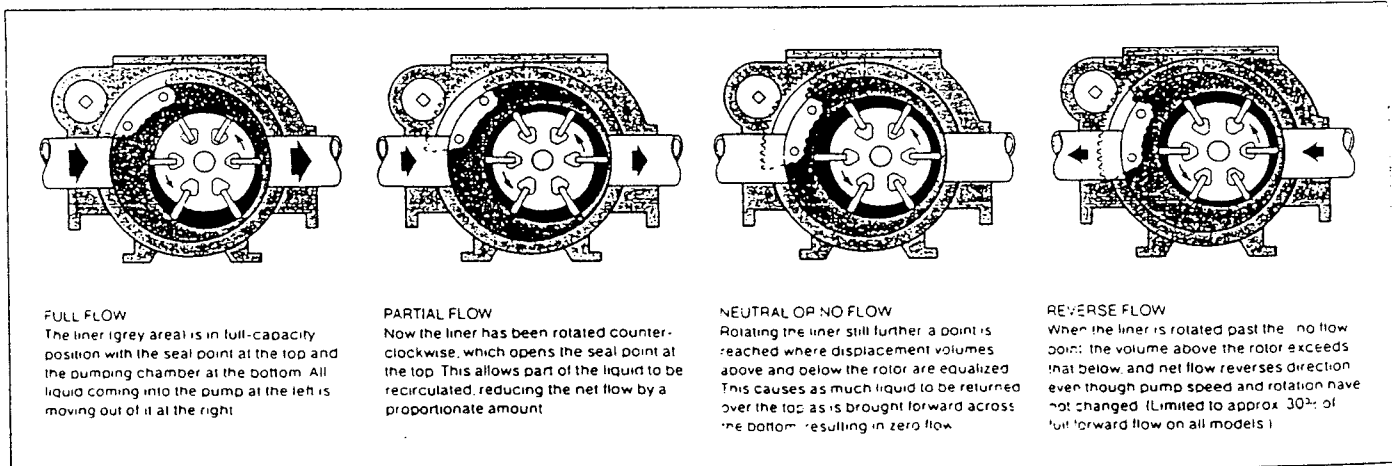
The type VNP is constructed with self-lubricating sleeve bearings and shaft packing or optional mechanical seals. The VNPJ is a jacketed version of the VNP and is designed to allow the use of steam or hot oil for handling high viscosity fluids.

Available in 2 and 3-inch port sizes VNP(J) pumps offer capacities up to 190 gpm (719.2 lpm) and can handle fluid viscosities in excess of 100,000 SSU at temperatures to 500°F (260°C) and maximum differential pressures to 150 psi (10.5 kg/cm²).

The 2-inch pumps have NPT tapped ports and the 3-inch pumps are offered with NPT tapped flanges.

*Accuracy of the flowrate setting when adjusted below 20 percent of full capacity will vary subject to viscosity.

FIGURE 9. How the Vari-Flow pump works



VNER AND PROPORTIONING APPLICATIONS

STANDARD MATERIALS OF CONSTRUCTION

PUMP MODEL	VANE	SEAL/PACKING	OPTIONAL MECHANICAL SEALS	INTERNAL BEARINGS	CASING	HEADS	ROTOR	SHAFTS	LINER	OPTIONAL RELIEF VALVE		
										BODY	VALVE	SPRING
VNP2 VNP3	Composition	Teflon Impregnated	John Crane Type 9	Metalized Carbon	Cast Iron	Cast Iron	Iron	Steel	Tin Plated Cast Iron	Iron	Cast Iron	Cadmium or Zinc Plated Steel
VNPJ2 VNPJ3	Bronze											

Seal vane extra clearance construction and other material options are available when required for specific applications—Consult factory.

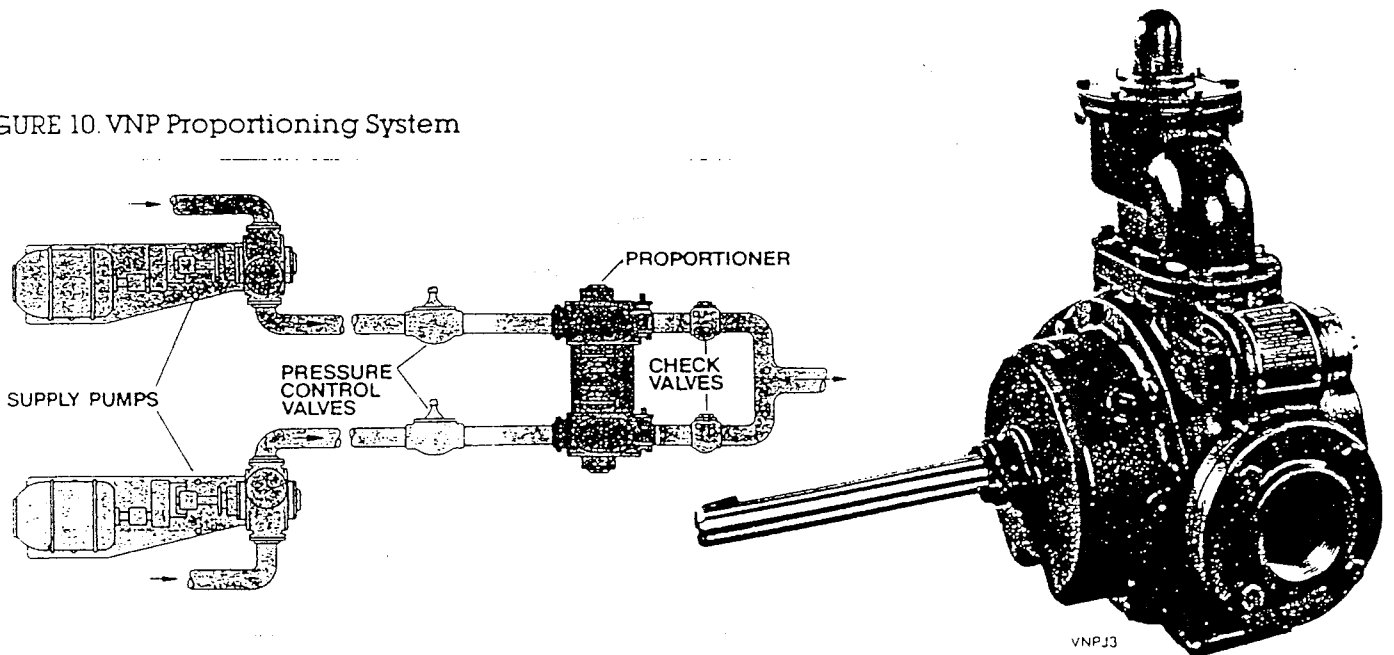
PUMP PERFORMANCE DATA

PUMP SERIES	PUMP MODEL	PUMP SIZE (INCHES)	CAPACITIES & HORSEPOWER REQUIRED (100 SSU LIQUID) (DENSITY 7.5 G/CC, 45.45 STOKES VISCOSITY) (PUMP SPEEDS SHOWN)										MAXIMUM OPERATING CONDITIONS (PUMP SPEEDS SHOWN)					MAXIMUM LIQUID TEMPERATURE (°F)
			1000 RPM	1500 RPM	2000 RPM	2500 RPM	3000 RPM	3500 RPM	4000 RPM	4500 RPM	5000 RPM	5500 RPM	6000 RPM	6500 RPM	7000 RPM	7500 RPM	8000 RPM	
VNP(J)2	2	2	520	46	174	2.0	44	167	3.0	40	151	5.0	150	125	100	3,000	3,000	500
			300	27	102	0.6	26	98	1.2	23	87	2.0	150	150	100	10,000	20,000	(260)
VNP(J)3	3	3	400	140	530	4.5	135	511	7.0	125	473	12.0	150	150	100	10,000	10,000	500
			300	27	102	0.6	26	98	1.2	23	87	2.0	150	150	100	10,000	20,000	(260)

*Capacities and horsepower based on 100 SSU liquid. For high viscosity applications, pump speeds should be reduced. Refer to performance curves for capacities and horsepower at other pressures and viscosities.

For pressure and temperature requirements in excess of those listed—Consult factory.

FIGURE 10. VNP Proportioning System



UNLOADING INSTRUCTIONS FOR TANK CARS OF ETHANOL

Inspection

If there is evidence of damage, leakage, tampering or theft, please contact the delivering railroad and ADM. This tank car has been sealed with ADM cup seals. Check these seal numbers against those printed on the Bill of Lading, they should correspond.

After the tank car has been spotted:

1. Attach grounding equipment to the frame of the tank car.
2. Open the dome cover.
3. Check the main outlet valve to be certain that it is completely closed. (Valve handle may be found in one of two locations — on top, near the dome, or at bottom of car, near outlet.
4. Check to be certain main valve is closed by removing small safety plug from the outlet cover at the bottom of the car. Any evidence of ethanol in the main outlet cover indicates the main outlet valve is or has been open. **Do not remove main outlet cover until valve is closed.**

Unloading

1. Remove the large cover on the main outlet downleg. The outlet pipe of the railcar is equipped with a 5" threaded end for connecting to your unloading hose.
2. Connect a tank car coupling assembly with a 45° elbow, such as an OPW 156-M coupler, to the 5" downleg. These elbows reduce down to 2", 3" and 4" sizes.
3. Open the main outlet valve and start your unloading pump.

After Unloading

When the tank car has been unloaded, close the main outlet valve. Close and secure the dome cover and replace the large outlet cover. Please advise the railroad when car is ready for return, using the "Return Bill of Lading" provided, to insure prompt forwarding of the car.

Safety

Ethanol is a flammable liquid. Handle with the same safety precautions as gasoline. Avoid sparks and flames.

It is advisable to wear safety goggles when unloading ethanol. If ethanol contacts the body or face, flush with water.

Problems

In case of difficulties, contact your ADM representative or the Traffic Department of ADM.

Information Courtesy of ADM

Other suppliers recommend similar procedures with the obvious exception that where ADM is listed you would instead contact the applicable ethanol supplier.

HANDLING AND UNLOADING PROCEDURES FOR TANK TRUCKS OF ETHANOL

1. Tank trucks or truck compartments must be dry before loading ethanol. Water, unleaded, regular, premium or No. 2 diesel must not be allowed to contaminate the alcohol and must be drained from carrier tanks.
2. **Ground the truck during loading operations.**
3. Hoses must be purged. It is best to have pumped alcohol or unleaded gasoline prior to pumping alcohol.
4. Before the first delivery to the alcohol storage system, make certain that the tank, lines and pump are clean.
5. **Ground the truck during unloading operations.**
6. Alcohol is a flammable liquid. Handle with the same safety precautions as gasoline. Avoid sparks and flames.
7. It is advisable to wear safety goggles when handling alcohol. If alcohol contacts the body or face, flush with water.
8. Use good ventilation. Avoid breathing vapors, because they can cause headache, dizziness and nausea.

METHOD OF DETERMINING APPARENT PROOF OF ETHANOL

Equipment

Laboratory equipment for determining the proof of alcohol by the proof hydrometer method can be obtained from laboratory supply houses. Use a 185-206 proof hydrometer. Consult your local laboratory equipment suppliers for the proper proof hydrometer and auxiliary unit. One of the suppliers with whom we are familiar is:

H.B. Instrument Company
American and Bristol Streets
Philadelphia, Pennsylvania 19140
(215) 329-9125

The H.B. Instrument Company Catalog Number for the 185-206 proof hydrometer is 6495A and the Catalog Number for the hydrometer jar and thermometer unit is 6700.

Procedure

When the above equipment is used for hydrometer readings at 60°F. the apparent proof at 60°F. is obtained. If sample temperatures are different from 60°F., use the table

ETHANOL DENATURATED WITH 5 PARTS NATURAL GASOLINE PER 100 PARTS ETHANOL

Apparent Proof, Specific Gravity and API Gravity at Various Temperatures

**Denaturant Added -
Natural Gasoline (API @ 60°F = 80°)**

Temp °F	200 Proof Ethanol*			199 Proof Ethanol*		
	Apparent Proof	Specific Gravity	API Gravity	Apparent Proof	Specific Gravity	API Gravity
30	196.0	.8038	44.5	195.1	.8060	44.1
40	198.3	.7987	45.7	197.0	.8010	45.2
50	200.1	.7939	46.7	199.3	.7950	46.5
60	202.1	.7879	48.1	201.1	.7900	47.6
70	203.7	.7848	48.8	202.9	.7867	48.4
80	205.3	.7806	49.8	204.5	.7828	49.3

Temp °F	198 Proof Ethanol*			197 Proof Ethanol*		
	Apparent Proof	Specific Gravity	API Gravity	Apparent Proof	Specific Gravity	API Gravity
30	194.0	.8082	43.6	192.6	.8125	42.7
40	196.0	.8031	44.7	195.0	.8056	44.1
50	198.3	.7970	46.0	197.4	.7983	45.8
60	200.3	.7930	46.9	199.1	.7950	46.5
70	202.1	.7890	47.8	201.1	.7910	47.4
80	203.7	.7851	48.7	203.0	.7871	48.3

*Proof of the ethanol before denaturant natural gasoline was added.

Instructions for the Use of the Hand Held T/C Refractometer

Ethanol Quality Control

The hand held T/C refractometer is a quick procedure for determining with reasonable accuracy the purity of the ethanol being received by the terminal. It checks the refractive index of the product, which should be within certain limits to be suitable for use in our gasoline.

The refractive index of the ethanol can be altered any number of ways: i.e., water, denaturants, contaminants, etc. The following procedure will give, within reasonable confidence, an accurate assessment of the ethanol's suitability for use in our gasolines.

PROCEDURES:

Step #1

- (1) Obtain sample from transport barge, etc., prior to its being received into storage. A pint should be sufficient. Save the samples or retain for at least 30 days.
- (2) Check refractive index in accordance to instructions provided with refractometer. Record this reading on log.
- (3) Using the graduate provided, blend 70 ml ethanol with 30 ml H₂O. Please be quite accurate blending these mixtures. There should be no separation of mixtures but some haziness of the mixture will be noticed.
- (4) Check refractive index. This value should be the same as ethanol index measured previously: +0.50_ND. Record this value in the log.

Step #2

- (1) Place 70 ml ethanol in the graduated cylinder.
- (2) Add 20 ml H₂O. Final mixture should be clear and no visible haze present.
- (3) With syringe, add water until haze forms (92-95 ml). Refractive index of this mixture should be 1.0-1.5_ND values higher than first measurement (ethanol only).

Using the 250 ml graduated cylinder:

- (1) Measure 100 ml ethanol into the cylinder.
- (2) Add water up to 250 ml mark.
- (3) Insert stopper and shake

Note: Shaking this mixture will often result in pressure building up and possibly expelling the stopper. Be careful to relieve the pressure slowly.

- (4) Allow to stand for five minutes.
- (5) Read the amount of denaturant found in the top level separated from the lower phase.

Denaturant should be approximately 2-4 1/2 ml. If a significantly higher amount or no denaturant is found, you may wish to contact your ethanol supplier to discuss your test results.

DETERMINING ACCEPTABILITY OF ETHANOL

Passing Criteria:

- (1) Initial reading 18.5-20.5
- (2) 70/30 reading 18.5-20.5
- (3) Haze value 93-95 ml.
- (4) Haze N^D value 1.0-1.5 N^D above reading #1
- (5) Denaturant layer 2-4 1/2 ml approximate after 15 minutes

NOTE

Occasionally check refractometer with water (distilled). It should read 0 on the scale.

Space provided for insertion of:

Ethanol Product Specification Sheet(s)

From you fuel ethanol supplier(s)

Transportation

Transportation considerations cover two areas, inbound deliveries of neat ethanol and outbound deliveries of gasoline/ethanol blends.

Inbound Ethanol Deliveries

Procedures for delivery of inbound ethanol encompasses barge, rail, and transport truck. Some information on receipt of product by these modes of delivery are provided in the "Terminal Operation" section of this manual. The following brief overview should provide additional guidance.

Barge

Procedures for receiving barge shipments vary from terminal to terminal and depend on whether or not an independent inspection company is involved.

Each company should conduct a review with the appropriate terminal manager to establish procedures which are incident-specific to the involved terminal. Such a review should address safety, product integrity, assurance of full measure and minimizing any demurrage on equipment as well as proper scheduling and inventory levels.

Rail

Many terminals receive product by rail, typically in up to 29,000 gallon capacity railcars. Whether the equipment belongs to the customer or the supplier, there are certain procedures that should be followed.

Inspection: If there is any indication of damage, leakage, tampering, or theft, the delivering railroad and supplier should be notified to ascertain appropriate action. Suppliers should use numerically identified seals, and write the numbers on the bill of lading. You should verify that these numbers correspond on arrival. After the tank car has been spotted, the grounding equipment should be affixed to the tank-car frame. You may then open the dome cover. Next check the main outlet valve, which should be completely closed. (Valve handles are located either on top near the dome, or at the bottom of the car near the outlet.) Most equipment will be equipped with an outlet cover which contains a small safety plug. Once the main valve is closed, you can remove the safety plug. Any evidence of ethanol in the main outlet cover indicates the valve is open or has been opened.

Unloading: Remove the main outlet cover and connect a tank-car-coupling assembly (45° elbow recommended) to the downleg. Use of a coupler such as an OPW 156-M allows reducers to be utilized with the elbow. After proper connections are made, open the main outlet valve and engage your unloading pump. Once the tank car is unloaded, close the main outlet valve, close and secure the dome cover and the large outlet cover. Advise railroad when car is ready for routing. Suppliers should provide a "Return Bill of Lading" to ensure prompt forwarding of the car. Caution - ethanol is a flammable liquid. Handle with the same safety precautions as gasoline. Avoid sparks and flames. It is advisable to wear safety goggles when unloading ethanol. If ethanol contacts the body or face, flush with water. See Material Safety Data Sheet - MSDS.

Transport Trucks

The most common method of ethanol delivery for a number of terminals is by transport truck (typically 7800-8200 gallons). While equipment suitable for transportation of gasoline is acceptable for handling ethanol, a few extra precautionary steps should be taken. Truck compartment(s) should be clean and dry before loading. Avoid contamination from water, leaded regular, or diesel, etc. Always ground the truck during loading and unloading operations. Hoses must be purged. It is best to have pumped ethanol or unleaded gasoline prior to pumping ethanol. Before the first delivery to the ethanol storage system, make certain that the lines and pump are clean. Ethanol is a flammable liquid. Handle with the same safety precautions as gasoline. Avoid sparks and flames. It is advisable to wear safety goggles when handling ethanol. If ethanol contacts the body or face, flush with water. Use good ventilation. Avoid breathing vapors, because they can cause headaches, dizziness, and nausea. If you are delivering to a terminal not within your own control, you should contact the terminal manager to verify their unloading hours and procedures. Transport loads of ethanol should be placarded as flammable - placard number 1987. Additional information pertaining to the transportation of ethanol can be found in the Code of Federal Regulations-Transportation Section 49CFR § 172/173.

Outbound Delivery - Blended Product

For many operations, outbound deliveries will present more preparatory steps. Many companies interface not only with their own corporate transport drivers but also corporate drivers from their customers and exchange partners, as well as common carrier drivers (for their own deliveries and those of others).

Regardless of who the transport driver works for, they should be familiarized with any new equipment installed for the blending program. Such items might include new transport load-out terminal screens, blend selection consoles, etc.

With the exception of equipment, most functions at the terminal will be the same as for other products. There may be some special steps for those terminals utilizing the old splash blending technique.

In instances where splash blending is still being utilized, the following information should be reviewed:

- Per API, it is recommended that the gasoline portion of the blend be loaded first to ensure that vapors in the transport tank compartment are above the upper flammability limit.
- If drivers are responsible for selecting blend proportions, they should be issued blend cards that pre-calculate product volumes by compartment (Sample for 10% blends is included in appendix).
- The importance of blending by compartment should also be stressed. Blending must be by compartment, not only to ensure proper mixing but also because of the potential for dropping in multiple tank configurations, split loads, and other variations that can occur during the normal delivery process.

Once loaded onto the truck, the delivery procedures become the same for all deliveries. Drivers should be informed of the following procedures:

- API or company color code for new blended products should be covered. In general, the API color code for gasoline/ethanol blends is the same for the corresponding grade of gasoline, except that a ring corresponding to the color of the cross (for unleaded grades) encircles the fill cap to indicate the product has been extended with ethanol. API Recommended Practice 1637 "Using the API Color Symbol System to Mark Equipment & Vehicles for Product Identification at Service Stations & Distribution Terminals" provides guidance on this topic. Space has been provided for insertion of API or other applicable color codes in the appendix to this section.
- Once the proper tank is identified, the driver should use water paste to test for water bottoms. If water bottom levels in excess of 1/4 inch are present, product should not be dropped. Appropriate phone contacts and procedures to follow when water bottoms are present should be established before program implementation. Once it is determined that no water bottom exists, the load can be dropped per normal procedures.

Conversion Procedures.

When converting a store or group of stores to gasoline/ethanol blends it is important to include the transport driver and his/her dispatcher in the information loop.

Depending on tax considerations, company policy, and other regulatory compliance concerns, a store/station may be converted to gasoline/ethanol blends in one of three ways as follows:

- A. The company could chose to remove all in-ground product and replace it with the new blend. Due to the complex accounting and strain on transportation capabilities, this is seldom, if ever, done. If this conversion method is employed, the procedures, both operational and accounting will be company specific. They should be written and provided to all involved drivers. This method will obviously strain transportation capabilities, so need versus capabilities should be reviewed with transportation personnel.
- B. One of the more common conversion methods is to simply reduce in-ground inventory to minimum operating levels, i.e. less than 1000 gallons, and then drop the first load of blended product. This normally requires no special considerations other than stressing the importance of deliveries exactly as timed. This will ensure low in-ground inventory while reducing the likelihood of product outage.
- C. Another method often used to convert into a gasoline /ethanol blend program is to upgrade in-ground product to the desired blend ratio. The normal procedure for this type of conversion is to reduce inventory to minimum operating levels and to include enough ethanol in the first load to upgrade in-ground inventory. Example-Store O is converting unleaded regular to an ethanol blend. They have a 10,000 gallon tank. It is Monday morning and inventory is at 2400 gallons. The store normally sells 1200 gallons of this grade on Mondays. The store is to be converted Tuesday morning. The volume to be ordered for this grade is 6,000 gallons. Under the above conditions, it would be assumed that in-ground inventory will be 1200 gallons. To determine the amount of ethanol needed to upgrade inground inventory multiply by .111. This yields 133 gallons of ethanol which when added to the 1200 gallons of gasoline yields 1333 gallons containing 133 gallons of ethanol, a 10% blend. When loading the 6000 gallons, you could start by loading 133 gallons of ethanol. The remaining 5867 gallons would be blended at 10%

or: 587 gallons of ethanol
 5280 gallons of gasoline 587/5867 = 10% blend
 5867

The total of the resulting drop would be as follows:

in-ground gasoline	1200 + gasoline delivery	5280	=	6480
in-ground ethanol	0 + ethanol delivery	720	=	<u>720</u> (1)
total				7200

(1) 133 gallons for in-ground gasoline + 587 for gasoline in tank

If this method is utilized special forms should be used to prepare the orders for the dispatcher. An example of a form utilized by one company is included in the appendix.

Despite the extra work, this procedure has advantages including being at the targeted blend level from program inception, capturing applicable tax incentives on in-ground inventory and improved water tolerance of the overall blend.

Once the tanks are converted (regardless of method) they should be filled to near capacity, i.e. 80%+, and kept as full as possible for 10 to 14 days. The reasoning for this is discussed in the retail conversion section but is mentioned here because it will usually result in an increase in the number of transport loads scheduled. Therefore transport personnel should be advised of increased load requirements.

Additionally it will be especially important to watch for water bottoms during this implementation period.

Transport personnel should also be advised of the importance of accurate blend ratios since inaccurate ethanol levels can result in fuels that do not comply with various regulations.

The more relevant detail you can provide to transport personnel, the smoother your program will be. A brief check list of key items to discuss is included following this page.

Transportation Personnel - Orientation Check List

Inbound Ethanol Delivery

- 1. Cover product delivery procedures
- 2. Cover applicable firefighting & safety procedures
- 3. Issue MSDS

Outbound Blended Product Delivery

- 1. Cover information on new terminal blending equipment
- 2. Cover splash blending procedure (if applicable)
- 3. Cover color codes
- 4. Discuss need to test for water bottoms and what procedures to follow when water bottoms are present. Any level of water above 1/4" should be removed.
- 5. Assuming no water bottoms are present, the load can be dropped per normal procedure

Conversion Procedures

- 1. Review conversion procedures
- 2. Review any special requirements & resulting increase in transportation demands
- 3. Stress importance of no water bottoms
- 4. Cover importance of accurate blend ratios

Transportation Appendix - Section IV

- Sample Blend Calculation Card
- API 1637 or other product identification guidelines
- Conversion Form to Upgrade In-ground Inventory

TOTAL QUANTITY DESIRED	90%	10%	80%	45%
1000	900	100	800	450
1100	990	110	880	495
1200	1080	120	960	540
1300	1170	130	1040	585
1400	1260	140	1120	630
1500	1350	150	1200	675
1600	1440	160	1280	720
1700	1530	170	1360	765
1800	1620	180	1440	810
1900	1710	190	1520	855
2000	1800	200	1600	900
2100	1890	210	1680	945
2200	1980	220	1760	990
2300	2070	230	1840	1035

TOTAL QUANTITY DESIRED	90%	10%	80%	45%
2400	2160	240	1920	1080
2500	2250	250	2000	1125
2600	2340	260	2080	1170
2700	2430	270	2160	1215
2800	2520	280	2240	1260
2900	2610	290	2320	1305
3000	2700	300	2400	1350
3100	2790	310	2480	1395
3200	2880	320	2560	1440
3300	2970	330	2640	1485
3400	3060	340	2720	1530
3500	3150	350	2800	1575

TO BLEND "TOTAL QUANTITY DESIRED"
 ADD 90% + 10%
 or
 ADD 80% + 10% + 10%
 or
 ADD 45% + 45% + 10%

Space provided for insertion of:

Product Identification Guidelines

API Recommended Practice 1637 or Appropriate Substitution

C

Recap of API Color Code for Ethanol Blends

The API color codes for gasolines extended with ethanol are the same as the base gasoline except the background color in the fill cap circle is encircled with the color used in the cross.

Unleaded regular with ethanol is a white background with a black cross encircled in black.



Unleaded midgrade with ethanol is a blue background with white cross encircled in white.



Unleaded premium with ethanol is red background with white cross encircled in white.



Terminal signage, fill box inserts, and tankage/piping identifications use markings similar to those above.

STORE # _____

P.O.# _____

TRUCK # _____

	REG.	ML	OTHER
Background Inventory	_____	_____	_____
Projected Sales	_____	_____	_____
Projected Inv. at Delivery	_____	_____	_____
Alcohol Needed to upblend	_____	_____	_____

TOTAL ORDER	ALCOHOL FOR UPBLEND	SPACE REMAINING	ALCOHOL SPACE REMAINING	TOTAL ALCHOL	TOTAL GASOLINE
Reg. _____	_____	_____	_____	_____	_____
ML _____	_____	_____	_____	_____	_____
Other _____	_____	_____	_____	_____	_____

COMPARTMENT SIZE	GRADE LOADED	AMOUNT GASOLINE	AMOUNT ALCOHOL
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____
_____	_____	_____	_____

Maintenance

When converting a store or station to a gasoline/ethanol blend program, it is important to advise the appropriate maintenance personnel of any steps they should take, and any special demands the program may put on their operation.

In some companies, minor maintenance items may be undertaken by store or field management personnel. In those cases, applicable items covered in this section should be covered with those employees.

Whether maintenance personnel are direct employees or those of a contract service company, you should not assume that they are aware of all necessary preparatory and ongoing steps to be taken. All applicable items should be covered and ideally a check list for each location should be completed.

Terminal Level

If the company will be maintaining ethanol inventory at an equity terminal, maintenance personnel may be involved in some preparatory steps. Guidance on terminal conversions is covered in the terminal operations section of this guide. Maintenance personnel should also be aware that screens/filters may plug for the first few days of a program. This would necessitate a rapid response to minimize any period when product is not available. Once the program is beyond the first few days, it should not present any special problems or required actions.

It is advisable to recalibrate the ethanol meter 10 to 14 days after program implementation to ensure accurate measure.

Retail Level

By far the most important precautions necessary to ensure product integrity are those applicable to the retail location. Since some companies may be converting a large number of stores within a short time frame, it is advisable to have the store/station manager maintain a check list for all preparations at his/her location. For this reason, these items are also covered in the retail section. Maintenance personnel should also be aware of these steps to the extent that they are responsible for those items. Without getting into the reasoning behind each specific action, the key to ensuring product integrity and a successful program basically involves ensuring that materials will be compatible, that the system is clean, and that moisture contamination is avoided.

The key steps for a retail unit conversion include several actions. First it is necessary to verify that tank (or liner) material is compatible with gasoline/ethanol blends. Next, any history of water problems should be investigated. Any water problems must be eliminated before conversion. Fill caps should be checked for a tight seal and manhole covers should be checked for proper water run off. Some submersible pumps (especially older models) may require modification to be totally compatible with gasoline/ethanol blends. In order to avoid impeller "swell" it may be necessary to upgrade seals and impellers. You should check with the equipment manufacturer to determine if their submersible pumps are compatible with gasoline/ethanol blends.

Water bottoms should be removed. Tilted tanks should be checked at each end. If "tank bottom protectors" have been installed, they should be removed (if possible) during removal of water bottoms to ensure that all water is removed. Tanks, especially older tanks, should be cleaned. An example of one tank cleaning system, the Gorman Rupp-Tank Kleenor is included in the appendix to this section.

All pumps and dispensers should be equipped with a 10 micron final filter. Some companies may elect to use special "water slug" filters. These type of filters are sensitive to water and will stop product flow if water is pumped through them. Shortly before delivery of the first load, tank bottoms should again be checked for water and any water should be removed. Maintenance personnel should, at this point, be utilizing water detection paste that is suitable for use with gasoline ethanol blends. Many regular water pastes are alcohol based and do not work properly in ethanol blends (see retail section appendix for information on type of appropriate water paste).

Maintenance personnel should be advised that it may be necessary to remove water bottoms and or any sludge build up during the first few days after conversion. Likewise it may be necessary to change final filters once or twice until the build up of residue is removed. These activities could result in more frequent calls during the initial conversion period so maintenance personnel should be advised to take whatever steps necessary to ensure adequate response times. Materials used in the dispenser, hoses, nozzle, etc., should not present any problems since these items were upgraded, years ago, to be compatible with gasoline/ethanol blends.

You should also ensure that maintenance personnel or contractors are following correct procedures and complying with applicable laws concerning water bottoms disposal. This material is considered a hazardous substance and must be handled and disposed of according to applicable laws.

Also some maintenance personnel could be handling water bottoms consisting of ethanol and gasoline so appropriate MSDS's should be issued.

Finally, since gasoline/ethanol blends may remove lacquer and deposits that build up in pump meters, it is advisable to recalibrate pumps about two weeks after the initial conversion.

Beyond the above actions, there are no ongoing special considerations except taking normal steps to ensure that water does not find its way into tanks. A check list of the above items is provided on the following page. These items are also covered in greater detail in the retail section of this program guide.

Maintenance Personnel - Orientation Check List

Terminal Level

- 1. Advise of any conversion procedures for terminal equipment
- 2. Advise of potential for screen/filter plugging in the first few days of program and the need for rapid response to minimize down time
- 3. Test/recalibrate ethanol meter 10 to 14 days after program implementation

Retail Level

- 1. Verify tank (or liner) material compatibility (also submersible pumps)
- 2. Investigate and correct any historic water problems. No level of water is acceptable!
- 3. Check for tight fitting seals on fill caps and proper water run off from man hole covers. Replace any suspect seals and/or repair any poor water run-off
- 4. Remove tank water bottoms (check both ends on titled tanks) (remove "tank bottom protectors" if possible)
- 5. Clean tank bottoms if necessary
- 6. 10 micron final filter (in some cases your company may elect to use a "water slug" filter)
- 7. Proper water paste issued (Sargel or equivalent)
- 8. MSDS issued
- 9. Recheck for water bottoms before initial conversion load
- 10. Remove any build up of water bottoms or sludge. Discuss proper disposal procedure and legal compliance
- 11. May need to replace final filters shortly after conversion
- 12. Recalibrate pump meters after 14 days

Maintenance Appendix - Section V

- Gorman Rupp-Tank Kleenor



tankleenor™

**DANGER
FLAMMABLE
LIQUIDS**

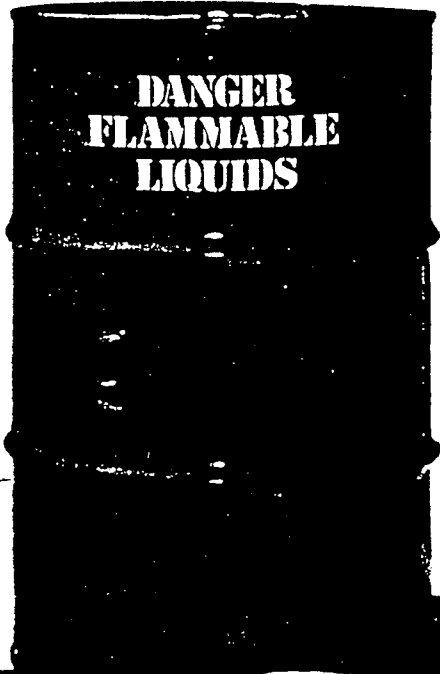
**The efficient and economical
petroleum tank cleaner.**



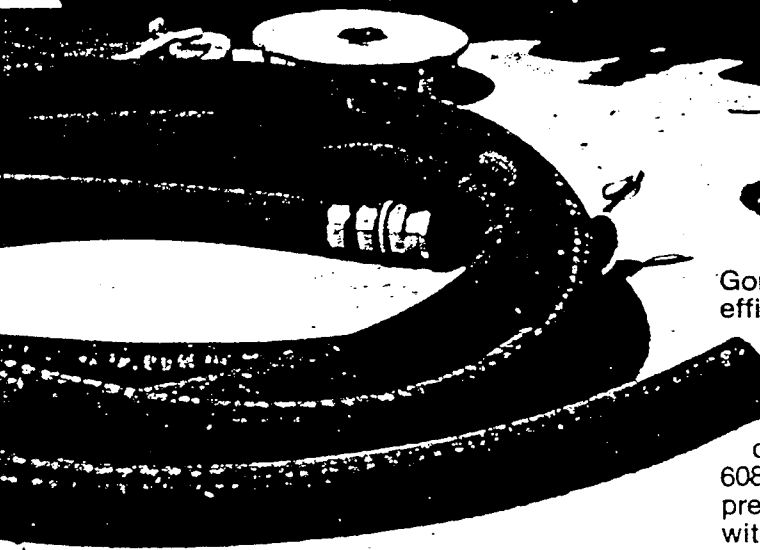
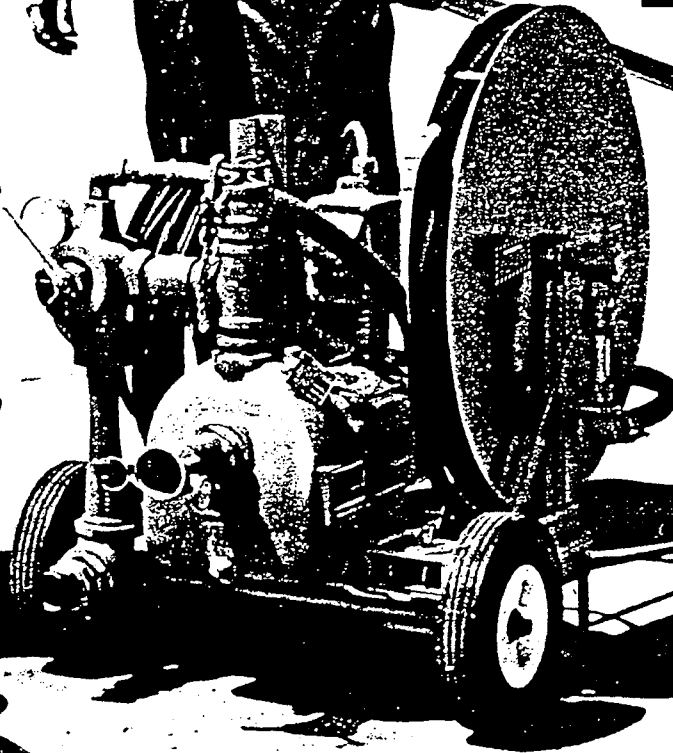
The efficient



1. Add operating liquid to container, install suction and discharge hoses.



NOTE
The 55-gallon drums in the illustrations are shown for demonstration purposes only, and are not furnished with the Unit. Contaminated liquid should be pumped into closed, ventilated tanks for removal to proper disposal areas.



Gorman-Rupp's Unit 608 Tankleenor provides quick, efficient and economical cleaning of below-ground petroleum storage tanks.

Even when tanks are thought to be free of moisture and foreign debris, they often contain enough water and other contaminants to degrade the stored product. The Gorman-Rupp Unit 608 Tankleenor can remove contaminants...like gel precipitates, microbial growths, rust and water... without disturbing the product or taking the tank out of service.

The Unit 608 tankleenor is a lightweight, wheel-mounted pumping unit designed for one-man operation and easily moved from job to job.

At the heart of this unit is a Gorman-Rupp "O" series self-priming centrifugal pump. With the same quality and design features that have proven so successful in bulk plants and in fuel oil and aviation fuel delivery service.

USE EXTREME CAUTION IN HANDLING FLAMMABLE LIQUIDS

oleum tank cleaning method.



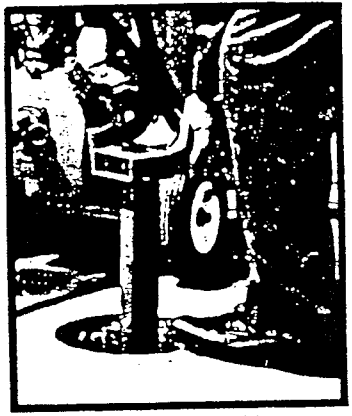
1. Attach quick-coupled hoses to pump suction and discharge.



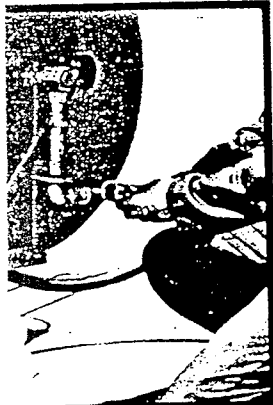
3. Fill volute casing with priming liquid.



4. Insert guide tube into storage tank.



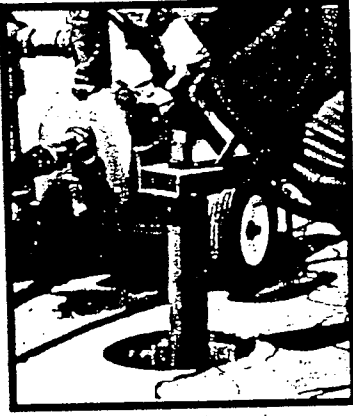
5. Secure hose reel to guide tube.



6. Attach hose from pump eductor to hose reel.



7. Attach ground wire clip to tank.



8. Feed hose through guide reel and into storage tank.



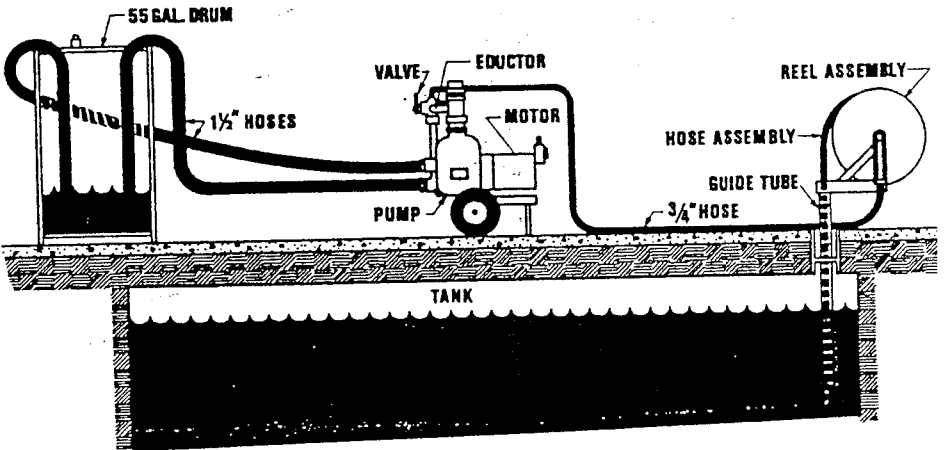
9. Start pump.

The Gorman-Rupp Unit 608 Tankleener comes complete with...

Pump. "O" Series 2 x 2-inch self-priming centrifugal pump close-coupled to a 1-horsepower Class 1, Group D, 60Hz, 115/230V, single phase explosion-proof electric motor with 50 feet of 14 gauge, 3 conductor, grounded-type power cord.

The pump is equipped with a venturi-type eductor permitting recirculation of operating fluid without contaminating the tank, and a hand-operated valve for backflushing. The discharge and suction ports are fitted with male quick-connect couplers.

Reel Assembly. Detachable reel assembly for storing hose and controlling direction and travel rate. The reel assembly is fitted with a built-in sight tube which enables the operator to locate pockets of contamination and observe them until they've been cleaned up.



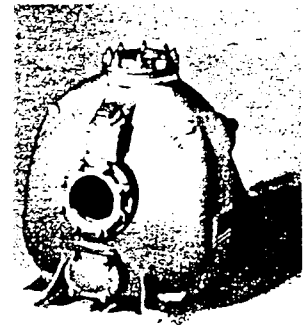
Hose Assembly. Hydrocarbon-resistant hose, 5/8-inch diameter by 42 feet long, with a spring steel integral strap insert and a specially designed nozzle.

Connector hose. 6-feet by 3/4-inch, to connect pump eductor and valve to reel assembly.

Suction and discharge hoses. In 15-foot lengths, fitted with quick-connect couplers to match pump suc-

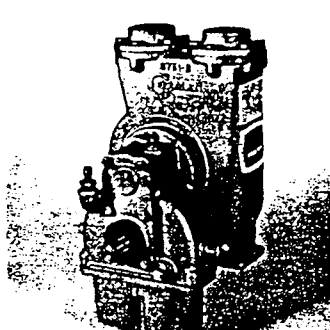
tion and discharge couplers.
Stainless steel adjustable-guide tube. 12-foot long, with spring-loaded foot.
Ground wire. 10-foot long, with clip, for grounding pump.
Optional 50Hz Motor. For 50Hz operation, Unit 608-A Tankleener is available with 1 1/2 horsepower, class 1, group D explosion-proof, 50 Hz, 115/220V, single phase electric motor.

Other proven Gorman-Rupp Petroleum-Handling Pumps



WALK PLANT OPERATION

'K' Series self-priming centrifugal pumps for petroleum product transfer. Industry standard for handling petroleum products. Available with standard or explosion-proof electric motors; engines, or bare shaft pumps only, in 2-inch to 6-inch sizes.



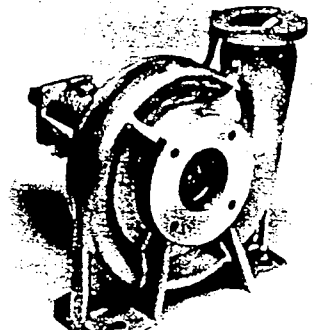
TRUCK MOUNTED PUMPS

"O" Series centrifugal pumps, power-take-off driven, for truck-mounting. For fuel oil and aviation fuel delivery, 2-inch and 3-inch models with right and left hand rotation. For fueling jet aircraft, 6-inch and 8-inch models for split shaft installation.



PORTABLE PUMPS

"80" Series Shield-A-Spark engine-driven, self-priming centrifugal pumps, for transfer, and delivery of flammable liquids. U.L. listed and State Fire Marshal Approved. Available in 2-inch, and 3-inch sizes.



ROTO PRIME PUMPS

Roto-Prime centrifugal pumps designed exclusively for handling petroleum products, derivatives, petrochemicals, and solvents. Integral variable-capacity vane pump automatically evacuates air and vapor. Available in 2-inch to 5-inch sizes.



Gorman-Rupp petroleum-pump distributors are located throughout the United States, Canada, and the free world. Most offer complete service facilities in addition to technical application information and sales assistance. Contact the distributor nearest you for complete details on Gorman-Rupp petroleum-handling pumps.



The Gorman-Rupp Company
P. O. Box 1217
Mansfield, Ohio 44901-1217
Ph. 419/755-1011 Telex 98-7422

Gorman-Rupp of Canada Ltd.
70 Burwell Road
St. Thomas, Ontario N5P 3R7
Ph. 519/631-2870 Telex 064-73530

The Gorman-Rupp International Co.
P. O. Box 1217
Mansfield, Ohio 44901-1217
Phone 419-755-1011 Telex 98-7422

Safety & Firefighting

Although ethanol does not present any dangers beyond those of other flammable products, it is important that pertinent safety and firefighting details be covered with the appropriate personnel.

This section contains Materials Safety Data Sheets (MSDS) for ethanol as well as some recommended safety and firefighting information.



Date issued 12/15/92
Supersedes 11/13/92

TEXACO
MATERIAL SAFETY DATA SHEET

NOTE: Read and understand Material Safety Data Sheet before handling or disposing of product.

1. CHEMICAL PRODUCT AND COMPANY IDENTIFICATION

MATERIAL IDENTITY

Product Code and Name:
92223 FUEL-GRADE ALCOHOL

Chemical Name and/or Family or Description:
Alcohol

Manufacturer's Name and Address:
Pekin Energy Company
P.O. Box 10 Pekin, IL 61555

Telephone Numbers:

TRANSPORTATION EMERGENCY Company: (914) 831-3400 CHEMTREC: (800) 424-930
HEALTH EMERGENCY Company: (914) 831-3400
GENERAL MSDS ASSISTANCE (914) 838-7204
TECHNICAL INFORMATION Fuels: (914) 838-7336; Lubricants/Antifreezes: (914) 838-750
Chemicals: (512) 459-6543

2. COMPOSITION/INFORMATION ON INGREDIENTS

THE CRITERIA FOR LISTING COMPONENTS IN THE COMPOSITION SECTION IS AS FOLLOWS:
CHRONIC HAZARDS (CARCINOGENIC, TERATOGENIC, MUTAGENIC, NEUROTOXIC, AND SENSITIZERS)
ARE LISTED WHEN PRESENT AT 0.01% OR GREATER; ACUTE HAZARDS ARE LISTED WHEN PRESENT
AT 1.0% OR GREATER AND NON-HAZARDOUS COMPONENTS ARE LISTED WHEN PRESENT AT 3.0% OR
GREATER. THIS IS NOT INTENDED TO BE A COMPLETE COMPOSITIONAL DISCLOSURE.

Product and/or Component(s) Carcinogenic According to:	OSHA	IARC	NTP	OTHER	NONE
	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input checked="" type="checkbox"/>	<input type="checkbox"/>

Composition:

Chemical/Common Name	CAS No.	Exposure Limit	Range in %
Ethyl alcohol	64175	1000ppm PEL OSHA 1000ppm TWA ACGIH	95.00 - 99.99
Mixture containing EITHER straight chain and branched paraffinic hydrocarbons, olefins, cycloparaffins and aromatics(the benzene content normally varies from 0.2-3.5% with a typical value of 1.4%; the MTBE content varies from 0-15%) OR hydrocarbon rubber solvent (CAS# 64742898)	mixture	None Established	3.00 - 10.99

Product is hazardous according to OSHA (1910.1200).
Component(s) is hazardous according to OSHA or one or more state Right-to-Know laws.

3. HAZARD IDENTIFICATION

EMERGENCY OVERVIEW

Appearance and Odor: Colorless liquid with gasoline odor.



PRODUCT CODE: 92223
 PRODUCT NAME: FUEL-GRADE ALCOHOL

Date issued: 12/15/92
 Supersedes: 11/13/92

3. HAZARD IDENTIFICATION (CONT)

WARNING STATEMENT

DANGER: EXTREMELY FLAMMABLE LIQUID AND VAPOR
 VAPOR MAY CAUSE FLASH FIRE
 CAUSES SEVERE EYE BURNS
 MAY CAUSE BLINDNESS
 HARMFUL IF SWALLOWED
 CAUSES SKIN IRRITATION

ATTENTION: POSSIBLE CANCER HAZARD
 MAY CAUSE CANCER BASED ON ANIMAL DATA

	HMIS				NFPA		
Health:	3	Reactivity:	0	Health:	3	Reactivity:	1
Flammability:	4	Special:	-	Flammability:	4	Special:	-

POTENTIAL HEALTH EFFECTS

	EYE	SKIN	INHALATION	INGESTION
Primary Route of Exposure:	<u>X</u>	<u>X</u>	<u>X</u>	-
Effects of Overexposure				

Acute

Eyes:

Vapor causes irritation, experienced as pain, with excess blinking and tear production, and seen as marked excess redness and swelling of the eye with possible injury to the cornea. Liquid will cause more severe irritation, with chemical burns to the eye.

Causes irritation, experienced as pain, with excess blinking and tear production, and seen as marked excess redness and swelling of the eye and chemical burns of the eye. Severe eye damage may cause blindness.

Skin:

Causes irritation with discomfort or pain, and seen as marked local redness and swelling, with possible blister formation.

Inhalation:

Vapors or mist may cause irritation of the nose and throat, headache, nausea, vomiting, dizziness, drowsiness, euphoria, loss of coordination, and disorientation. In poorly ventilated areas or confined spaces, unconsciousness and asphyxiation may result.

Ingestion:

Moderately toxic. May cause abdominal discomfort, nausea, vomiting, and diarrhea.

Sensitization Properties:

Unknown.

Chronic:

Prolonged and repeated overexposure to ethanol vapor may cause headache, lack of coordination, sleepiness, fatigue, and difficulty concentrating. Repeated ingestion of ethyl alcohol can result in alcohol abuse, and cause behavioral changes, memory loss, impaired judgement, decreased appetite, abdominal pain, muscle tremors, difficulty walking, irregular heartbeat, and decreased fertility. Chronic alcohol abuse may also result in damage to the nervous system, liver, stomach, and heart. Ethanol abuse in pregnant women can cause miscarriage, premature birth and low birth weight, and birth defects (fetal alcohol syndrome).

Repeated skin contact may cause a persistent irritation or dermatitis.



PRODUCT CODE 91223
PRODUCT NAME FUEL-GRADE ALCOHOL

Date Issued 12/15/91
Supersedes 11/13/91

3. HAZARD IDENTIFICATION (CONT)

Medical Conditions Aggravated by Exposure:

Repeated overexposure may aggravate or enhance existing nervous system dysfunction produced by disorders known to cause nervous system effects or damage such as diabetes, alcohol or drug abuse, and Parkinson's disease.

Repeated overexposure may aggravate existing liver or kidney disease.

Because of its defatting properties, prolonged and repeated skin contact may aggravate an existing dermatitis (skin condition).

Other Remarks:

The toxicological properties of this experimental product have not been fully investigated and its handling or use may be hazardous. Texaco recommends that exposure to this product be minimized to avoid potential adverse health effects.

Ethyl alcohol is rapidly taken up after ingestion. Initial symptoms of acute intoxication include excitement, behavioral changes, slurred speech, dizziness, staggering, difficulty walking, irritability, drowsiness, sleepiness, stupor, and coma. Facial flushing, dilated pupils, sweating, nausea and vomiting may also occur.

4. FIRST AID MEASURES

Eyes:

Immediately flush eyes with large amounts of running water for at least 15 minutes. Hold eyelids apart while flushing to rinse entire surface of eye and lids with water. Get medical attention immediately. Continue flushing with water for an additional 15 minutes if medical attention is not immediately available.

Skin:

Immediately flush skin with large amounts of running water for at least 15 minutes. Remove contaminated clothing and shoes. Get medical attention immediately. Wash clothing before reuse. Destroy non-resistant footwear.

Ingestion:

If patient is conscious and can swallow, give two glasses of water (16 oz.) Induce vomiting as directed by medical personnel. Never give anything by mouth to an unconscious or convulsing person.

Inhalation:

Remove to fresh air. If not breathing, give artificial respiration. If breathing is difficult, qualified personnel may administer oxygen. Get immediate medical attention.

Other Instructions:

None

5. FIRE-FIGHTING MEASURES

Ignition Temp. Degrees F.: N.D.
Flammable Limits (%) Lower: 3.3%

Flash Point Degrees F. (Method): -5 F (CC)
Upper: 19%

Recommended Fire Extinguishing Agents And Special Procedures:

According to NFPA Guide, use dry chemical, foam, or carbon dioxide. Water may be ineffective on flames, but should be used to cool fire-exposed containers. If a leak or spill has not ignited, use water spray to disperse the vapors and to provide protection for personnel attempting to stop the leak.

When handling, use non-sparking tools, ground and bond all containers.

N.D. - Not Determined
< - Less Than

N.A. - Not Applicable
> - Greater Than

N.T. - Not Tested



PRODUCT CODE 92223
PRODUCT NAME FUEL-GRADE ALCOHOL

Date Issued 10.15.91
Supersedes 11.13.91

5. FIRE-FIGHTING MEASURES (CONT)

Unusual or Explosive Hazards:

Danger! Extremely flammable materials may release vapors that travel long distances, ignite, and flash back. Containers may explode in a fire. Do not expose to heat, sparks, flame, static, or other sources of ignition. When handling, use non-sparking tools, ground and bond all containers.

Use alcohol-compatible foam. Flame is invisible in daylight.

6. ACCIDENTAL RELEASE MEASURES (Transportation Spills Call: CHEMTREC (800) 424-9300)

Procedures in Case of Accidental Release, Breakage or Leakage:

Eliminate all ignition sources including internal combustion engines and power tools. Ventilate area. Keep people away. Stay upwind and warn of possible downwind explosion hazard. Avoid breathing vapor. Wear self-contained breathing apparatus. Avoid contact with skin, eyes or clothing. Use self-contained breathing apparatus or supplied air mask for large spills or confined areas. Contain spill if possible. Remove with inert absorbent. Prevent entry into sewers and waterways.

7. HANDLING AND STORAGE

Precautions to be Taken in Handling and Storage:

Transport, handle, and store in accordance with OSHA Regulation 1910.106 and applicable DOT Regulations. Ground and bond shipping container, transfer line, and receiving container. Use spark-proof tools. Keep away from heat, sparks, flame and other sources of ignition. Material may be at elevated temperatures and/or pressures. Exercise due care when opening bleeders and sampling ports.

Eye wash and safety shower should be available nearby when this product is handled or used.

8. EXPOSURE CONTROLS/PERSONAL PROTECTION

Protective Equipment (Type)

Eye/Face Protection:

Avoid eye contact. Chemical type goggles with face shield must be worn. Do not wear contact lenses.

Skin Protection:

Protective clothing such as uniforms, coveralls or lab coats should be worn. Launder or dry-clean when soiled. Gloves resistant to chemicals and petroleum distillates required. When handling large quantities, impervious suits, gloves, and rubber boots must be worn.

Respiratory Protection:

Airborne concentrations should be kept to lowest levels possible. If vapor, mist or dust is generated, use respirator approved by MSHA or NIOSH as appropriate. Supplied air respiratory protection should be used for cleaning large spills or upon entry into tanks, vessels, or other confined spaces. See below for applicable permissible concentrations.

Ventilation:

Use explosion-proof equipment to maintain adequate ventilation to meet occupational exposure limits, if applicable (see below), prevent accumulation of explosive air-gas mixtures, and avoid significant oxygen displacement. Oxygen levels should be at least 19.5% in confined spaces or other work areas (OSHA value).

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PRODUCT CODE: 90223
 PRODUCT NAME: FUEL-GRADE ALCOHOL

Date Issued: 12/15/90
 Supersedes: 11/13/90

8. EXPOSURE CONTROLS/PERSONAL PROTECTION (CONT)

Exposure Limit for Total Product:
 None established. Recommend using TEXACO internal standard for hydrocarbons
 TWA: 100ppm.

9. PHYSICAL AND CHEMICAL PROPERTIES

Appearance and Odor: Colorless liquid with gasoline odor
 Boiling Point (Degrees F.): 173.3 F Percent VOC: 100
 Specific Gravity: 0.794 (H2O=1) Vapor Density: 1.6 Aqueous:
 pH of undiluted product: N.A. Solubility in Water: Complete
 Vapor Pressure: 5 @ 20 C mmhg Other: N.D.
 Viscosity: N.D.

10. STABILITY AND REACTIVITY

This Material Reacts Violently With: (If others is checked below, see comments for details)
 Air Water Heat Strong Oxidizers Others None of These

- - - Y Y -

Comments:

This material reacts violently with acids.

This material reacts with alkali metals to produce hydrogen. DO NOT store in aluminum. This material is capable of reacting with oxidizing agents such as: nitrates, peroxides and acids, etc..

Products Evolved When Subjected to Heat or Combustion:

Toxic levels of carbon monoxide, carbon dioxide, irritating aldehydes and ketones.

Hazardous Polymerizations:

OCCUR DO NOT OCCUR
 - X

11. TOXICOLOGICAL INFORMATION

TOXICOLOGICAL INFORMATION(ANIMAL TOXICITY DATA)

Median Lethal Dose (LD50 LC50) (Species)

Oral: believed to be > 0.5-2 g/kg (rat); moderately toxic

Inhalation: N.D.

Dermal: believed to be > 3 g/kg (rabbit); practically non-toxic

Irritation Index, Estimation of Irritation (Species)

Skin: believed to be 5-6.5/8.0 (rabbit); severely irritating

Eyes: believed to be 80-110/110 (rabbit); extremely irritating

Sensitization: N.D.



PRODUCT CODE 91113
PRODUCT NAME FUEL-GRADE ALCOHOL

Date Issued 10 15 81
Supersedes 11 13 80

11. TOXICOLOGICAL INFORMATION (CONT.)

Other:

Studies in laboratory rats and mice exposed to constant levels of wholly vaporized unleaded gasoline for six hours per day, five days per week for two years caused kidney damage and kidney cancer in male rats and liver tumors in female mice. Many scientists do not believe that the male rat is an appropriate predictor of human kidney disease and are not in agreement on the relationship between liver tumors in laboratory animals and humans.

Middle distillates have caused skin irritation and skin cancer in laboratory animals when repeatedly applied and left in place between applications. Studies to further evaluate the carcinogenic potential of middle distillates are currently underway. Kidney damage has also been observed in laboratory animals exposed to middle distillates.

In male mice, prolonged and repeated exposure to high levels of MTBE vapor produced a higher than expected mortality due to urinary tract obstruction believed caused by physical non-neoplastic blockage of the urethral canal. In female mice, data indicate increased incidence of hepatocellular adenomas (benign liver tumors). Prolonged and repeated exposure to high levels of MTBE (up to 8000 ppm for over 15 months) resulted in excess mortality (82 %) in male rats. Preliminary evaluation showed a chronic progressive nephrosis (kidney damage) as the possible cause of death.

Associated with the increased severity of nephropathy was an increase in the number of renal tubular cell adenomas (benign kidney tumors) and carcinomas (malignant kidney tumors). There was also a difference in the number of testicular interstitial cell adenomas (benign testicular tumors).

MTBE has been shown to cause embryo/fetal toxicity and birth defects in mice, but only at maternally toxic doses. No developmental effects were seen in rabbits at the same exposure levels. Although the significance of these findings to humans is unclear, workers should minimize exposure to MTBE vapor.

Additional or repeat studies are planned or underway to better define the toxic potential of this product, or to verify the results obtained from previous animal studies.

12. DISPOSAL CONSIDERATIONS

WASTE DISPOSAL METHODS

This product (as presently constituted) has the RCRA classification of benzene toxicity and ignitability. If discarded in its present form, it would have the hazardous waste numbers D018 and D001 respectively. Under RCRA, it is the responsibility of the user of the product to determine, at the time of disposal, whether the product meets RCRA criteria for hazardous waste. This is because product uses, transformations, mixtures, processes, etc. may change the classification to non-hazardous, or hazardous for reasons other than, or in addition to benzene toxicity and ignitability.

REMARKS

Aquatic toxicity rating: LC50 (96 hr) = greater than 1000 ppm; relatively harmless.



PRODUCT CODE 92113
 PRODUCT NAME FUEL-GRADE ALCOHOL

Date Issued 12/15/92
 Supersedes 11/13/92

3. TRANSPORT INFORMATION

TRANSPORTATION

DOT: PROPER SHIPPING NAME: Denatured alcohol
 HAZARD CLASS: 3
 IDENTIFICATION NUMBER: NA1967, II, RQ (Benzene)
 LABEL REQUIRED: Flammable liquid
 IMDG: PROPER SHIPPING NAME: N.D.
 IATA: PROPER SHIPPING NAME: N.D.
 TDG: PROPER SHIPPING NAME: N.D.

4. REGULATORY INFORMATION

A. SARA TITLE III

Title III Section 302/304 Extremely Hazardous Substance:

Component	CAS No.	Percent	RQ (lbs)	TPQ (lbs)
NONE				

CERCLA Section 102(a) Hazardous Substance

Component	CAS No.	Percent	RQ (lbs)
Cumene	98828	< 160 ppm	5000
Methyl Tert Butyl Ether	1634044	0.10-0.99	1
Benzene	71432	<0.01	10

Title III Section 311 Hazard Categorization

Acute	Chronic	Fire	Pressure	Reactive	Not Applicable
X	X	X	-	-	-

Title III Section 313 Toxic Chemicals

Component	CAS No.	Percent
Benzene	71432	<0.01
Methyl tert-butyl ether	1634044	0.10-0.99

B. WHMIS CLASSIFICATION

NA

C. MICHIGAN CRITICAL MATERIALS

Benzene present at <0.01 %

5. OTHER INFORMATION

Texaco recommends that all exposures to this product be minimized by strictly adhering to recommended occupational controls procedures to avoid any potential adverse health effects.

THE INFORMATION CONTAINED HEREIN IS BELIEVED TO BE ACCURATE. IT IS PROVIDED INDEPENDENTLY OF ANY SALE OF THE PRODUCT FOR PURPOSE OF HAZARD COMMUNICATION AS PART OF TEXACO'S PRODUCT SAFETY PROGRAM. IT IS NOT INTENDED TO CONSTITUTE PERFORMANCE INFORMATION CONCERNING THE PRODUCT. NO EXPRESS WARRANTY, OR IMPLIED WARRANTY OF MERCHANTABILITY OR FITNESS FOR A PARTICULAR PURPOSE IS MADE WITH RESPECT TO THE PRODUCT OR THE INFORMATION CONTAINED HEREIN. DATA SHEETS ARE AVAILABLE FOR ALL TEXACO PRODUCTS. YOU ARE URGED TO OBTAIN DATA SHEETS FOR ALL TEXACO PRODUCTS YOU BUY, PROCESS, USE OR DISTRIBUTE AND YOU ARE ENCOURAGED AND REQUESTED TO ADVISE THOSE WHO MAY COME IN CONTACT WITH SUCH PRODUCTS OF THE INFORMATION CONTAINED HEREIN.

DO NOT DETERMINE APPLICABILITY OR EFFECT OF ANY LAW OR REGULATION WITH RESPECT TO THE PRODUCT. USER SHOULD CONSULT HIS LEGAL ADVISOR OR THE APPROPRIATE GOVERNMENT AGENCY. TEXACO DOES NOT UNDERTAKE TO FURNISH ADVICE ON SUCH MATTERS.

Date: 12-15-92 New Revised, Supersedes: 11-13-92
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PRODUCT CODE 92223
PRODUCT NAME FUEL-GRADE ALCOHOL

Date Issued 12/15/92
Supersedes 11/13/92

15. OTHER INFORMATION (CONT)

Inquiries regarding MSDS should be directed to:
Texaco Inc.
Manager, Product Safety
P.O. Box 509
Seacon, N.Y. 12508

PLEASE SEE NEXT PAGE FOR PRODUCT LABEL

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PRODUCT CODE 92223
 PRODUCT NAME FUEL-GRADE ALCOHOL

Date Issued 10/15/92
 Supersedes 11/13/92

16. PRODUCT LABEL

READ AND UNDERSTAND MATERIAL SAFETY DATA SHEET BEFORE HANDLING OR DISPOSING OF PRODUCT

92223 FUEL-GRADE ALCOHOL

WARNING STATEMENT

DANGER: EXTREMELY FLAMMABLE LIQUID AND VAPOR
 VAPOR MAY CAUSE FLASH FIRE
 CAUSES SEVERE EYE BURNS
 MAY CAUSE BLINDNESS
 HARMFUL IF SWALLOWED
 CAUSES SKIN IRRITATION

ATTENTION: POSSIBLE CANCER HAZARD
 MAY CAUSE CANCER BASED ON ANIMAL DATA

PRECAUTIONARY MEASURES

AVOID PROLONGED BREATHING OF MIST OR VAPOR
 AVOID CONTACT WITH EYES, SKIN, AND CLOTHING
 KEEP CONTAINER CLOSED
 USE WITH ADEQUATE VENTILATION

WASH THOROUGHLY AFTER HANDLING
 KEEP AWAY FROM HEAT, SPARKS AND FLAME

FIRST AID

INGESTION:

If patient is conscious and can swallow, give two glasses of water (16 oz.)
 Induce vomiting as directed by medical personnel. Never give anything by
 mouth to an unconscious or convulsing person.

INHALATION:

Remove to fresh air. If not breathing, give artificial respiration. If
 breathing is difficult, qualified personnel may administer oxygen. Get
 immediate medical attention.

EYE CONTACT:

Immediately flush eyes with large amounts of running water for at least 15
 minutes. Hold eyelids apart while flushing to rinse entire surface of eye
 and lids with water. Get medical attention immediately. Continue flushing
 with water for an additional 15 minutes if medical attention is not
 immediately available.

SKIN CONTACT:

Immediately flush skin with large amounts of running water for at least 15
 minutes. Remove contaminated clothing and shoes. Get medical attention
 immediately. Wash clothing before reuse. Destroy non-resistant footwear

FIRE

In case of fire, use foam, dry chemical, or CO2. Use water spray to keep
 containers cool.

Chemical/Common Name	CAS No.	Range in %
Ethyl alcohol	64175	95.00 - 99.99
Mixture containing EITHER straight chain and branched paraffinic hydrocarbons, olefins, cycloparaffins and aromatics (the benzene content normally varies from 0.2-3.5% with a typical value of 1.4%; the MTBE content varies from 0-15%) OR hydrocarbon rubber solvent (CAS# 64742896)	mixture	3.00 - 10.95

- Product is hazardous according to OSHA (1910.1200).
- Component(s) is hazardous according to OSHA or one or more state Right-to-Know laws.

HMIS

Health : 3 Reactivity : 0
 Flammability: 4 Special : -

National Fire Protection Association

Health : 3 Reactivity : 3
 Flammability: 4 Special : -

DCT Proper Shipping Name: Denatured alcohol

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PRODUCT CODE 90023
PRODUCT NAME FUEL-GRADE ALCOHOL

Date Issued 12-15-91
Supersedes 11/13/90

16. PRODUCT LABEL (CONT.)

DOT Hazardous Class 3

CAUTION: Misuse of empty containers can be hazardous. Empty containers can be hazardous if used to store toxic, flammable, or reactive materials. Cutting or welding of empty containers might cause fire, explosion or toxic fumes from residues. Do not pressurize or expose to open flame or heat. Keep container closed and drum bungs in place.

Manufacturer's Name: Pekin Energy Company
P.O. Box 10 Pekin, IL 61555

TRANSPORTATION EMERGENCY Company: (914) 831-3400
CHEMTREC: (800) 424-9300

HEALTH EMERGENCY Company: (914) 831-3400

First Aid

If swallowed and patient is conscious, induce vomiting and repeat until vomit is clear. Never give anything by mouth to an unconscious person.

If inhaled, remove victim to fresh air immediately. If not breathing, or breathing is difficult, give mouth-to-mouth artificial respiration. Oxygen may be administered by trained personnel only.

In case of contact with eyes or skin, immediately flush affected area with plenty of water for at least 15 minutes. Remove and wash clothing before re-use. Call a physician.

Safety Considerations

FLAMMABLE NATURE

Ethyl alcohol is a Class 1B flammable liquid, as defined by the National Fire Protection Association's Flammable and Combustible Liquids Code (NFPA 30).¹ Ethyl alcohol has a Tag Closed Cup flashpoint of approximately 5.4°C (42°F) (13°C). At atmospheric pressure (14.7 psia), ethyl alcohol has a boiling point of 173°F (78°C), an autoignition temperature of 793°F (423°C), and lower and upper flammability limits of 3.3% and 19%, respectively, by volume in air.²

STORAGE AND HANDLING

Because ethyl alcohol is flammable, special care must be used when working with it to insure that all sources of ignition such as heat, sparks and flames have been eliminated from the workplace. Specific guidelines governing the storage and handling of ethyl alcohol are contained in NFPA 30.

Unless they are specifically exempted, all operations in which ethyl alcohol is used should conform to these standards. In particular, all electrical wiring and electrical equipment potentially in contact with flammable vapor mixture of ethyl alcohol must be suitable for Class 1 operations, as defined by the National Electrical Code (NFPA 70). Additionally, wherever the possibility of the accumulation of flammable vapor mixtures of ethyl alcohol exists, adequate exhaust ventilation should be provided.

Properly constructed and marked safety containers should be used when transporting or storing small quantities of ethyl alcohol. Drums and other containers used for dispensing ethyl alcohol should be equipped with self-closing valves. When ethyl alcohol is being transferred between electrically conductive containers, the containers should be grounded and electrically bonded. The inlet fill pipe on ethyl alcohol storage tanks should discharge to the bottom of the tank and should be designed to minimize the liquid turbulence within the tank. Special care must be taken to insure that no possible ignition sources exist in the vapor space of an ethyl alcohol storage tank.

TANK ENTRY

Before entering any empty tank, the tank should be isolated to prevent materials from accidentally entering the tank. A qualified safety specialist should determine that the atmosphere in the tank is non-toxic, non-flammable and contains sufficient oxygen to maintain life. In the case of an empty tank that previously had contained ethyl alcohol, it is recommended that the tank be purged with steam or water. Purging the tank with air may result in the formation of a flammable gas mixture within the tank during the purging operation. Purging the tank with an inert gas may result in the atmosphere in the tank being oxygen deficient subsequent to purging.

The OSHA standard for worker exposure to ethyl alcohol is 1,000 ppm (See Health Considerations, Workplace Exposure). Precautions should be taken to ensure that workers entering tanks previously containing ethyl alcohol are not overexposed.

A tank or any other confined space in which the oxygen content of the atmosphere is or could be immediately hazardous to life or health should not be entered unless the individual is wearing either (1) a NIOSH-approved positive pressure self-contained respirator, or (2) a NIOSH-approved combination supplied-air respirator, pressure-demand type, with an auxiliary pressure-demand self-contained air supply. Before any work is to be performed within a confined space which previously contained ethyl alcohol, care should be taken to insure that a flammable vapor mixture does not exist.

SPILL CLEANUP

In the event of an ethyl alcohol spill, the affected area should be evacuated as soon as possible. All ignition sources within the area should be eliminated. The spill should be contained and, if possible, pumped into a closed container. Any spill material which cannot be collected in this manner should be absorbed using an appropriate absorbent or flushed with water to a suitable containment basin and treated in accordance with applicable local, state and federal wastewater regulations. If absorbent is used, it should be collected in liquid-tight containers and disposed of in accordance with applicable waste disposal regulations. All personnel participating in the cleanup operations should be provided adequate personal protective equipment, including impervious suits, gloves, boots and respirators. Eye protective devices, such as chemical safety goggles, should be used when necessary.

FIRE-FIGHTING

Ethyl alcohol fires should be extinguished by using dry chemical, "alcohol" foam or carbon dioxide extinguishers (these are suitable for small fires, but have a tendency to spread large spill fires, and should not be used with them). Large amounts of water can be effective as an extinguishing agent when fighting ethyl alcohol fires. It can be applied in the form of a spray to absorb the heat of the fire and to keep fire-exposed material and containers in the area adjacent to the fire cool. When following this procedure, care should be taken to ensure that the fire is not spread by the inadvertent overflowing of vessels containing ethyl alcohol.³

Health Considerations

WORKPLACE EXPOSURE

Many individuals work with ethyl alcohol in industrial settings, where they may be exposed to it by breathing the vapors, or they may experience direct skin contact.

The inhalation of excessive quantities of ethyl alcohol vapors can lead to health problems. Because of this fact, the federal government, through the Occupational Safety and Health Administration (OSHA), has established a limit on the amount of ethyl alcohol vapors to which an individual may be exposed over a workshift. The OSHA standard for ethyl alcohol is 1,000 ppm. This means that over an eight-hour workday, the average air concentration to which an employee can be exposed should not exceed 1,000 parts of ethyl alcohol vapor per million parts of air (ppm). Short-term worker exposure may exceed 1,000 ppm, provided this exposure is compensated by an equivalent level below 1,000 ppm. The average concentration to which a worker is exposed during the same workday must be 1,000 ppm or less.

Although individual susceptibilities may cause a small percentage of individuals to experience discomfort when exposed to ethyl alcohol concentrations at or below 1,000 ppm, all available evidence indicates that most workers can be repeatedly exposed to this level without adverse health effects.⁴ Under most circumstances the human body can eliminate ethyl alcohol at the same rate that it is absorbed.⁵

EXPOSURE MEASUREMENTS

The actual concentration of ethyl alcohol to which an individual is exposed can be determined by measuring the alcohol concentration in the ambient air which the individual breathes. Tests of this nature are generally conducted by professional industrial hygienists, who are trained in the recognition, evaluation and control of occupational health hazards.

ODOR THRESHOLD

The vapors of ethyl alcohol can be detected at concentrations significantly less than the OSHA standard. Ethyl alcohol's odor threshold is reportedly in the range of 10 ppm⁶ to 350 ppm⁷. At 6,000 ppm to 9,000 ppm, the odor is reportedly very intense. However, due to olfactory fatigue, even at these concentrations, continued exposure is characterized by loss of odor perception.

TOXIC EFFECTS

Acute Inhalation

Human Experience—The effects of short-term inhalation exposures to ethyl alcohol on the health of individuals have been studied extensively. In one such study,⁵ human volunteers were exposed to ethyl alcohol vapor concentrations of between approximately 5,000 ppm and 10,000 ppm for periods of up to six hours. The individuals involved reported that the alcohol exposure caused coughing and smarting of the eyes and nose. Once the individuals were removed from the ethyl alcohol environment, the symptoms were reported to have disappeared within a few minutes. Volunteers could not tolerate being exposed to vapor concentrations of approximately 20,000 ppm for even a short period.

In evaluating the results of their study, the investigators calculated that the breathing rate required for a 150-pound man exposed to an ethyl alcohol vapor concentration of 1,000 ppm to become overexposed to the alcohol vapors would have to be much higher than the breathing rate normally required for hard physical labor.

Other studies involving human inhalation exposures to ethyl alcohol are referenced for the interested reader.^{7,8} It should be noted that at least one case of fatal intoxication following ethyl alcohol vapor inhalation has been reported.⁹

Animal Testing—Several studies¹⁰ using laboratory animals to determine lethal vapor concentrations have been reported. The results of these studies are summarized in the following table.

LETHAL CONCENTRATION VALUES FOR ETHYL ALCOHOL

Species	Concentration	Time Until Death
Mice	30,000 ppm	Not Specified
Rats	10,000-12,500 ppm	21 hours
Rats	45,000 ppm	4.5 hours
Guinea Pigs	45,000 ppm	10.75 hours

Chronic Inhalation

Human Experience—There appear to be very few published reports^{7, 10, 11, 12} addressing the effects of long-term human inhalation exposure to ethyl alcohol vapors. It has been reported that an individual can develop a tolerance to repeated exposures to ethyl alcohol vapor. This tolerance is demonstrated by a slight decrease in severity and a delayed onset of overt symptoms such as headache and drowsiness.⁷ Asthma patients inhaling an ethanol mist reportedly do not show ethyl alcohol toxicity.¹¹

Animal Studies—Limited animal testing has been conducted to determine subchronic and chronic inhalation health effects.^{7, 13}

Dermal

Acute Effects—Short-term, non-repeated contact with ethyl alcohol may cause eye irritation and mild skin irritation. Ethyl alcohol also dehydrates the skin.⁹ Acute ethyl alcohol intoxication by dermal exposure is unusual, but it has been reported.^{10, 14}

Chronic Effects—Allergic contact dermatitis has been reported in some individuals repeatedly exposed to ethyl alcohol.¹⁵ As with other contact allergens, there is an initial sensitization period, after which further skin contact may result in redness or blistering.

CONTROL OF OCCUPATIONAL EXPOSURES

There are several methods which can be used to reduce industrial exposures to ethyl alcohol. In general, these methods include engineering controls, work practice controls and respiratory protection.

Engineering Controls—Wherever possible, industrial processes should be designed to prevent the release of ethyl alcohol vapors into the workplace. Where this is not possible, mechanical ventilation should be used to control and to remove the ethyl alcohol vapors from the work environment. If possible, local exhaust ventilation should be used to collect and exhaust the ethyl alcohol vapors at the point of contaminant generation. If the process or operation prohibits the use of local exhaust, then it may be necessary to ventilate the entire workplace.

Work Practice Controls—Workers can prevent unnecessary exposures to ethyl alcohol by following good work practices. These include the regular use of protective clothing (gloves, aprons, coveralls, etc.) to prevent skin contact. They may also be used when storing and transferring ethyl alcohol in closed containers, and the operation of all process equipment in such a manner as to avoid accidental or unnecessary releases of ethyl alcohol vapors into the workplace.

Respiratory Protection—If the airborne concentrations of ethyl alcohol which exist in the workplace cannot be reduced to acceptable levels, workers should be protected through the use of respiratory equipment. Care must be taken in choosing and using a respirator. All aspects of any respiratory protection program should be thoroughly reviewed and approved by a competent safety or health professional.

References

1. National Fire Codes, Vol. 2, 1980.
2. Sax, N. Irving (ed.), *Dangerous Properties of Industrial Materials*, 5th ed., Van Nostrand Reinhold Co., New York (1979).
3. Meidl, J., *Flammable Hazardous Materials*, Glencoe Press, Beverly Hills, California (1970).

SUMMARY

FIRE FIGHTING PROCEDURES

Alcohol and gasoline/ethanol blend transportation and storage has raised many questions from fire marshals and fire departments. In order to provide the most current information on fire fighting foams that will control these fires, the following reports, literature and publications are provided.

Below is a summary of recommendations based on the foam manufacturer's literature and the results of fire fighting tests conducted at Iowa State University.

I. Gasohol

A. Spill Fires: Preferred foams are polymeric "alcohol type", fluoroprotein, and AFFF in that order for permanence of blanket and security of the area. "Alcohol type" and AFFF will produce most rapid fire knock-down, while the "alcohol type" and fluoroprotein will give the best protection against reflash. Small spill fires can be extinguished with BC extinguishers.

B. Tank Fires: For over the top application use "alcohol type" foam or Light Water AFFF. For subsurface application, the "alcohol type" foam is the preferred agent.

Burn back resistance in these applications is sometimes lowered and therefore, additional foam application after fire extinguishment is recommended.

II. Alcohol

A. Spill Fires: Thin (less than one inch) spills can be controlled and extinguished by dilution with water. They can be more quickly controlled with "alcohol type" foams or dry chemical BC application. Other foams are rapidly broken down by the alcohol and the net fire control effect is primarily by dilution, not smothering.

B. Tank Fires: "Alcohol-type" foams are the only effective agents.



EXPERIMENTS CONDUCTED BY FIRE SERVICE EXTENSION IN COOPERATION WITH: ADM CORN SWEETENERS IOWA FIRE EQUIPMENT

On November 20, 1979, Fire Service Extension, Iowa State University, Ames, Iowa, in cooperation with ADM of Cedar Rapids, Iowa, and Iowa Fire Equipment of Des Moines, Iowa, conducted field research using alcohol and gasoline/ethanol blends under fire conditions at the Demonstration and Research Area. The type of alcohol employed for the fire tests was C.D.A. 19, the chemically denatured ethyl alcohol currently used in practically all of the blends in the United States. The blend was composed of 10% C.D.A. 19 and 90% unleaded gasoline, a standard formula at that time for commercial sales at service stations throughout the country. The C.D.A. 20 and fuel alcohol formulas currently marketed have similar fire extinguishing characteristics. Several extinguishing agents were used at differing rates of discharge on various sizes of flammable liquid fires. The day was overcast, with light mist and rain showers. Temperatures were in the mid to upper 30's, with a light wind blowing.

48 Inch by 44 Inch Fire Pans

The first experiments were conducted in metal pans, 48 inches by 44 inches by 12 inches, using five (5) gallons of alcohol, formula C.D.A. 19, containing 5% denaturants. The flame was light orange in color. Using a 15 second preburn to prevent excess heating of the container, a 20-pound 40 BC dry chemical extinguisher was applied for 5 seconds by a fire fighter to obtain extinguishment. The remaining fuel was reignited with various individuals using the same extinguishing agent with similar results, even after heating of the container. The only difference noted was that the vaporization of fuel on subsequent fires resulted in a flash upon approach of the ignition source.

The next experiment used five (5) gallons of alcohol in the same size containers with a 15 second preburn before application of a 2½ gallon portable "Light Water" 20 B-rated extinguisher. Two gallons were applied to obtain coverage of the alcohol in 51 seconds. Flame was detected near the hot pan walls resulting in a deterioration of the light water blanket and reignition at 2 minutes, 20 seconds from initial ignition. Several applications were made by individuals using light water with similar results.

The next fire in the same size container consisted of five (5) gallons of water mixed with five (5) gallons of alcohol. A 20-pound 40 BC extinguisher, applied after a 15 second preburn, required 2 seconds for extinguishment. The same results were obtained by several individuals using a 40 BC extinguisher.

The next experiment was performed in the same pans using five (5) gallons of water and five (5) gallons of alcohol as fuel. After a 15 second preburn, water was applied through a 1½ inch line with a 30 gpm nozzle, 30-60° fog at 100 psi. At the end of 7 minutes, 26 seconds, the fire ceased and could not be reignited with an ignition stick. This showed that the fuel had been diluted to the point where it would not reignite, or the fuel had been completely consumed.

The last series of experiments in the 48 inches by 44 inches pans consisted of five (5) gallons of a standard 90/10 blend. A 15 second preburn required a 7 second application of the 30-pound 80 BC dry chemical extinguisher by the first operator. The second operator, after reignition of the remaining fuel, took 5 seconds and the third operator required only 3 seconds.

The five (5) gallons of blend in the 48 inches by 44 inches pans required 33 seconds of application with the portable light water extinguisher and resulted in reignition along the edges of the hot container. There was a slow breakdown across the surface resulting in total surface combustion.

5 Foot by 8 Foot Containers

The next series of tests were in 5 foot by 8 foot containers. Fifteen (15) gallons of alcohol were allowed a 15 second preburn. The fire was extinguished with a 4 second application of a 20-pound 40 BC dry chemical extinguisher. The same time was required by several operators in subsequent fires using a 30-pound 80 BC extinguisher.

The next fire was in the 5 foot by 8 foot pan with fifteen (15) gallons of alcohol. A 60 gpm nozzle of water was applied until the fuel burned out.

Then, fifteen (15) gallons of blend in the 5 foot by 8 foot pan was allowed a 15 second preburn and extinguished with the dry chemical extinguishers. Several operators extinguished the blend in an average time of 10 seconds.

The next experiment of gasohol in the 5 foot by 8 foot pan was allowed a 15 second preburn and extinguished with the dry chemical extinguishers. Several operators extinguished the blend in an average time of 10 seconds.

The next experiment of gasohol in the 5 foot by 8 foot pans was with a 20 B light water portable extinguisher. This method was ineffective and the blend burned itself out.

55 Gallon Alcohol Spill

The next series of experiments consisted of fifty-five (55) gallons of alcohol spilled on the ground, resulting in a spill fire of approximately 100 square feet. The equipment used for extinguishment was a 1½ inch hose line with a 75 gpm constant gallonage fog nozzle at 100 psi and an in-line educator set at 6% for all special foam agent tests. The first extinguishing agent used was 3M Light Water A.T.C. 6-9% concentrate. Following a 30 second preburn, control was obtained after 24 seconds of application.

The next spill of fifty-five (55) gallons of alcohol was extinguished in 30 seconds using the same hardware applying National Foam's Aer-O-Water P.S.L. 3, 6, or 10% Polymeric/Aqueous Film Forming Foam Liquid. This material was designed for use on polar solvents.

It should be noted that an equal volume of agent, approximately four (4) gallons, was used in each of the above experiments and reignition was not possible. Both agents seemed to be equally effective.

Simulated Bulk Plant Spill

The final experiment was a simulated bulk plant spill fire using 700 gallons of blended product. Time was not measured for this exercise because the objective was to observe the agent reaction in and around the various tanks, valves, and other obstructions within the spill area. A simulated leak from a 1½ inch pipe was flowing during application of agent until the supply terminated which was approximately 200 additional gallons, about 3 minutes into the application phase of the agent. A 95 gpm fog nozzle was used with the in-line educator and 3M "Light Water". Back-up lines were charged and manned for use if necessary but were not turned on during the exercise. The evaluation by observers of this gasoline/ethanol fire noted no observable difference in extinguishment of the blend from the many, many previous exercises in the same area using gasoline.

Summary

Dry chemical hand extinguishers, foams, and water react the same on gasoline/ethanol blends in field usage as you presently expect to occur with gasoline. When encountering a pure alcohol fire, it should be noted that it will break down light water and possibly some of the other foams normally found in the fire station.

Special thanks go to ADM, Cedar Rapids, Iowa; Iowa Fire Equipment, Des Moines, Iowa; the Cedar Rapids Fire Department for personnel, and the many fire department individuals who were present for the tests and provided comments on their observations.

FIRE FIGHTING AGENTS

Roy F. Canavan
Rockwood Systems Corporation

Rockwood tested all its foam concentrates on a mixture of gasoline and ethanol. This paper discusses the results of those tests, offers an explanation of the results, and makes some suggestions about handling emergencies.

For years, fire fighters have relied on foam as the most dependable and predictable agent to use against gasoline fires and to secure spills against ignition. Foam's ability to deprive a fire of its essential fuel vapor and oxygen and to isolate an extinguished fire against reignition has earned it an excellent reputation among fire fighting professionals.

The recent introduction into several areas of the country of gasoline/ethanol blends has brought inquiries from fire service commanders who are aware of the effects of alcohol on standard foams and would like some guidelines for using foams on blended product fires and spills.

Fire Fighting Foam

In order to understand the potential problems of dealing with an alcohol-gasoline emergency, it is helpful to understand the nature of fire fighting foams and of alcohol. Foam is composed of innumerable air bubbles. Each bubble has a "skin" consisting of water and a minute amount of foam concentrate. By reducing the surface tension of the water, the concentrate allows a bubble to form and protects it from bursting. The bubbles are cohesive—that is, they tend to cling to each other—and are lighter than hydrocarbons, which is what gives foam its fire-smothering properties.

When foam is applied to a gasoline fire, the flames are quickly overcome, because of the opposing nature of the two substances. Gasoline is a hydrocarbon made from petroleum. Foam is primarily water. Since the two do not mix, but actively repel each other, the foam stays intact and flat on the surface of the gasoline.

Alcohol, however, is a polar solvent; it combines with water. And since it prefers to combine with water rather than with gasoline, alcohol will seek out the water in the foam, collapsing the bubbles and destroying the foam blanket. This was the concern expressed by fire commanders; since alcohol destroys foam, will the alcohol in gasoline/ethanol blends render protein, fluoroprotein, aqueous film forming, and high expansion foams ineffective against gasoline/ethanol blends?

To determine the effects of blends on the different types of foam, we ran a series of tests at the Rockwood testing laboratory—a 24-acre site not far from our manufacturing plant—where fires can be extinguished under controlled conditions. We use the test site to measure the effectiveness of our fire fighting products against new chemicals and solvents as they come on the market.

Protein Foam

We set up a series of tests in standard test pans. The gasoline/ethanol blend was ignited and allowed to burn for 1 min. before foam application was started. A foam stream was directed against the inner wall of the pan and allowed to flow onto the burning liquid surface. To have some sort of a benchmark against which to measure the effectiveness of other foams, we began the series with standard 3 percent protein foam (Rockwood 3% Double Strength), applied at a rate of 0.06 gpm ft⁻² by an aspirating nozzle. (The application rate is a testing standard well below the prescribed 0.16 gpm handline rate for use in the field).

The most dramatic difference we noted between tests involving gasoline and a blend of gasoline and ethanol was in the time it took for the foam to gain control over the burning blend. Unlike its effect on gasoline, upon which it will immediately form a blanket and then gain control, protein foam had virtually no effect on the fire for about 1 minute. After 1 minute had passed, the foam began to react normally, spreading out in a moderately thick blanket and extinguishing the fire. During the first minute, while foam was being applied without effect, the stream disappeared into the blend as soon as it contacted the liquid surface. We then applied the same type of foam to another pan of the blend to test its ability to secure a simulated spill. In this case, the fuel was not ignited. The foam blanket spread out slowly and immediately developed large, ragged tears and blisters.

When the stream was stopped, most of the blanket disappeared within a few minutes. Close inspection revealed that the bottom of the pan was covered with a milky, white substance, which was determined to be a mixture of foam solution and alcohol. The alcohol drew water out of the foam, thus destroying the bubbles. The standard foam did extinguish the test fire, although it took slightly longer than normal to do it. What was happening?

We theorize that the alcohol in the blend does indeed destroy the foam blanket by pulling water out of the bubbles so quickly that the foam appears to vanish as soon as it touches the liquid. However, there is a limit to the amount of water that alcohol can absorb before it separates out of the fuel mix and sinks with the water to the bottom of the container. Once the alcohol has been extracted this way, the fire is, to all intents and purposes, a gasoline fire and is readily extinguished by additional applications of foam. The alcohol-water mix at the bottom of the container is not flammable and poses no further hazard. The residual alcohol continues to degrade the foam blanket, so that after an extended period of time, there is the possibility of reignition. This degradation occurs at varying rates in different types of foams.

Aqueous Film Forming Foam

Next we tested aqueous film forming foam (Rockwood AquaFoam 3%), which has a good performance record against flammable liquid fires. AFFF creates a film on the surface of the burning liquid that advances ahead of the foam blanket, suppressing flammable vapors before they can escape. Developed originally for aircraft crash rescue work, AFFF has been used successfully in other applications, particularly within the hydrocarbon chemical industry.

We found that AFFF would extinguish a gasoline/ethanol blend fire almost as quickly as a gasoline fire, but it would not secure the pan against reignition as well as protein foam did. Due to the presence of residual alcohol and the fragile nature of the aqueous film, there was sufficient flammable vapor present following extinguishment to permit reignition of portions of the fuel surface.

During the tests made with an unburning blend, the alcohol was quick to destroy the aqueous film. Even after copious quantities of foam had been applied, the residual alcohol continued to attack and destroy the aqueous film. Because of the quick draining characteristics of AFFF, we decided not to recommend it as an agent to secure unignited spills.

Fluoroprotein Foam

In the next test series, we used a fluoroprotein foam (Rockwood Super Pro 3%), which is a protein foam having fluorocarbon additives. We thought the fluorocarbons might allow the foam blanket to better resist alcohol's solvent action. The test series confirmed our theory. The fluorocarbon additives slowed the rate at which the alcohol combined with water, so that there was only a slight delay in extinguishing the fire.

In the unignited spill test, the fluoroprotein foam performed much better than either the standard foam or AFFF. A torch was passed over the test pan, but there was no sign of escaping flammable vapor. After 30 minutes the foam blanket was still intact, indicating that the fluorocarbon additives made this type of foam more suitable for use on fuel spills as well as on fires. Breakdown does occur, but so slowly that it poses no real problem to the fire fighter. We suggest that sufficient fluoroprotein foam concentrate be kept on hand to deal with any fuel emergency.

High Expansion Foam

Our final test was a series of applications of high expansion foam (Rockwood Jex X) to gasoline/ethanol blends. The variations in time to start forming a foam blanket on blends compared to standard gasoline were almost negligible, and the fire was easily extinguished. Tests on unignited blends revealed that, because of large bubble structure, the foam tended to bridge the fuel surface, protecting itself from the alcohol. After 30 minutes, it was possible to see where the alcohol had ultimately attacked and destroyed the foam blanket. Deep holes to the fuel surface and holes covered by only one bubble wall were clearly visible. The foam blanket was easily refreshed, and the agent judged very effective.

Other Foams

There are, of course, specialty foams that have been developed for use on polar solvent fires. It might seem logical at first for fire companies to stock sufficient quantities of polar solvent foam concentrate to handle any potential emergency. But these foams have their drawbacks; they are expensive and frequently require special proportioning equipment or techniques, a high percentage of concentration, or special application.

Conclusions and Recommendations

One very real problem will be the inability of fire fighters to distinguish between a gasoline and a gasoline/ethanol emergency. Blends smell only slightly different from gasoline, and there is no requirement to label the two products differently. Remember, blends will take longer to bring under control. A foam blanket will not form or flow during initial application because of the effects of the alcohol on the foam.

If it is known that a blended product is involved, it might be of value in an emergency to make one or two slow sweeps with a widespread water fog patten to saturate the alcohol. If this were done while foam equipment was being set up, there would be little, if any, delay in the foam's effectiveness once the stream was started. One or two slow sweeps with the fog line should be sufficient to saturate the alcohol but should not seriously increase the size of the spill. Remember, the water will go to the bottom, displacing the blend. Too much water could cause the fire to start running. Finally, be extremely careful not to disrupt the foam blanket with a water line.

Rockwood does not, under any circumstances, recommend the use of regular foams against pure alcohol or alcohol solvent spills or fires. Polar solvent and other specialty foams were developed to deal with these situations, and they do it best. Rockwood conducted an exhaustive series of tests with gasoline/ethanol blends prior to making these recommendations.

Retail

Introduction

Sales of gasoline containing ethanol have grown dramatically in recent years. This has been due, in part, to ethanol's evolving role as a gasoline component. In the late seventies and early eighties, ethanol was merely a product extender used to stretch gasoline supplies. By the mid eighties, ethanol began to see widespread use as an octane enhancer and was added to gasoline to maintain the octane quality previously achieved by the addition of lead.

More recently, expanding sales of gasoline/ethanol blends have been driven by environmental concerns. Ethanol is an oxygenate. Oxygenates (alcohols & ethers) add oxygen to the fuel. This results in more complete combustion and lower tailpipe emissions of carbon monoxide. In the late eighties and early nineties, several areas of the county began to require the sale of oxygenated fuels during certain winter months to address their excessive levels of carbon monoxide. The success of such programs led congress to add similar requirements for all carbon monoxide non-attainment areas when they passed the 1990 Clean Air Act Amendments. These amendments required all carbon monoxide non-attainment areas to implement so called oxyfuel programs beginning in the fall of 1992. These regulations will result in the expanded use of oxygenated fuels including gasoline/ethanol blends. In fact, the only oxygenates that have seen significant use in these programs are ethanol and methyl tertiary butyl ether (MTBE). Companies select which oxygenate to use based on a number of considerations including cost and availability of oxygenates, transportation and storage considerations, and operational considerations.

While many of the characteristics of MTBE and ethanol are similar, gasoline/ethanol blends are more sensitive to water and therefore necessitate some special handling procedures. These procedures include steps at the distribution terminal, and during product transport and delivery, as well as at the retail level. Procedures at the retail level are very important and are necessary to ensure that the consumer receives the high quality product that they expect.

The extent of procedures which are the responsibility of retail personnel will vary among companies. Some companies may assign a portion of retail level tasks to maintenance or supervisory personnel while others may assign such responsibilities to store/station personnel.

This guide addresses the procedures that are typically considered retail unit procedures or considerations. Depending upon the policies and procedures of your specific company, some of the tasks covered in this guide may be assigned to someone else. If you are unclear on how any of the covered topics apply to your operation you should consult the appropriate management personnel within your company to determine their applicability to your operation.

The guidelines for implementing and maintaining a successful gasoline/ethanol blend sales program at the retail level can be divided into three phases, the Investigative/Preparatory Phase, the Conversion Phase, and the On-going Phase. Each of these phases require certain steps as set forth below.

Investigative/Preparatory Phase

Prior to converting a retail unit to gasoline/ethanol blends it is necessary to assess that units suitability for handling such products. The two major concerns in this area are determining the compatibility of tanks (or tank liners) and other materials and determining tank history for any water problems.

Tank Compatibility: Steel tanks and nearly all fiberglass tanks are compatible with gasoline/ethanol blends. In some instances, tanks may have been lined with polyester or epoxy linings to prevent leakage. Although many of these lining materials are compatible with gasoline/ethanol blends not all are. Epoxy and polyester linings which are not suitable for gasoline/ethanol blends can deteriorate resulting in degradation of the gasoline being dispensed into the automobile. If a tank was lined due to leakage, the leak could reoccur if the lining is chemically incompatible with the blend. Fiberglass tanks also must be checked for suitability for use with gasoline/ethanol blends. If it is unknown whether a tank is steel, fiberglass, or "lined", this should be determined prior to conversion, and there are tests which will help in this determination. It is imperative that the tank integrity and type be known prior to conversion to gasoline/ethanol blends. If there is any doubt regarding the suitability of a tank, contact the tank manufacturer or lining contractor prior to conversion.

Materials Compatibility: Above ground equipment such as nozzles, hoses, and meter seals have long been compatible with ethanol and should not present any need for modification. Some older submersible pumps may require modification to operate with gasoline/ethanol blends. Although this is rather rare, a determination should be made as to the compatibility of these pumps with gasoline/ethanol blends. Some units could require replacement of impellers and/or seals to avoid impeller "swell". If any doubt exists as to the compatibility of these units, the manufacturer should be consulted.

Control of Water Levels: Underground storage tanks frequently have small amounts of water at the bottom of the tanks, referred to as water bottoms. Excessive water levels can cause the ethanol in a gasoline/ethanol blend to "phase separate" resulting in a phase of water and ethanol on the bottom of the tank. Therefore, it is imperative that water be eliminated from the system. The maintenance history of all tanks to be used for storage of gasoline/ethanol blends should be reviewed. Any tank with a history of excessive water problems should be reviewed closely. The source of water entering the tank must be identified and eliminated if the tank is to be converted to gasoline/ethanol blends. If historic data is not available, it is recommended that historic data be developed and reviewed prior to conversion.

NOTE: The above items, though retail level considerations, are usually handled by company management or maintenance personnel. However the station/store manager may wish to inquire if these items have been properly considered.

If the investigative/preparatory phase indicates that the unit can be converted to gasoline/ethanol blends, the next phase is the conversion phase.

Conversion Phase

Prior to the first delivery of a gasoline/ethanol blend, several steps should be taken. These steps include the following.

1. Check to see if tanks have excessive tilt. This can usually be done by sticking opposite ends of the tank. If one end of the tank is lower, it will result in a higher stick reading than the other end. When one end of the tank is lower, water can collect at the low end and go undetected. In such cases, the

low end of the tank should be tested for water prior to the first delivery as well as on an on-going basis. Also if tanks are equipped with tank bottom protectors, it is recommended that these be removed to test for and remove water. This will ensure that all water is removed.

2. Fill line caps should be checked for proper fit and seal. Any improper fit or seal should be repaired. Man hole covers should be checked for proper water run off and modified if necessary.
3. Each retail pump or dispenser should be fitted with a 10 micron filter. Your specific company may desire to utilize a special filter such as a "water sorb" filter. You should check to determine if a special filter is to be used.

It is desirable that the filter be installed at a location prior to the dispenser meter to eliminate any suspended sediment from entering the metering device. However this is not always possible.

Important Safety Note: When a unit is equipped with submersible pumps, product flow can be activated at a dispenser even though the dispenser is not turned on. In other words, if you are changing a filter on pump A and someone turns on pump B, if pump B is connected to the same submersible pump it will activate product flow. If you have the filter off of pump A when this happens, you could be sprayed with gasoline. For this reason, pumps should be deactivated at the breaker panel when filters are being installed or changed.

4. Utilizing water paste you should test for the presence of water bottoms, If any water bottoms are present, they should be pumped off and disposed of in accordance with any federal, state, or local laws and regulations.
5. Older tanks may have a build up of "silt" or sediment on the tank bottom. In such cases it is recommended that the tank bottoms be cleaned. This can be achieved by utilizing special equipment such as a Gorman-Rupp "Tank Kleenor". Your company should be able to provide guidance as to whether or not this procedure will be necessary for your unit.
6. A few states have specific regulations regarding the conversion of retail units to dispense gasoline/ethanol blends. You should check with company management to determine if any such requirements exist for your state.
7. Prior to the first load of gasoline/ethanol blends you should be issued an ethanol compatible water paste such as "Kolor Kut" or Sargel. Once you have been issued the appropriate water paste you should discard any old paste as it may not work properly with gasoline/ethanol blends. See appendix for information on water paste.
8. Most states have labeling regulations that require labels on pumps and dispensers which distribute gasoline/ethanol blends. These requirements can vary from state to state. In most cases, labels can be obtained from your company. If not, company management should be able to provide guidance on the type of labels and proper placement. This information is also usually available through the state Weights & Measures department.

You should obtain the necessary labels and placement instructions prior to the first delivery so they can be placed on the pumps/dispensers immediately after the first delivery.

9. Accounting procedures at the time of conversion vary significantly from one company to the next. You should ensure that you have obtained and understand the proper accounting guidelines to be used at the time of conversion.

Once the above items have been properly handled, you are ready to order your initial conversion load to gasoline/ethanol blends. There are several techniques that could be utilized for your conversion deliver. The method selected by your company will depend on a number of items including the targeted blend level (i.e. 10% blend or some lower level), state and federal regulations, motor fuel excise tax, state fuel tax factors, and operational considerations.

There are basically three ways to convert to gasoline/ethanol blends. Those methods are as follows:

- A. To remove all product from the tank and replace with gasoline/ethanol blend.
- B. To order enough extra ethanol in the initial delivery to accomplish upgrading of existing inventory.
- C. To lower inventory to extremely low levels and merely begin delivery of gasoline/ethanol blends (this procedure could result in product being below targeted blend levels).

Each of the above procedures has advantages and disadvantages which in many cases are company specific. Additionally, each of the above procedures may have certain variations from one company to the next. However, once the initial delivery is scheduled, the procedures become similar if not identical.

In conjunction with your initial delivery, you should take the following steps.

1. Before the scheduled delivery, retest tanks for water bottoms. If any water bottoms are present, you should contact company management. Water bottoms should be removed prior to the initial delivery.
2. When the initial load arrives, follow normal delivery procedures. Take stick readings and pump readings so that you have an accurate inventory record at the time of delivery.
3. When you have more than one tank for a specific product and you are attempting to upgrade (up blend) product in storage, be sure the driver is putting the correct compartment into the correct tank. (Check with company management for more specific details).
4. It is recommended that pumps be shut down during the initial delivery.
5. After the initial delivery is dropped, it is recommended that a few gallons of product be run through each dispenser to ensure that it is clear and bright. Ethanol blends have a solvency effect and may loosen sediment and sludge in tanks and fill lines. Once dispensed product is clear and bright, the tank can be placed back in service. Be sure to install any required pump labels, before tank is placed back in service. Also if the octane level is different than the previous product, the octane decal should be changed to reflect the correct octane.

NOTE: You should check with company management for the exact accounting and operational procedure to be used when using product to purge lines. As an example, some companies will return purged product to the appropriate tanks and list it as a pump test. Others may have lines purged by maintenance personnel who take the product to a terminal for proper disposal.

6. Conversion loads should fill tanks to 80% of capacity. If this is not accomplished with the initial load, a second load should be brought in immediately after the initial deliver. This allows the solvent effect of the ethanol to loosen any sediment or varnish type deposits from the sides and upper portions of the tank. It is recommended that the tanks be kept as full as possible for the first seven to ten days to accelerate this process. This will result in dealing with any build up in tank bottoms during a time frame when everyone is acutely aware of the program conversion.
7. During the first forty-eight hours after delivery, tanks should be tested for water bottoms and/or phase separation once every eight hours. This should be done with a tank gauge stick and the appropriate water detection paste. If your unit is equipped with an automatic inventory measurement system and water detector alarms, you should still utilize a tank gauge stick and water finder paste as an added precaution. Be sure to use a paste designed for use with ethanol blends such as Sar-Gel (see appendix).
8. After this initial forty-eight hour period, you should utilize the tank gauge stick and water finder paste on a daily basis to detect any water bottoms.
9. At any sign of water build up, you should notify the designated personnel or maintenance contractor and have the water removed at once.

The most important step in ensuring that your ethanol blending program is a success is to eliminate any moisture from the system before it can become a problem.

10. Unless there is a problem with the tanks or lines, you should not experience any water build up after the conversion phase. Gasoline/ethanol blends will pick up and remove trace levels of water from the system thus eliminating water build up in properly maintained tanks. None the less, you should continue to monitor for water build up on a daily basis.
12. Some companies may utilize tank bottom samplers during the conversion process. These samplers help identify any build up of sludge in tank bottoms. The typical tank bottom sampler is affixed to the tank gauge stick. If your company intends to utilize such a device, they should provide instructions for its use. An illustration of Universal Valve's tank bottom sampler is included in the appendix.
14. Since ethanol loosens varnish like deposits in the tank, you may need to change pump filters once or twice shortly after your initial conversion load(s). Employees should watch for any signs of filter plugging (slow running pumps). If it is necessary to change the filter, follow the procedures mentioned earlier in this guide.
15. It is recommended that pumps/dispensers be recalibrated approximately two weeks after initial conversion. Occasionally, some meters will over dispense a small amount when first converted to ethanol blends. This should be corrected to avoid any unnecessary inventory shortage.

Ongoing Maintenance

Once through the initial two week conversion period, you should notice no difference in your day to day operations except for the need to check for water on a daily basis.

Phase Separation

If proper steps are taken to eliminate water from the storage system, you should not experience any phase separation. If excess water is introduced into the storage tank (e.g. leaving a fill cap off), phase separation could occur. This can happen because excess water can combine with the ethanol in the blend, causing it to drop out of suspension or "phase separate". When this occurs, the product separates into two phases. The upper phase is gasoline and a small amount of ethanol while the lower phase is predominantly ethanol (approximately 70%) and water (approximately 20%) plus around 10% hydrocarbons. Since tank submersibles or pumps pick up product from the bottom of the tank, it is this mixture that would be dispensed into the vehicle. Obviously, vehicles cannot operate on such a blend, so if you experience a phase separation, all dispensers supplied from that tank must be deactivated immediately. The appropriate company representatives should be notified. Since a portion of the phase separation contains some level of hydrocarbons, federal regulations require that they be treated as a hazardous substance. Their handling and disposal is therefore subject to some very specific requirements.

Gasoline Ethanol Blend Program Station/Store Operator Checklist

Investigatory/Preparatory

- 1. Verify tank material compatibility. Also submersible pumps.
- 2. Investigate tank water problems and correct. Review history of water problems and initiate any necessary corrective action.
- 3. Tight seals on fill caps and proper water run off from an hole covers.
- 4. Remove water bottoms (if present). Check for tilted tanks.
- 5. Clean tank bottom, if necessary.

Conversion Plan (before first delivery)

- 1. Equip pump or dispenser with 10 micron filter. (or "water slug" filter)
(Remember - SAFETY FIRST - SHUT OFF BREAKER)
- 2. Recheck for water bottoms and remove any present.
- 3. Issue alcohol compatible paste. Discard old pastes.
- 4. Procure proper pump labels.
- 5. Confirm any applicable accounting procedures.

First Delivery

- 1. Check for water. Water bottoms must be removed before first delivery of ethanol blends..
- 2. Follow normal delivery procedures and ensure that accurate stick and pump readings are taken.
- 3. Verify (with transport driver) correct compartment for correct tank.
- 4. Pumps should be shut down during initial delivery. (check policy)
- 5. Purge lines from tanks to dispensers. (check policy)
- 6. Install required decals and if necessary change octane decals.
- 7. Fill tanks to 80% of capacity. Keep as full as possible for 7 to 10 days.
- 8. Test for water bottoms every 8 hours for the first 48 hours after initial delivery.
- 9. Check for water bottoms daily.
- 10. Notify designated personnel if water is detected and have it removed at once.
- 11. Replace filters if pump/dispenser is running slow.
- 12. Check pump calibration two weeks after initial load(s).

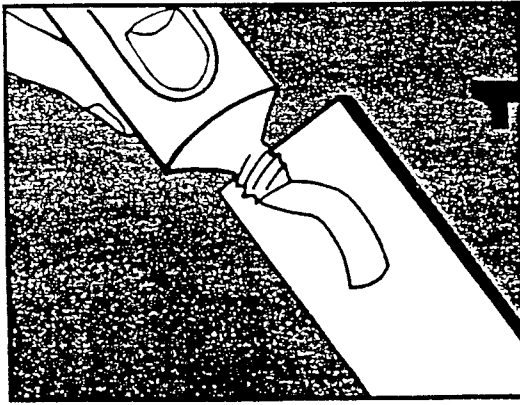
Ongoing Maintenance

- 1. Check for water. No level is acceptable.

Retail Appendix - Section VII

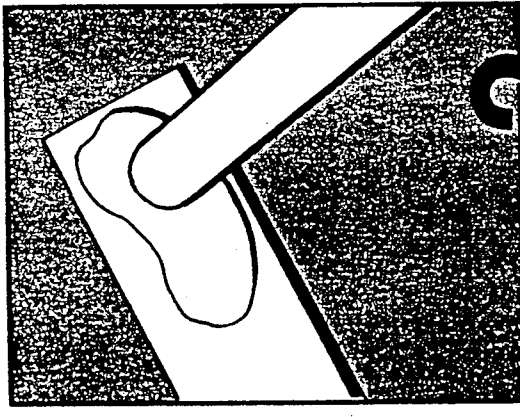
- SarGel Water Indicating Paste
- Tank Bottom Sampler

Fast, reliable way to detect water in fuel tanks



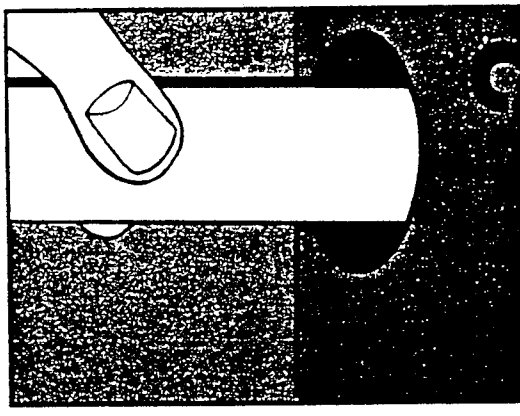
1.

Apply small amount of SAR-GEL paste to end of dip stick.



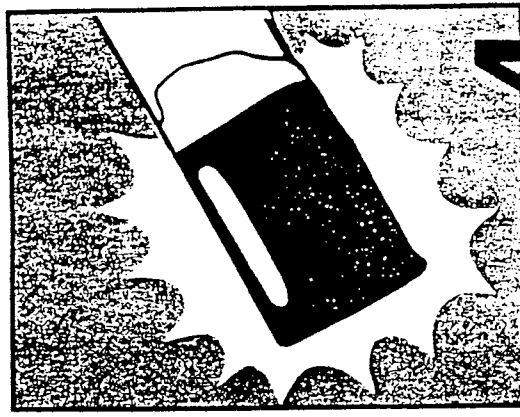
2.

Spread over surface.



3.

Insert dip stick in tank for 10 seconds.



4.

Presence of water indicated where SAR-GEL paste turns bright red.

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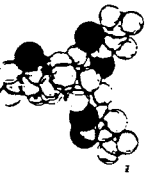
Water Indicating Paste

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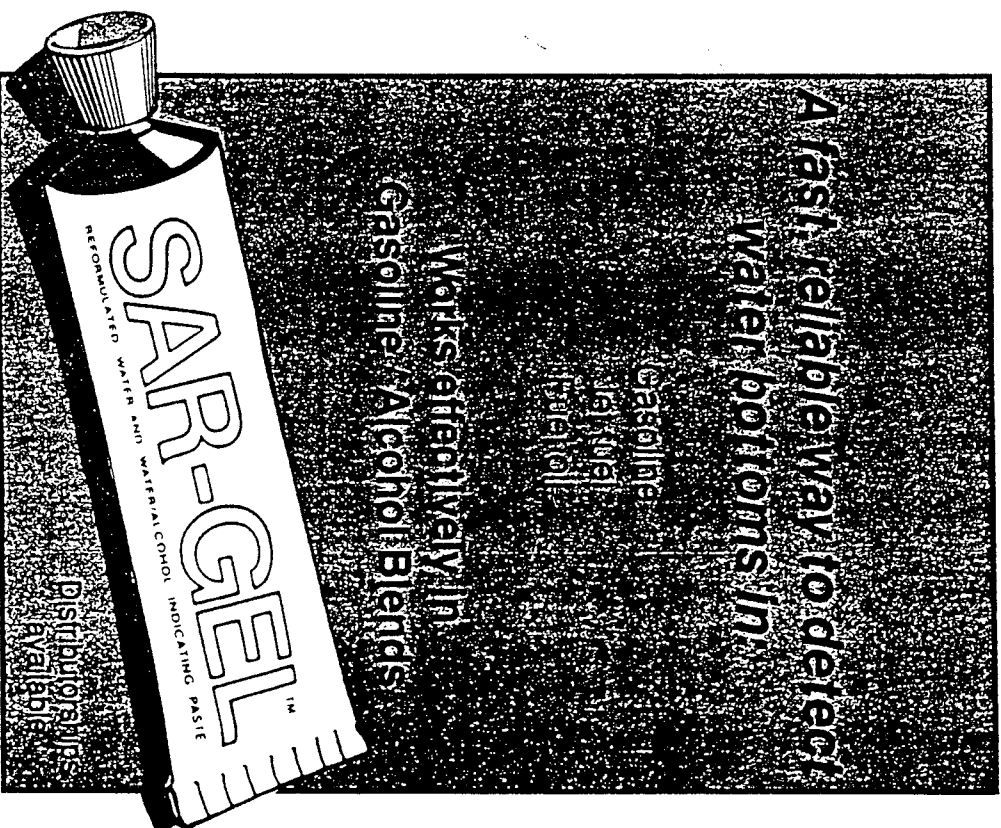
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Consumer Information

In many areas of the country, gasoline/ethanol blends are well established and are a normal part of the product mix. In these areas, consumers are familiar with the product, have few concerns about it, and in fact, may prefer it over non-blended fuels.

In areas where the product is new, consumers may have questions about what they deem to be a new or different fuel. Some of the typical questions/comments and appropriate answers/responses are as follows.

Q. Will my car operate any differently on gasoline/ethanol blends?

A. Most motorists will notice no differences, some may actually notice improved performance.

Q. Why have you added ethanol to your gasoline?

NOTE: The appropriate response should be prepared by management or public relations for your company. Some ideas are as follows:

A. Ethanol is an octane enhancer and is used to maintain (or improve) the octane quality of the fuel. It also adds oxygen to the fuel which can improve combustion thereby lowering carbon monoxide emissions. The U.S. EPA has mandated that certain areas of the country utilize oxygenated fuels including ethanol blends, during winter months, to reduce carbon monoxide emissions. It is also domestically produced, reducing our dependence on foreign oil by utilizing agricultural crops which are in excess.

Q. Will my car require any adjustment to operate on gasoline/ethanol blends?

A. Automobiles sold in the U.S. should be able to utilize the fuel without any adjustment.

Q. I've heard this fuel will damage metal and rubber components in the fuel system. Is this true?

A. While some alcohols such as methanol can cause such damage, this is not true with ethanol. Ethanol is no more aggressive to these fuel system parts than many other fuel components. There have been a number of test programs which indicate that properly formulated gasoline/ethanol blends present no special concerns in this area.

Q. Do the auto manufacturers say its OK to use ethanol?

A. Every major automobile manufacturer selling vehicles in the US indicates that gasoline/ethanol blends are acceptable for use in their vehicles. They will not void any applicable warranties. In fact, some manufacturers, including General Motors and Chrysler, recommend the use of properly formulated gasoline/ethanol blends and other oxygenated fuels.

Q. What is ethanol?

A. Ethanol is grain alcohol and made from agricultural products, primarily corn. The manufacturing process is similar to making beverage alcohol except all moisture is removed to improve product quality for automotive applications. Ethanol is the same alcohol contained in alcoholic beverages. Ethanol should not be confused with other alcohols such as methanol. Their chemical properties are different and unlike ethanol, some other alcohols are not as suitable for gasoline blending.

- Q. Are there any quality controls on this blend or the ethanol it contains?**
- A.** There are product specifications and standards for both the ethanol, the gasoline to which it is added, and the resulting blended product. These standards and specifications along with appropriate blending procedures ensure that you will be receiving a high quality product.
- Q. Will ethanol effect my fuel injectors (carburetor)? Does it cause fuel system deposits?**
- A.** Ethanol will remove deposits that build up in the fuel delivery system. As with other gasolines, it is necessary to add a detergent to prevent deposits in carburetors and fuel injectors.
- Q. What about engine deposits?**
- A.** As with other gasolines, ethanol blends must be treated with a deposit control additive to minimize valve deposits. In the combustion chamber, gasoline/ethanol blends burn more completely and may reduce combustion chamber deposits.
- Q. I've heard that ethanol causes vapor lock?**
- A.** No one ingredient in gasoline causes vapor lock. This is controlled by finished product specifications. Fuels of too high a volatility cause vapor lock. Vapor lock is primarily a spring/summertime problem. During this period gasoline including gasoline/ethanol blends are now required to be of lower volatility than in the past. This has nearly eliminated fuel related vapor lock and hot driveability problems.
- Q. Is the octane of this fuel higher or lower?**
- A.** The minimum octane is posted on each dispenser. Product octane will be adjusted to, at a minimum, meet the posted octane.

NOTE: Additional information is included in the manual, "Changes in Gasoline II - The Auto Technician's Gasoline Quality Guide" which is contained in the "Miscellaneous Information" section of this program guide. In addition, the appendix to this section contains various consumer pamphlets which have, in the past, been used to provide consumer information. Some of these pamphlets are now several years old. They have been prepared by a variety of sources. No representation is made as to their technical accuracy. They are provided solely as an example. If you wish to develop a similar brochure, it is recommended that you address any questions regarding its preparation to your ethanol supplier or a member of the RFA Technical and/or Market Development Committee(s).

Retail Appendix - Section VII

- Retail Brochures

and create a need for frequent oil changes. So you see, substituting ethanol for lead is good news for your car . . . and you.

Q. All right, but I've heard ethanol makes cars harder to start in the winter.

A. The ethanol recommended for use in motor fuels is an anhydrous or water free additive, and by absorbing moisture it helps prevent gas line freeze up in cold weather. It works much the same as gas line anti-freeze some motorists add to their gas tanks in the winter.

Q. Are you aware of any test of ethanol blends?

A. Yes, a major refiner, Texaco, ran one fleet of company cars on ethanol fuel for their entire useful life. The engines were then torn down. Inspectors found these engines were cleaner than engines from other cars run on straight gasoline.

In addition, Ashland Oil Co. reported at a recent petroleum conference their findings with regard to a 50,000 mile two-year study on ethanol blends. The following quote summarizes the report

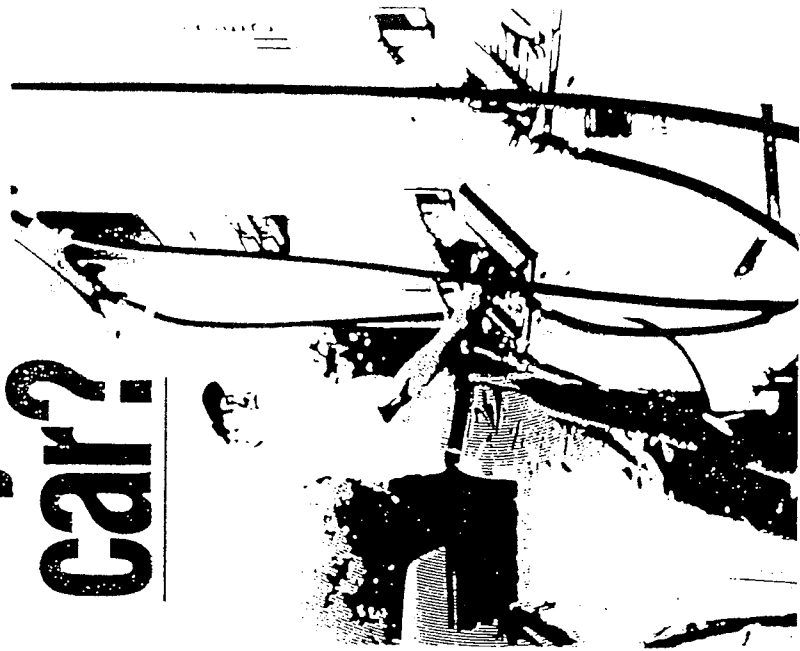
"Both test vehicles showed little or no depreciation in overall driveability. Experienced raters evaluated vehicle driveability during baseline conditions and again after 50,000 miles. During the two years of operation, all vehicle drivers were required to complete daily driveability records. Vehicles had acceptable cold engine performance, smooth idle quality, and good to excellent engine operation. At no time during the test did either vehicle experi

involving the two vehicles fueled by ethanol-extended fuel provided encouraging data in support of ethanol-extended gasolines as satisfactory motor fuels. In these vehicles, materials compatibility and driveability were very satisfactory."

Q. Has anybody else done any testing?

A. Well, the American Institute of Chemical Engineers compared ethanol fuel to straight gasoline. In a published report, the Institute said ethanol was, "Very similar in driving characteristics to straight gasoline, except that pre-ignition and dieseling (run-on) are noticeably reduced and acceleration can be improved" with ethanol. The report continued, "Ethanol should be looked on as an octane enhancer. Mixing it with gasoline in 9-to-1 ratio improves octane rating about three octane numbers."

HOW WILL ETHANOL affect my car?



2000 Pennsylvania Ave. S.E. Washington, D.C. 20003

Here are the facts on ETHANOL!

There have been many conflicting reports about ethanol fuels. In too many cases, ethanol has been the scapegoat — blamed for all sorts of unrelated problems. If as some believe, experience is the best teacher, then consider this:

1. Last year 7½ percent of all gasoline in the United States contained ethanol.
2. Over the past eight years, 25 billion gallons of ethanol blends have been consumed in the United States.
3. With average mileage of 18 mpg, that is over 450 billion miles of proven experience.
4. In many markets ethanol blends make up 50 percent of the available gasoline.

Today we have the evidence and experience to support these facts: Ethanol fuel is good for your car, your bank account, your country, and our environment. In short, ethanol is the fuel additive of the future, here to serve you today.

Q. How do car manufacturers feel about the use of ethanol under their warranty terms?

A. Every auto manufacturer in the world encourages use of 10 percent ethanol blends

engines, will ethanol help?

A. The ethanol industry is responding to the auto industries request by adding gasoline detergents to their ethanol. When the ethanol is added to the gasoline the resulting blend will provide an adequate level of detergent to keep your fuel injection system or carburetor clean.

Q. Some people say ethanol cleans a car's engine . . . others say it damages carburetors and other parts. Who's right?

A. Part of the confusion arises because there are two types of alcohol. Ethanol and methanol. Ethanol is made from grain and is safe. Methanol, commonly known as wood alcohol, is made from natural gas and is quite another matter. It can pose a potential problem in vehicles when added to gasoline at higher than 5 percent rate. Also, methanol should be accompanied by a cosolvent to prevent corrosion and separation in the fuel tank.

Q. Okay, but how do I know which one I'm getting when I fill up?

A. Many of the major refineries and independents now offer ethanol blended fuels. These fuels are customarily identified at the pump, or ask your station manager.

Q. I thought ethanol was only blended with gasoline in a few midwestern states.

A. At one time, yes. However, over the past eight years ethanol blends have become popular nationwide.

Q. For what reason?

A. Because ethanol, which is both a fuel extender and an octane-enhancer, is an ideal replacement for lead. At the 10 percent level

Q. I understand leaded gasoline is being phased out to help control air pollution?

A. Yes, as of January 1, 1986, the allowable amount was reduced to only one-tenth gram per gallon, with total elimination of lead proposed by 1988. This move by the EPA is creating a large demand for ethanol as a clean burning octane enhancer.

Q. Then ethanol definitely helps reduce air pollution?

A. Yes, there is a significant reduction in both carbon monoxide and hydrocarbon tailpipe emissions when ethanol is used. In fact, to help meet federal clean air standards, Colorado is considering a program to encourage 100 percent use of ethanol blends in the state's front range area, including Denver. Other cities also not in compliance are closely following Colorado's action. For the nation, ethanol fuels offer the promise of significantly cleaner air. Along with the conservation of natural petroleum resources. And an abundant new source of energy for the future?

Q. If ethanol is so clean, how can it foul fuel filters?

A. Ethanol, as such, is not the problem. What happens is that over a period of time regular gasoline will leave a deposit of varnish-like residue in the fuel system. Ethanol helps clean out this deposit, as well as dirt and grime, and these particles may get trapped in the fuel filter.

Q. How about spark plugs? I've heard that ethanol can cause fouling.

A. Wrong! As for fouling, lead and its

**ONLY ONE OF THE CLEANER
BURNING FUELS AVAILABLE
TO YOU THIS WINTER CAN MAKE
ALL THESE CLAIMS:**

ETHANOL

1. Over 650 million gallons already sold in Colorado.
2. Nationwide, the fuel used for over 500 billion miles of driving by consumers like you.
3. Approved in every new car warranty.
4. Contains detergents to keep fuel injectors clean.
5. Marketed by major and independent marketers today.
6. Reduces CO by up to 30%.
7. Cost competitive with today's gasoline.
8. Made from domestic renewable resources.

**ETHANOL Lets You Clean Your
Air With Confidence**

CLEANING YOUR AIR WITH CONFIDENCE

ETHANOL

COLORADO

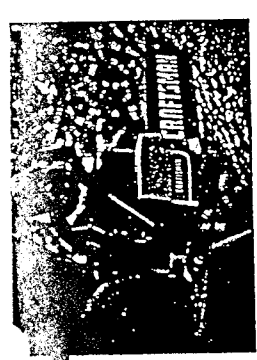
BROUGHT TO YOU BY THE RENEWABLE FUELS ASSOCIATION





Ethanol is the "Clean Air Gasoline"

Ethanol contains oxygen. When blended with gasoline, it promotes better combustion in your car's engine to dramatically reduce carbon monoxide tailpipe emissions by up to 33%. The use of ethanol means we breathe cleaner air.



"Years ago, Sears buyers began to demand that their products tolerate ethanol-blended gasoline."

"Proper ethanol gasoline blend ratios (up to 10% ethanol) will not adversely affect engine performance. Present Sears products are capable of operating on 10% ethanol alcohol blends without harm to internal components."

Thomas B. Sweeney
Sears Merchandise Support Group

The Toro Company strongly recommends the use of fresh, clean, unleaded regular grade gasoline containing no more than 10% ethanol in this model 26624 self-propelled walk power mower.

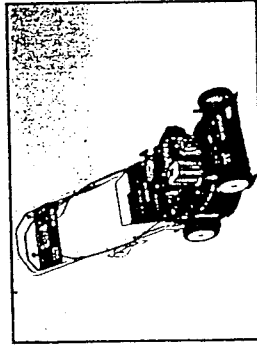


Photo courtesy of Toro Company

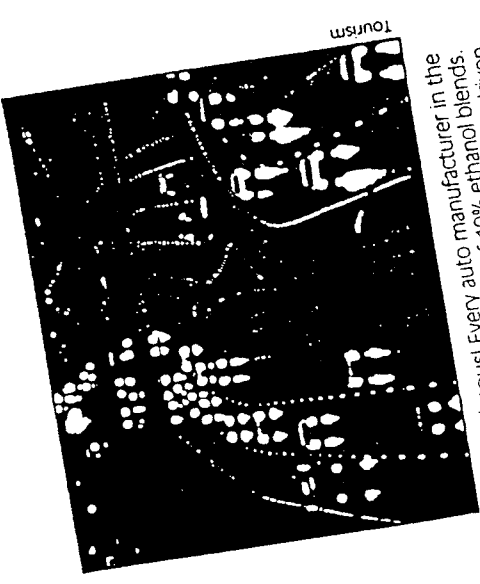
The John Deere model 240 lawn and garden tractor is powered by a 14-hp 4-cycle engine that can be fueled by gasoline blended with a maximum of 10% ethanol.



Photo courtesy of John Deere

MINNESOTA ETHANOL COMMISSION

Brought to you by the Minnesota Ethanol Commission.



It's unanimous! Every auto manufacturer in the world approves the use of 10% ethanol blends. More than 650 billion miles have been driven trouble-free nationwide on ethanol-blended fuels in the last 10 years.

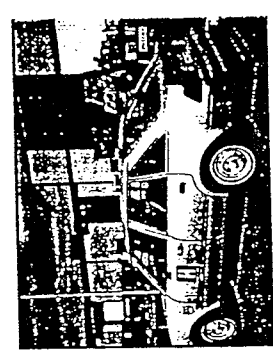
United Power Association



Throughout Minnesota, public and private sectors have responded to the benefits of ethanol by running their fleet vehicles on ethanol-blended fuels.

United Power Association of Elk River runs all 90 of its gasoline-pow-

Hennepin County



Hennepin County has one of the most impressive fleet programs in the country. In its first 5 years, it has used 891,000 gallons of ethanol-blended fuel in all types of vehicles under every weather extreme. The more than 13 million vehicle miles driven in this

WINTER

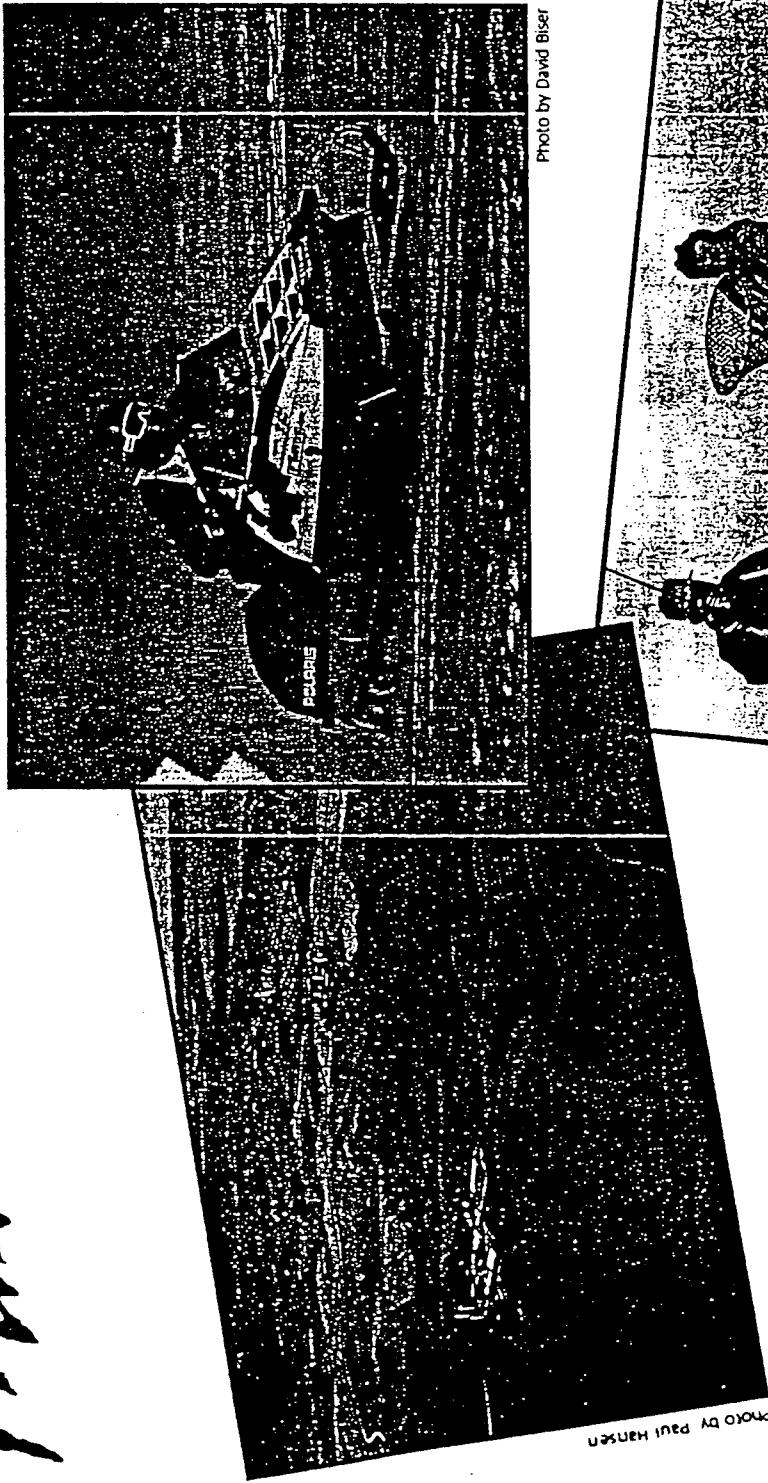


Photo by David Biser

Ethanol Team Northway races its Polaris snowmobiles to victory on ethanol blends. High octane and protection from gas line freeze are a winning combination, outperforming other fuels in grueling competition during severe Minnesota winters.

Using ethanol-blended fuel since 1987, driver Greg Walter stated: "given a side-by-side choice, the other drivers and I definitely would choose ethanol blends over non-blended fuel."

Ethanol, the product of Minnesota's tremendous agricultural capacity, promises to lessen our dependence on imported oil — and keep our money at home.

Ethanol Is the Performance Choice . . .

- it replaces lead as an octane enhancer. A 10% ethanol blend will increase gasoline octane by as much as 3 points, making it a natural choice for today's lead-free, high performance fuels.
- it cleans fuel systems. Ethanol and its detergent additives help keep fuel injectors and your car's entire fuel system clean.
- it's a natural de-icer. Ethanol absorbs moisture in gasoline, providing extra protection for winter driving. It works much the same as the gas line anti-freeze some motorists add to their gas tanks in winter

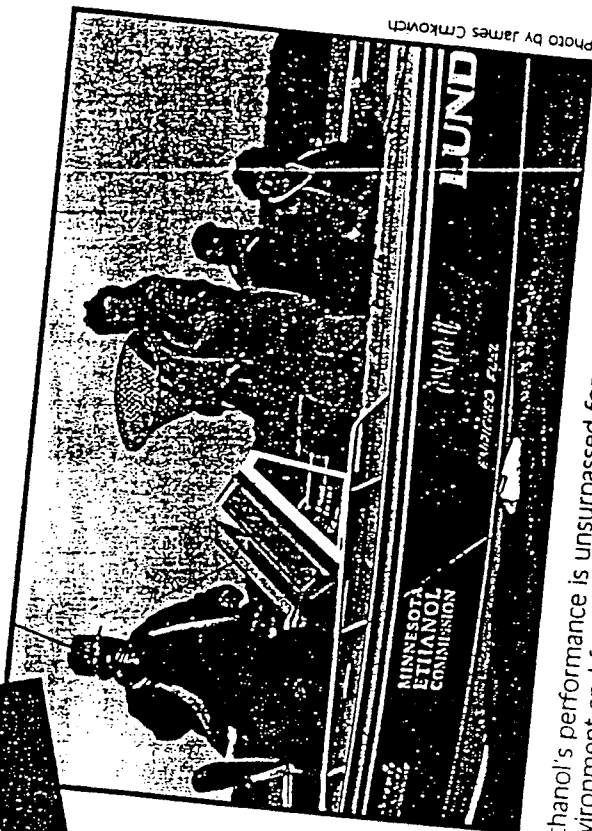


Photo by James Cmkovitch

"Ethanol's performance is unsurpassed for cars, for agriculture, for the environment and for Minnesota's economy. Ask for it . . . you can't buy a better fuel!"

Governor Rudy Perpich

Governor Rudy Perpich demonstrates his commitment to ethanol and to Minnesota energy at the Governor's Fishing Opener. This ethanol-powered Lund boat provided smooth sailing even in roughest waters.

In 1983 Governor Perpich's first executive order placed Minnesota's State fleet vehicles on ethanol blends. Since then, over 100 million miles have been driven by State fleet vehicles on ethanol blends with excellent engine performance.



Photo by Kay Kruse

have been shown to reduce engine emissions of pollutants and to improve engine motor fuel mileage at a cost that is low. To date, American motorists have driven over 800 billion miles on ethanol-blended fuels and every major manufacturer in the world provides warranty coverage for both premium and demand fuel.

Worldwide, a long list of auto manufacturers — such as General Motors and Chrysler — are also encouraging the use of gasoline with ethanol, because of their clear commitment to safety and superior performance. More than just an automotive fuel, ethanol blends have been proven performers in small, two-cycle engines which power many of the tools used around our homes. A recent test of 11 two-cycle engines using ethanol blends found that after more than 1300 hours of rigorous operation, not a single fuel-related problem was detected. Furthermore, among the manufacturers and distributors who include ethanol blends in their warranty coverage are: Sears, Evinrude, Briggs & Stratton, Tecumseh, Skidoo, Polaris, John Deere, Lawn Boy.

"The use of oxygenated materials in gasoline can also contribute to cleaner air, especially in those parts of the country where carbon monoxide and ozone levels are high. Where available, General Motors recommends use of oxygenated fuels such as ethanol in gasoline."
General Motors Auto Warranty (1990)

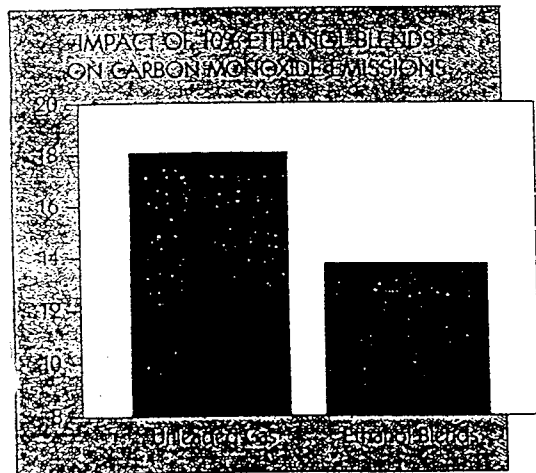
"In some areas of the country where carbon monoxide levels are high, gasolines are being treated with oxygenated materials such as MTBE and ethanol. Chrysler Motors supports these efforts toward cleaner air. You can help by using these blends as they become available."
Chrysler Corporation Auto Warranty (1991)

ETHANOL: THE CLEAN AIR FUEL

On November 15, 1990, President George Bush signed into law the Clean Air Act Amendments of 1990. This new legislation has recognized the significant clean air benefits of oxygenated fuels — such as ethanol — for our nation's most polluted cities.

Ethanol blends have a number of air quality and public policy benefits. Because of ethanol's high oxygen content, its ability to reduce carbon monoxide levels is greater than other oxygenates. The U.S. EPA, in fact, has determined that ethanol blended fuels reduce carbon monoxide emissions by some 25-30%!

In addition, the U.S. EPA has concluded that ethanol blends will dramatically reduce hydrocarbon



emissions thereby reducing the formation of ozone. Thus, in the effort to reformulate gasolines, ethanol and ETBE will help to produce cleaner gasoline by effectively and safely replacing dangerous aromatic octane compounds found in today's gasoline.

Recent technical studies have also found that ethanol is the only motor fuel which will not exacerbate the "Greenhouse Effect" but rather helps reverse the global warming currently threatening our environment.

While many environmental solutions have been proposed for the future, ethanol is here today. And, as a result of the new Clean Air Act, our automobiles will be fueled in the 1990's by cleaner fuels.

With the resulting increase in the use of oxygenates — such as ethanol blends, ETBE and E-85 fuels — Americans across the country will begin to enjoy cleaner, safer air while also reducing our dependence on imported oil.

PROTECTING OUR ENERGY SECURITY

The Persian Gulf crisis has again shown our nation's overwhelming dependence on imported oil. Fortunately, however, the production of ethanol can help reduce our reliance on these unreliable sources. Statistics have shown that one of the most successful energy independence programs to emerge from the crisis of the 1970's is the development of alternative fuels, such as ethanol, from home-grown agricultural feedstocks. One acre of corn, for example, produces the equivalent of 10 barrels of oil and 21 gallons of corn-derived ethanol displaces one barrel (42 gallons) of imported oil. In 1990 alone, the 900 million gallons of ethanol produced reduced U.S. oil imports by more than 42 million barrels of crude oil!

A firm commitment to alternative fuels can temper our dependence on foreign oil and protect our energy security by utilizing our own domestic, renewable fuel sources.

RENEWABLE FUELS ASSOCIATION
 One Massachusetts Avenue, N.W.
 Suite 820
 Washington, D.C. 20001
 Phone: (202) 289-3835

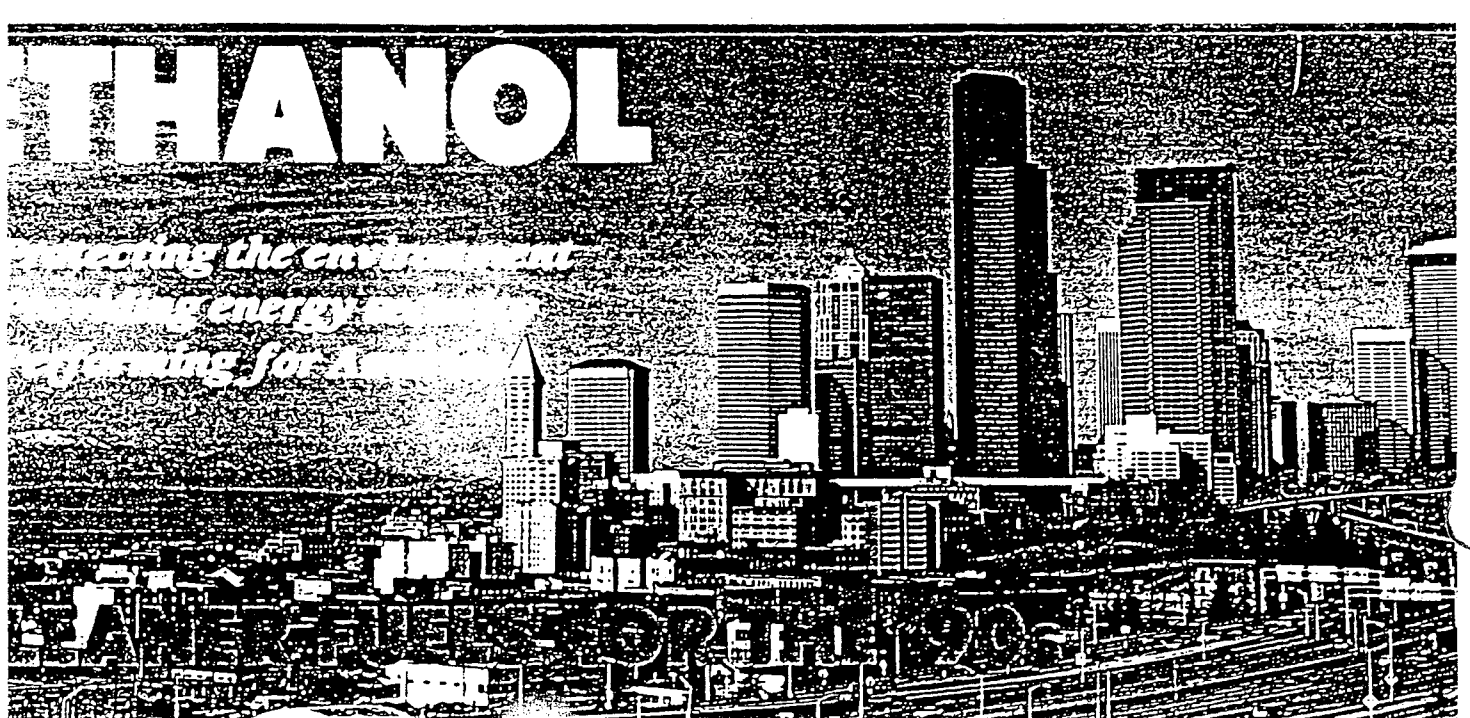
A 1990 General Accounting Office study found that ethanol fuels, produced from surplus grain, would save federal taxpayers between \$480 and \$610 million annually because of reduced farm program costs resulting from the increased demand for grain. According to The National Advisory Panel on Ethanol Cost-Effectiveness, each billion gallons of ethanol production increases employment by more than 4400 farm jobs and 3700 industrial jobs. Ethanol production increases the export of co-products — such as corn gluten. In 1989, corn gluten exports exceeded \$700 million. The combination of reduced oil imports and increased corn gluten exports could reduce the U.S. trade deficit by more than \$5 billion.

ETHANOL PERFORMS FOR AMERICA

ETHANOL

*Protecting the environment
 Making energy security
 Beginning for America*

AMERICAN ETHANOL



ETHANOL BLENDED MOTOR FUELS Provide Improved Quality, Higher Octane And A Cleaner Environment.

Q. Does an ethanol additive improve the octane and performance of the gasoline it is blended with?

A. Yes, 10 percent ethanol added to gasoline will increase the octane of the blended fuel by two to three octane points, eliminating the pinging and run on associated with lower octane fuels. Ethanol is an ideal replacement for lead as an octane enhancer and is often blended into the new midrange and premium leadfree grade gasolines to improve their octane level.

Q. Do domestic and foreign car makers approve ethanol blends under their warranty terms?

A. Yes, every automaker in the world allows the use of 10 percent ethanol gasoline blends under their warranty coverage.

Q. Are ethanol blends that contain fuel system detergents approved for use in the new fuel injected automobiles?

A. Yes, in fact, a recent General Motors Technical report suggests their new car buyers use only gasoline or ethanol blends that contain fuel detergent additives.

Q. Is it true that ethanol blends with detergent additives will clean up my car's fuel system?

A. Yes, regardless if your car is fuel injected or not, ethanol blends with detergent will clean up the varnish-like deposits and other dirt and grime in your car's fuel system and improve the performance of your automobile. As a routine maintenance procedure you may want to replace your car's fuel filter if you have an older car or an extremely dirty fuel system.

Q. Have there been any qualified tests of ethanol blends?

***A.** Yes, a major refiner, Texaco, ran one fleet of company cars on ethanol fuel for their entire useful life. The engines were then torn down. Inspectors found these engines were cleaner than engines from other cars run on straight gasoline.

In addition, Ashland Oil Co., reported at a recent petroleum conference, their findings with regard to a 50,000-mile, two-year study on eth-

anol blends. The following quote summarizes the report.

"Both test vehicles showed little or no depreciation in overall driveability. Experienced raters evaluated driveability during baseline conditions and again after 50,000 miles. During the two years of operation, all vehicle drivers were required to complete daily driveability records. Vehicles had acceptable cold engine performance, smooth idle quality, and good to excellent engine operation. At no time during the test did either vehicle experience performance problems.

"Overall, the results of this 50,000-mile test, involving the two vehicles fueled by ethanol-extended fuel, provided encouraging data in support of ethanol-extended gasolines as satisfactory motor fuels. **In these vehicles, the materials compatibility, and driveability were very satisfactory.**"

* - Detailed test results are available upon request

Q. Has there been a survey of consumers who have used ethanol blends for several years?

A. Yes, consumers in Iowa, where ethanol blends have been available for over eight years, were surveyed on their cars' performance in mileage, warm up, acceleration, pinging, and run on. The results were that 95% of the drivers using an ethanol blend **reported better or no change in vehicle performance.**

Q. I've heard that ethanol blended fuels can make my car easier to start in the winter, is this true?

A. Yes, ethanol is a water free additive and will absorb the moisture it comes in contact with. It works much the same as the gasoline antifreeze some motorists add to their gas tanks in the winter time.

Q. Do ethanol blends really help to reduce air pollution?

A. Yes, there is a significant reduction in both carbon monoxide and hydrocarbon tail pipe emissions when ethanol is used. In fact, to help meet federal clean air standards, Colorado is considering a program to encourage use of ethanol blends in the state's front range area, including Denver.

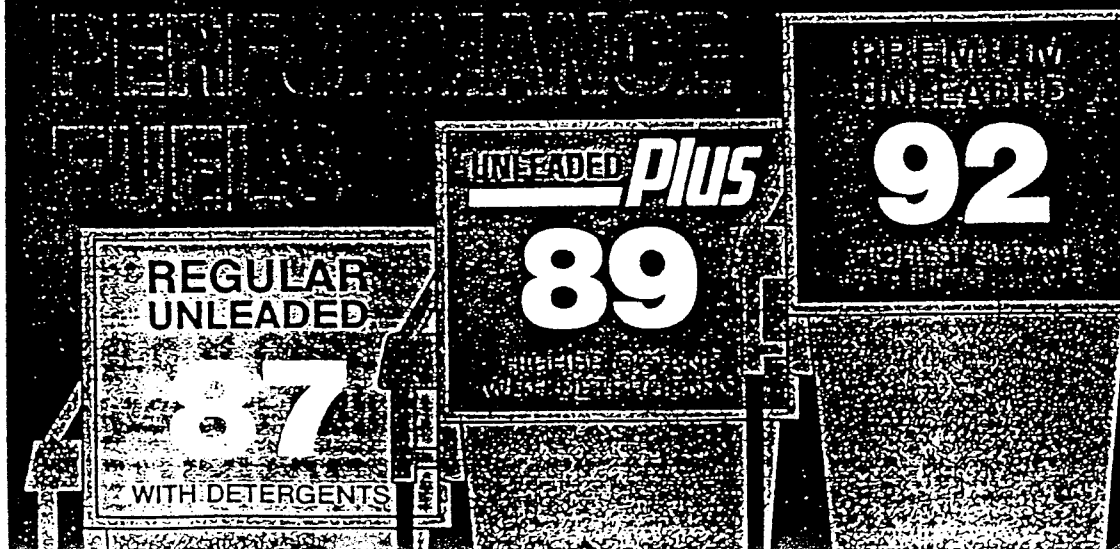
ETHANOL'S ROLE IN TODAY'S PERFORMANCE FUELS

1. Ethanol and reduces pinging and run on
2. Ethanol blends are in the world
3. Ethanol blends are recommended by G.M. for their fuel injected cars
4. Ethanol blends have been and are performance proven
5. Ethanol blends have fueled consumer's automobiles for
6. Ethanol blends by reducing deadly carbon monoxide emissions

201 Massachusetts Ave., N.E., Washington, D.C. 20002, Phone (202) 543-3802



ETHANOL'S ROLE IN TODAY'S



**THEIR
FUTURE IS
UP IN
THE
AIR...**



BUT ETHANOL IS MAKING IT A LOT MORE CLEAR

The first year Colorado instituted the Oxygenated Fuels Program was the winter of 1987-88 and dramatic reductions in CO levels were evident: by 1982 the average high pollution day reached over 2008 tons of CO in the air; in 1987 it registered 1563 tons.

The 1989-90 high pollution season in Denver saw a 10% decrease in CO levels through the use of ethanol. The Colorado State Health Department's Pollution Control Division credits the use of oxy fuels with a 10% to 15% decrease in CO levels. Due mainly to the oxy fuels program, the city of Denver has gone from the top of the CO pollutant list to number seven. Other cities such as Phoenix, Las Vegas, Reno and Albuquerque are following Denver's lead by adopting similar programs.

Ethanol — the renewable fuel made in America removes more CO from the air than any other oxy fuel blend. Ethanol is helping clear up our future and making our air as clean as it was — once upon a time.

est carbon monoxide levels. Major cities along the front range of the Rockies, such as Denver, EPA's carbon monoxide levels — posing a significant health hazard to the public.

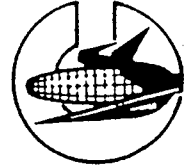
After 18 months of extensive study, Colorado pinpointed the major source of the problem and came up with a solution that gave everyone who drives a car an opportunity to improve air quality without changing their lifestyle. During the winter months all gasoline stations in high pollution areas were required to offer oxy fuels to customers. By establishing a level of 2% to 3.7% oxygen by weight in the fuel, carbon monoxide (CO) emissions could be cut significantly. Ethanol with 3.7% oxygen was shown to reduce CO exhaust emissions between 24% and 34% depending on the type of emission equipment on the vehicle. Other advantages were also evident; ethanol blends were shown to be an important octane enhancer and valuable in extending supplies of gasoline — lessening our dependence on foreign oil sources.

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Ethanol — the renewable fuel made in America removes more CO from the air than any other oxy fuel blend. Ethanol is helping clear up our future and making our air as clean as it was — once upon a time.

Presently, at least 60 U.S. cities are seeking solutions to health hazards caused by automobile exhaust pollution. Cleaning up our environment has become a national priority and many cities are initiating oxygenated fuels programs. A national study on public perceptions of oxy fuels showed that the gasoline and oxygen blends are gaining widespread public acceptance and that individuals are ready to do their part to improve the quality of our air. Nearly eight out of ten Americans said it would be their preference to purchase gasoline from a pump labeled "Contains Ethanol for Clean Air," assuming price is not a factor.

The same number said they would favor a mandatory program to reduce auto emissions through the sale of oxygenated fuels and that they believe it is their responsibility to participate in clean air programs.



COLORADO CORN
Administrative Committee
5500 S. Quebec St.
Suite 114
Englewood, CO 80111
(303) 740-4328

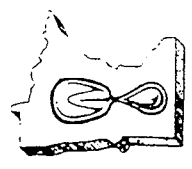
Why is ETHANOL the Premium Choice?



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ETHANOL... Performs



Minnesota ETHANOL Advisory Board

90 West Plato Blvd.
St. Paul, MN 55101

A. They reported good performance and good starting, especially in cold weather, with no vapor lock problems even at higher altitudes. "Many said ethanol seemed to improve pickup." "Incidentally, gasoline mileage was increased by an average of 5 percent in the test cars, compared to unleaded gasoline."¹

Q. Are you aware of any other tests?
A. Yes... a major refiner, Texaco, ran one fleet of company cars on ethanol fuel for their entire useful life. The engines were then torn down. Inspectors found these engines were cleaner than engines from other cars run on straight gasoline."²

Q. Has anybody else done any testing?
A. Well, the American Institute of Chemical Engineers compared ethanol fuel to straight gasoline. In a published report, the institute said ethanol was, "Very similar in driving characteristics to straight gasoline, except that pre-ignition and dieseling (run-on) are noticeably reduced and acceleration can be improved" with ethanol. The report continued, "Ethanol should be looked on as an octane enhancer. Mixing it with gasoline in 9-to-1 ratio improves octane rating about 3 octane numbers."³

Q. A final question: Should I use ethanol fuel in my car?
A. Yes... we think you should. There have been many conflicting reports about ethanol fuels. In too many cases, ethanol has been the scapegoat — blamed for problems caused by one or more of many other components... or contaminants... found in gasoline. Today we have the evidence and experience to support these facts: Ethanol fuel is good for your car. Your bank account. Your country. And our environment. In short, ethanol is the fuel of the future, here to serve you today.

sense. Thermostats control engine temperature. Ethanol actually burns cooler than gasoline. "Vapor lock usually comes about when a winter grade of gasoline, which is formulated for cold weather starts is used under summer-like conditions. For example, on a warm spring day when you fill up and winter grade gas is still in the tanks at your service station."⁴

Q. If all this is true, why do car manufacturers rule out the use of ethanol under their warranty terms?
A. They don't. The truth is, as of the 1986 model year, all 19 U.S. auto manufacturers and manufacturers of imports sold in this country have approved use of 10% ethanol blends under their warranty coverage."⁵

Q. I've heard that Nebraska state government cars now use ethanol.
A. Yes... it began as part of a Two Million Mile Test Program, conducted under close supervision. Half of the State fleet was put on ethanol fuel and the others on unleaded regular gasoline for comparison purposes."⁶

Q. What was the outcome?
A. Extremely favorable for ethanol. The two million miles were logged in highway patrol cars... all types of vehicles. Engines were inspected by qualified mechanics regularly and driver interview reports filed."⁷

Q. What did the inspections cover?
A. The inspections were conducted at regular intervals and covered valves, spark plugs, compression ratios, cylinder wear and so forth. There were no signs of unusual wear or deterioration in any of the vehicles! Also, engineers reported no premature wear of any engine parts or fuel line components."^{8,9}

Q. What did the drivers say about ethanol?

Here are the facts on ETHANOL!

Ethanol fuels, Gasohol, Super Unleaded with Ethanol, Ethanol Blend.
All the same product. All used extensively.
But — for many motorists today, ethanol fuels still remain a question mark. Will they damage car or truck engines? Will they cause driveability problems? Trigger excessive maintenance costs? Or — are they truly the fuels of the future?
In this booklet we answer your questions. Not with opinions. But with hard facts, gathered first-hand from the most reliable sources

Q. Some people say ethanol cleans a car's engine . . . others say it eats away at the carburetor and other parts. Who's right?

A. Part of the confusion arises because there are two types of alcohol fuels . . . ethanol and methanol. Ethanol is made from grain and is safe in your automobile, truck or tractor. Methanol, commonly known as wood alcohol, is usually made from natural gas and is quite another matter. It can pose a potential problem in commercial vehicles when added to gasoline at higher than 5% rate. Also, methanol should be accompanied by a cosolvent to prevent separation in the fuel.¹

Q. OK . . . but how do I know which one I'm getting when I fill up?

A. A dozen major refineries and many independents now offer ethanol fuel.² These are customarily identified at the pump, or ask your station manager. Incidentally, ethanol fuels are constantly under the watchful eye of state officials in Nebraska and are subject to an ongoing fuel testing program to help assure a high quality product.³ Other states have similar programs.

Q. I thought ethanol fuels were only available in a few states.

A. At one time, yes . . . however, with the EPA phaseout of lead in gasoline, the use of ethanol has greatly increased.⁴

Q. For what reason?

A. Because ethanol, which is both a fuel and an octane-enhancer, is an ideal replacement for lead. At the 10% level approved in most states, ethanol increases octane rating an average of 3 points.⁵ In other words, the fuel properties of ethanol are superior to gasoline and it is a premium product though usually at a lower price!

Q. I thought lead was necessary in gasoline for lubrication, as well as to raise octane rating. True or false?

A. A number of years ago that was true, to a degree. Automobiles manufactured since 1975 are designed to use unleaded fuels.⁶

Q. And so leaded fuels are being phased out to help control air pollution?

A. Yes . . . as of January 1, 1986, the allowable amount was reduced to only one-tenth gram per gallon, with total elimination of lead proposed by 1988.⁷

Q. Then ethanol definitely helps reduce air pollution?

A. Yes . . . there is a significant reduction in both carbon monoxide and hydrocarbons when ethanol is used.⁸ In fact, to help meet federal clean air standards, Colorado is considering a program to encourage 100% use of ethanol fuel in the state's front range area, including Denver.⁹ Other cities also not in compliance are closely following Colorado's action. For the nation, ethanol fuels offer the promise of significantly cleaner air. Along with conservation of natural petroleum resources. And an abundant new source of energy for the future.

Q. If ethanol is so clean, how can it foul fuel filters?

A. Ethanol, as such, is not the problem. What happens is that over a period of time regular gasoline will leave a deposit of varnish-like residue in the fuel system. Ethanol helps clean out this deposit, as well as dirt and grime, and these particles may get trapped in the fuel filter.¹⁰ The problem will usually correct itself in a short time.

Q. How about spark plugs? I've heard ethanol can cause fouling.

A. Wrong! As for fouling, an article by the Renewable Fuels Association points out that

lead and its scavengers form corrosive salts that foul spark plugs, corrode exhaust systems and create a need for frequent oil changes.¹¹ So you can see that substituting ethanol for lead is good news for your car and you. In fact, EPA estimates the new rule will save drivers about \$900 million a year.

Q. But what about newer cars . . . I've heard ethanol is hard on fuel injection systems.

A. Not at all. As a matter of fact, ethanol helps keep these systems clean so they perform better. Problems with fuel injection plugging are the result of dirty fuel. (Remember 90% of the fuel mixture is non-ethanol.) Some gasoline today does not have sufficient detergent.¹² Ethanol is, therefore, more valuable than ever as a cleaning additive.

Q. All right . . . but I've heard ethanol makes cars harder to start in winter and causes vapor lock in summer.

A. Neither story is true. In fact, by "absorbing" moisture, ethanol helps prevent gas line freeze-up in cold weather.¹³ It works much the same as alcohol-type anti-icers some motorists add to gas tanks in winter.

Q. Yes, but the explanation I got was that alcohol attracts water and that's where the freeze problems start.

A. It's true ethanol is a form of alcohol, but the ethanol recommended for use in motor fuels is an anhydrous or water-free additive. Thus, ethanol increases the water tolerance of the mixture before separation takes place and causes problems.¹⁴

Q. How about that matter of vapor lock in summer?

A. Again, the evidence is in favor of ethanol. Claims you may have read that ethanol makes engines run hotter are so much non-

The most widely used of the alcohols is ethanol. And its role has changed and grown since its initial impact as a product extender during shortages of the 1970s, when it was called gasohol. Ethanol came into its own a few years later as an octane enhancer. To reflect this important new role, ethanol enhanced products began being marketed as "unleaded plus" or "super unleaded plus." Ethanol, when blended in the standard 10 percent ratio into a fuel, adds 2.5 to 3 numbers to the fuel's octane rating.

The use of ethanol as a fuel extender and octane enhancer is accepted and supported by a variety of groups, including automakers, agricultural and environmental groups, federal and state governments and some segments of the petroleum industry.

One of ethanol's benefits is that it is an "oxygenate" — an octane enhancer that contains oxygen. This trait means that ethanol blended fuels burn with less carbon monoxide emissions than do non-oxygenated fuels.

As of 1988, more than 650 billion miles have been driven on ethanol-blended gasolines, with a market share of about 8 percent of all gasoline sold in the U.S.

Methanol

Methanol, often confused with ethanol, is produced from coal or natural gas. It is permitted in unleaded gasoline provided it contains a co-solvent (heavier alcohol); however, it is not frequently blended with consumer fuels.

Methyl Tertiary Butyl Ether (MTBE)

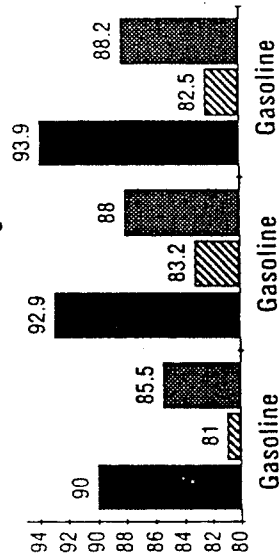
Permitted in unleaded gasoline at a level of up to 11 percent by volume, MTBE blends have experienced significant growth in recent years. MTBE is manufactured by the chemical reaction of methanol and isobutylene and is not as sensitive to water as are the alcohols. While both MTBE and ethanol

and ethanol is a renewable fuel.

Octane

Octane is the most common measure of gasoline performance, as established by the American Society for Testing and Materials. You usually see the octane rating posted at the pump, in numbers ranging from the mid-80s to the low-90s. Generally, the higher the octane number, the less tendency there will be for a gasoline to induce "knocking" or "pinging."

**Finished Octane from Common Components
(at 10% Concentration)**
85.5 octane base gasoline



■ Research Octane - affects acceleration at low speeds and engine run on.

▨ Motor Octane - affects performance under more severe operating conditions, i.e. passing, climbing hills.

■ Pump Octane $\frac{R+M}{2}$ - average performance of the Research and Motor Octane indicating the anti-knock capabilities of the fuel.

"Knocking" or "pinging" describe conditions under which the air-fuel mixture in an engine cylinder burns unevenly — due to unwanted spontaneous combustion. Normally, the mixture should burn evenly across the cylinder as a result of ignition from the spark plug, supplying a smooth, even thrust to the piston.

Knocking results in a loss of power and, if the

Al...es

Refiners mix numerous additives, in small amounts, in gasoline to enhance fuel quality. Standard additives include detergents, anti-icers, combustion enhancers, corrosion inhibitors and fluidizer oils (for valve deposit protection).



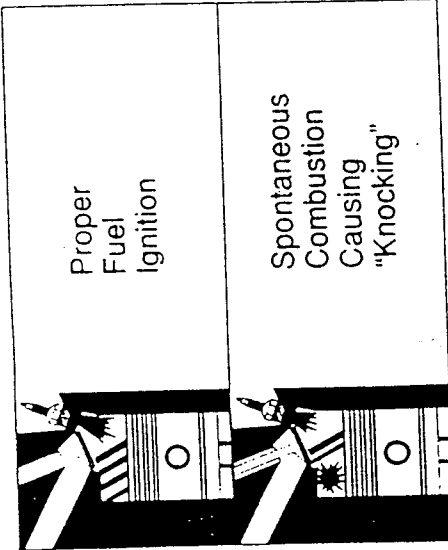
One example of the effect of detergent additives is shown in the illustration above. Detergents, which are added to all high quality fuels today – including ethanol blends – help keep port fuel injectors clean and functioning properly. The spray from the "fouled" injector on the left shows an uneven pattern which would lead to poor motor performance. The right injector is clean.

These and other additives provide consumers with the benefits of fewer harmful deposits, increased engine life, better fuel economy and improved automobile performance.

Fuel System Metals

Many components in gasoline could cause corrosion or rust of the metals in your vehicle's fuel system. Water and acidic compounds, and even air may be corrosive.

Fortunately, corrosion inhibitors are routinely added to gasoline (including ethanol blends) to provide protection against corrosion. Ethanol blends have not exhibited any tendency to increase corrosiveness.



The top illustration shows how the spark from the spark plug creates an even burn of the fuel mixture across the cylinder. In the lower illustration, spontaneous combustion "explodes" the fuel mixture, causing knocking or pinging.

Volatility

Before gasoline enters your vehicle's engine cylinders, it is mixed with air and then vaporized. When and how well it vaporizes is important.

Volatility is used to describe a fuel's ability to change from liquid to vapor — or to vaporize.

In hot temperatures, a highly volatile fuel may cause vapor lock — because the fuel vaporizes too soon, in fuel lines. In cold temperatures, gasolines that do not vaporize adequately may cause hard starting and operating difficulty.

Climate and vapor lock are two main variables that fuel manufacturers consider when making fuel volatility adjustments. With any fuel on the market today, unseasonable weather can contribute to volatility problems that can't be anticipated. Ethanol, like many other high octane components, will increase fuel volatility slightly. However the in-

Both ethanol and methyl... abilities to increase octane. But ethanol, which typically raises the base gasoline's octane rating about 2.5-3 numbers is derived from renewable resources and is considered to be the most environmentally safe of the octane enhancers.

Plastics

Unleaded gasolines contain components that could cause plastic and rubber-like parts in the fuel system to swell, soften, crack or deteriorate. However, through cooperation among automakers, parts manufacturers and the petroleum industry, all fuel systems have been upgraded to avoid this problem. Assurance of this comes from the fact that today's fuel formulations, including 10 percent ethanol blends, are covered under the manufacturers' warranty on all vehicles manufactured since 1980.

Fuel Filters

There have been some occasional, isolated reports of fuel filter problems in older cars using ethanol-blended gasolines. This happens because fuel system deposits that have accumulated over many years of driving suddenly get flushed free by the superior cleaning ability of ethanol. Naturally, the fuel filter catches these particles on the way through, and you may then need to replace your filter. But keep in mind that today's fuel filter materials are compatible with ethanol-enhanced fuels.

The Environment and Oxygenates

Carbon monoxide pollution from automobiles continues to threaten our health and environment. If inhaled in high concentrations, these emissions can cause serious health effects.

By early 1988, one major city, Denver, had started attacking the carbon monoxide problem by taking advantage of the oxygen found in ethanol and MTBE. Second only to Los Angeles in carbon monoxide levels, Denver instituted the nation's first "Oxygenated Fuels Program," which mandates the use of these blended fuels during winter months.

A large number of studies, including those done by the Colorado Air Quality Control Commission, all conclude that fuels such as ethanol would

study included drivability tests of public and private sector fleets, totaling 2,450 vehicles.

The Commission did not mandate the use of a specific oxygenate. However, when blended at the maximum allowable levels, ethanol contains a higher level of oxygen, 3.5 percent, than does the petroleum product MTBE, at 2 percent oxygen.

The initial environmental impact of this program on the Denver area was an eight percent reduction in carbon monoxide levels in just two months, according to the Department of Health.

Energy Security and Economics

Ethanol is unique among the popular fuel components because it is derived from abundant renewable resources — most commonly corn. Because of this derivation and its clean burning "oxygenated" properties, ethanol is considered to be a very environmentally-safe fuel.

And, because most ethanol comes from corn produced in the U.S., the economic impact generated by ethanol's production benefits this country's economy. Because the use of ethanol directly reduces the need for imported oil, the U.S. balance of trade improves; and because every barrel of ethanol replaces the gasoline produced from two barrels of crude oil, the impact is even more significant.

Because ethanol is processed here, the U.S. industrial base is stronger, and since the raw product — corn — is grown here, the use of ethanol directly adds value to our nation's agricultural output.

And that combination is working for Iowa — this state is the second largest producer of ethanol. While Iowa produces only two percent of its total energy needs, the growing production and utilization of ethanol presents the state with a very viable and renewable energy source to reduce the dependence on outside energy supplies.

Conclusion

Just as automobiles are better today than ever, so are fuels and the component additives used to enhance them. Ethanol-blended fuels are now a tested, established and wise choice for all drivers.

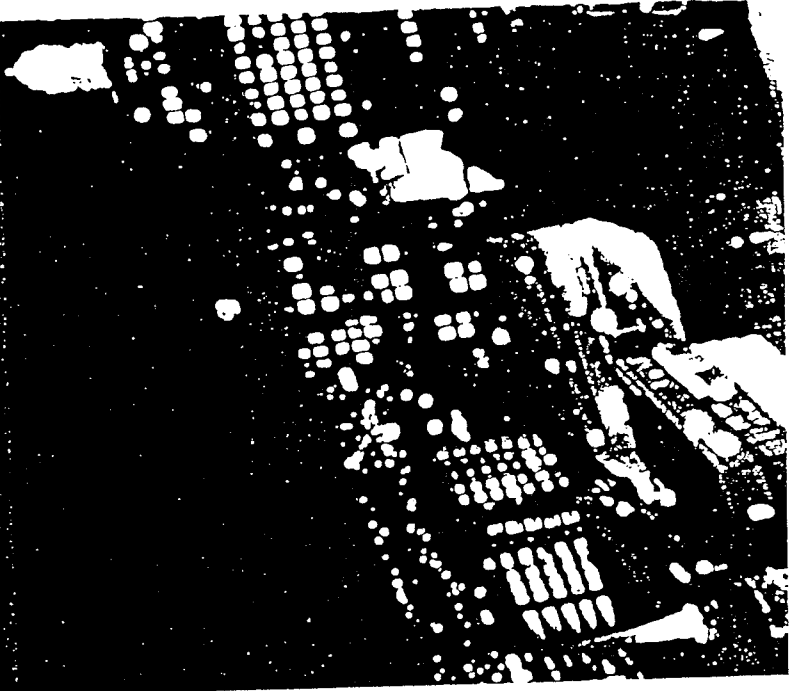
Ethanol boosts the fuel's octane rating, which provides extra protection against knocking and more power for your car when you need it.

Ethanol blends cleaner-burning qualities are good for your car's engine and the air you breathe. And ethanol is American made — which helps this nation's economy.

Some myths have been spread about ethanol, either by uninformed mechanics and consumers, or by some in the oil industry who view ethanol as a threat to their markets. But the evidence continually points toward ethanol as a reliable additive: all major automakers support 10 percent ethanol blends by covering it under their new car warranties; numerous fleet test results all establish its credibility; and Americans have shown their trust in it by making ethanol their choice for more than 650 billion miles of travel so far.



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For more information, contact: The Iowa Corn Growers Association, 1200 35th St., Suite 306.

Technical Information

The motive to use ethanol in one or more grades of gasoline will vary among companies and geographic areas. Until recently, the primary motive was one of economics where the blender could simply lower product costs by adding ethanol to their gasoline. Today, the motive is generally either to improve octane economics or to comply with minimum oxygen requirements for mandatory oxygenated fuel programs. In the future, ethanol could also be used to comply with the minimum oxygen standard for reformulated gasoline.

As the motives for blending become more complex, so to does the need for accurate concise technical information. In addition to information on ethanol itself, it is necessary to identify what characteristics of the base gasoline are altered due to the addition of ethanol.

This section provides some of the key information on ethanol characteristics and the affect it has on various gasoline properties.

Denatured Fuel Ethanol

Before distribution to gasoline manufacturers/blenders, ethanol (C_2H_5OH) must be denatured to render it unfit for human consumption. The fuel blender is typically working with a denatured ethanol containing approximately 5% denaturant.

This denaturant is typically unleaded gasoline or unleaded hydrocarbons which boil in the gasoline boiling range.

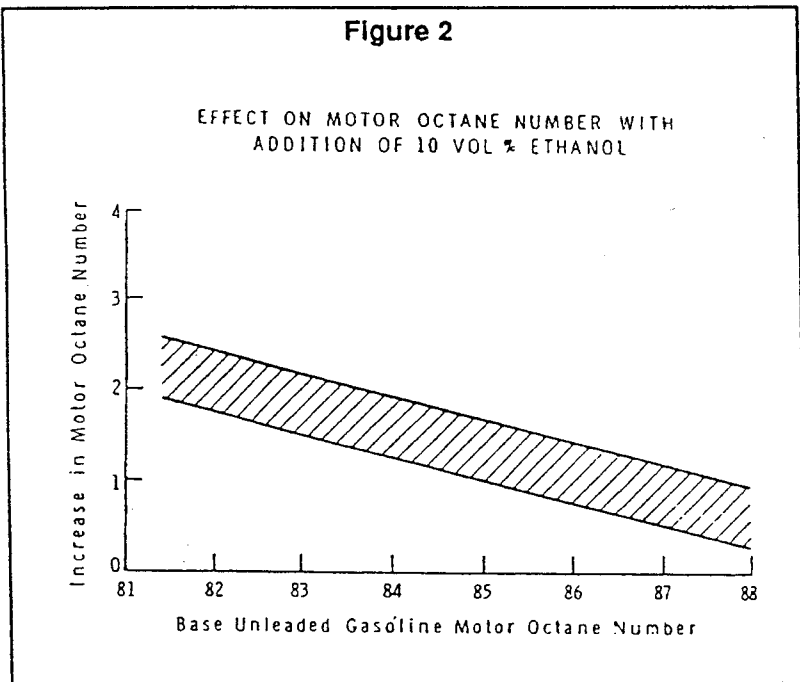
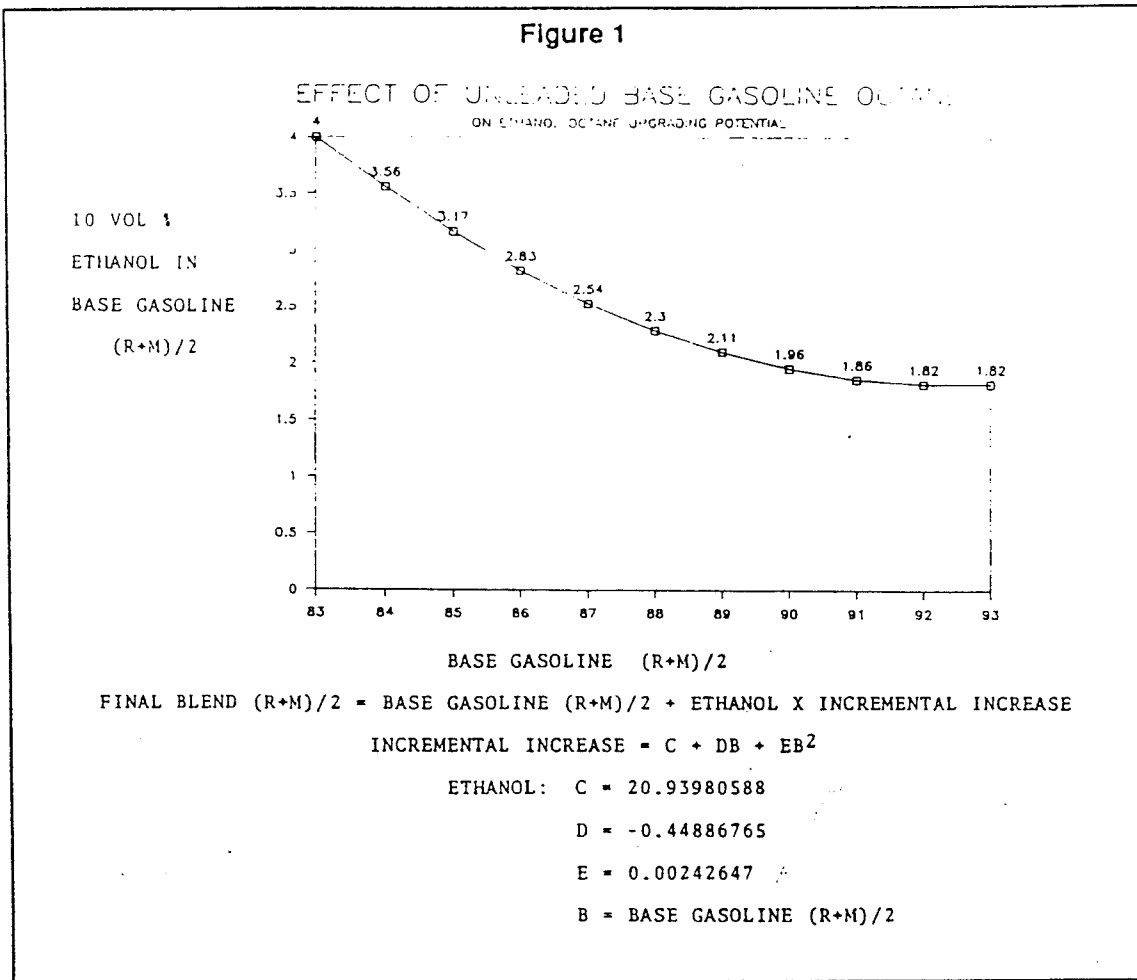
There are a number of guidelines available to assess the quality and characteristics of fuel grade ethanol. The industry standard is ASTM D4806 Standard Specification For Denatured Fuel Ethanol For Blending With Gasolines For Use As Automotive Spark-Ignition Engine Fuel. In addition most major ethanol producers provide "Typical Property" or specification guides for their product. Also the Renewable Fuels Association has developed a product quality guide entitled "Ethanol and Gasoline-Ethanol Blends - Fuel Quality Considerations & Recommendations" (RFA Recommended Practice 911201) which discusses quality issues for ethanol and gasoline/ethanol blends. All of the aforementioned items are included in the appendix to this section.

Other information that the blender may need includes a table to correct product volume to 60°F (net gallons). Determination of proof and specific gravity, and methods for determining purity by Gas Chromatograph (GC). Information of these items is also provided in the appendix to this section.

Gasoline/Ethanol Blends

Ethanol will affect a number of properties of the gasoline to which it is added. This includes octane, oxygen content, vapor pressure, distillation curve, and water solubility. ASTM D 4814-Standard Specification For Automotive Spark Ignition Engine Fuel is included in the appendix to this section. The following provides detail on various gasoline properties and how they are affected by the addition of ethanol.

Octane: Generally speaking, the addition of 10 volume % ethanol will increase the octane of the gasoline to which it is added by 2 to 3 (R+M)/2 octane numbers. However, the actual octane increase is dependent upon the octane of the base fuel and, to a lesser degree, its composition. The octane increase is more pronounced for research octane than for motor octane. Figure #1 provides a blending response curve based upon the octane of the base fuel. Minimum blending octane values for ethanol are Research Octane 129, Motor Octane 96, and AKI or (R+M)/2 of 112.5.



Figures number #2 and #3 provide octane response ranges for motor and research octane (respectively) based upon the octanes of the base fuel.

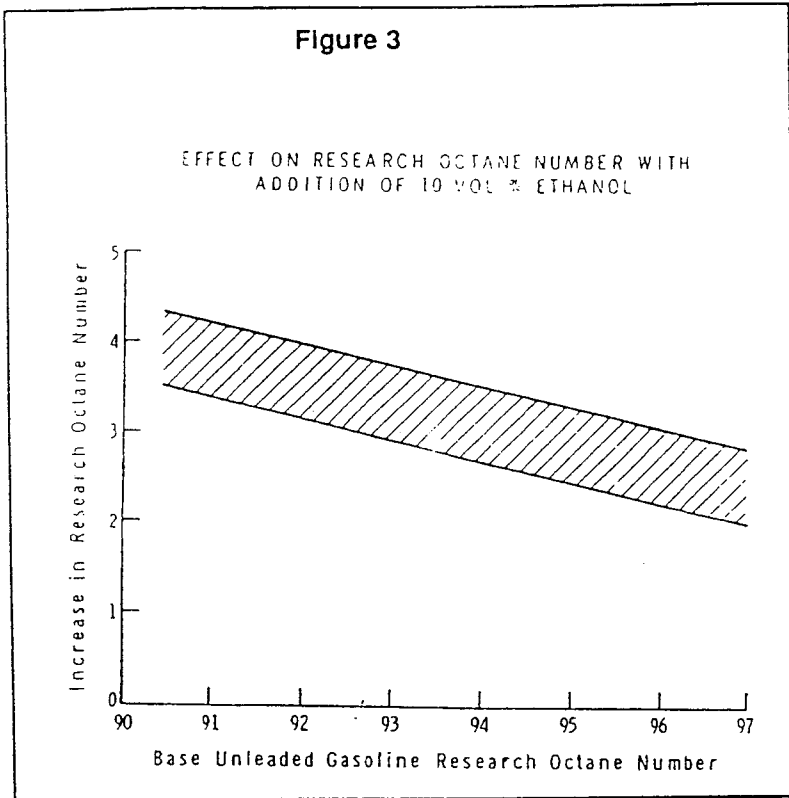


Table #1 provides information on the approximate octane response of various gasoline components when they are enhanced with ethanol.

These figures and tables should provide guidance in determining blend ratios and corresponding octane response. Of course, each blender should verify octane response with the appropriate test procedures.

Table 1
OCTANE RESPONSE WITH ETHANOL

Refining Component	RON	MON	(R+M)/2
Alkylate	96.5	93.5	95.0
10% EtOH	101.9	94.3	98.1
EtOH BV*	151	102	126
Light St. Run (Refinery A)	72.3	70.0	71.2
10% EtOH	80.4	77.1	78.8
EtOH BV	153	141	147
Light St. Run (Refinery B)	69.8	67.8	68.8
10% EtOH	77.6	74.8	76.2
EtOH BV	148	139	143
Cat Cracked (Refinery A)	60.7	59.5	60.1
10% EtOH	70.6	68.4	69.5
EtOH BV	148	160	149 154
Cat Cracked (Refinery B)	87.6	78.9	83.3
10% EtOH	91.7	80.9	86.3
EtOH BV	129	99	113
Reformate (Refinery A)	94.0	83.2	88.6
10% EtOH	96.9	85.4	91.2
EtOH BV	123	105	115
Reformate (Refinery B)	84.1	76.8	80.5
10% EtOH	89.5	80.6	85.1
EtOH BV	138	115	127

*Blending Value
Source: ADM

Terminal blenders often utilize ethanol as the octane trimming component to make mid-grade and premium grade gasolines. The mathematical calculation for these easily formulated blends is as follows.

Mid-grade

	Octane Contribution
Unleaded regular 87 octane @ 90%	78.30
Ethanol 112.5 octane @ 10%	11.25
Octane of finished blend	89.55

Premium Grade

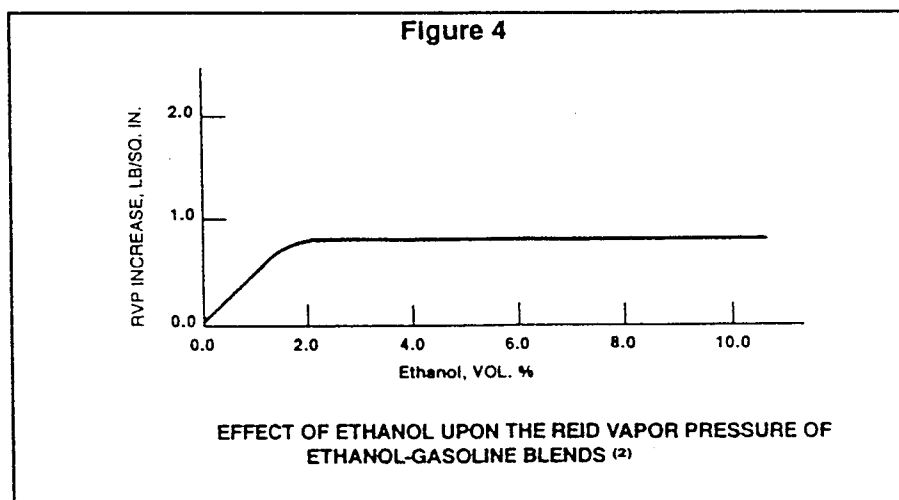
	Octane Contribution
Unleaded regular 87 octane @ 40%	34.80
Unleaded premium 92 octane @ 50%	46.00
Ethanol 112.5 octane @ 10%	11.25
Octane of finished blend	92.05

Some blenders may utilize low octane components such as raffinate in their ethanol blending programs. Proper utilization of such components provides greater flexibility and allows more accurate trimming of finished product octane. This can eliminate "octane give-away" thus improving octane economics. Some brief information on this is provided in the appendix to this section. However, the octane value and other properties of raffinate and similar components can vary from one refinery to another or even one product stream to the next. Therefore, if you wish to engage in such a program, you should discuss your particular circumstances with your ethanol sales representative or other qualified personnel.

Volatility: The addition of ethanol to gasoline will also increase its volatility. There are three common measurements of fuel volatility, vapor pressure (VP), distillation, and Vapor/Liquid (V/L) Ratio. Each of these properties is thoroughly discussed in ASTM D 4814 - Standard Specification For Automotive Spark-Ignition Engine Fuel.

Vapor Pressure: Adding ethanol will increase the vapor pressure of gasoline by up to around 1.0 psi. This effect is dependent upon the vapor pressure of the base gasoline and to some extent, to its composition.

The vapor pressure increase is non-linear with the increase peaking between 2 volume percent and 3 volume percent ethanol addition. In other words, the addition of 10 v% ethanol causes no greater vapor pressure increase than the addition of 3 v% ethanol. The typical vapor pressure response is depicted in figure 4.

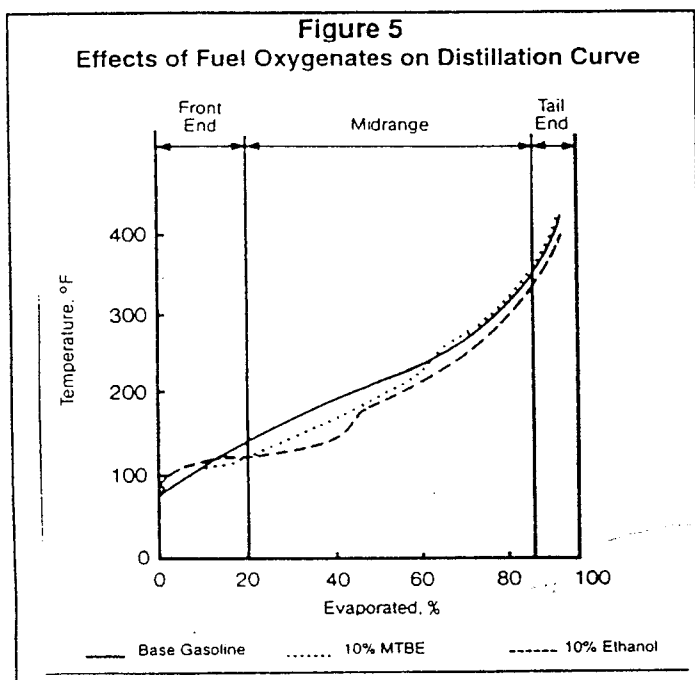


In general, higher volatility base gasolines will exhibit less of a vapor pressure increase than lower volatility base fuels. Base gasoline of 14 to 15 psi vapor pressure may exhibit vapor pressure increases of 0.3 to 0.5 psi while base gasolines of 8 to 9 psi vapor pressure will generally exhibit vapor pressure increases in the 0.8 to 1.0 psi range.

NOTE: During the time period from June 1st to September 15th (at retail), the USEPA requires that certain volatility restrictions be met. A vapor pressure of 9.0 psi or 7.8 psi is required dependent upon geographic area and attainment of clean air standards. Gasoline ethanol blends (containing 9% to 10% ethanol) are allowed to be 1.0 psi higher than other gasoline. Certain state regulations and future federal gasoline regulations may or may not allow such a vapor pressure tolerance. Beyond the above specified time frames for EPA volatility regulations, there are no federal restrictions on the volatility of gasoline / ethanol blends. However it should be noted that excessively high vapor pressure can result in vehicle driveability problems and therefore, should be controlled within reasonably accepted guidelines. The addition of other more volatile components in conjunction with ethanol should be avoided.

Distillation Curve: The driveability of a vehicle can also be affected by the distillation characteristics of a fuel. Specification ASTM D 4814 provides guidelines for temperatures at which 10%, 50%, 90% and 100% of the gasoline should evaporate. These points are referred to as T_{10} , T_{50} , T_{90} , and end point, respectively.

When ethanol is added to gasoline (and no other alterations are made) it will tend to depress T_{50} . This is demonstrated in figure 5.



The minimum specification for T_{50} is 170°F for an all hydrocarbon fuel. There are no federal requirements for gasoline/ethanol blends to meet this specification. Some states may, however, limit the T_{50} minimum for gasoline/ethanol blends to 158°F. Blending should be accomplished in such a manner to ensure that T_{50} is not excessively low. As of mid 1993, ASTM was in the process of finalizing standards to lower the T_{50} temperature for winter volatility grades D and E.

Vapor/Liquid Ratio: Some refiners also monitor the temperature required to create a vapor to liquid ratio of 20 or $T(V/L=20)$. This test helps to define a fuel's tendency to contribute to vapor lock in carbureted vehicles. It is a test to monitor a fuel's front end volatility. Greater detail on $T/VL20$ can also be found in ASTM D 4814.

Other Volatility Parameters: Some refiners may also utilize other volatility standards such as a "driveability index" (DI). A DI is typically comprised of a percentage weighting of T_{10} , T_{50} , and T_{90} . If your company or customers have such a standard you should discuss how these standards apply to gasoline/ethanol blends.

Oxygen Content: In many cases, ethanol is added to gasoline to meet minimum oxygen requirements for mandatory oxygenated fuel requirements stipulated under the 1990 Clean Air Act Amendments. Denatured ethanol contains approximately 35.3% oxygen. The three most common blend ratios and their corresponding oxygen content is provided in Table 2.

Table 2

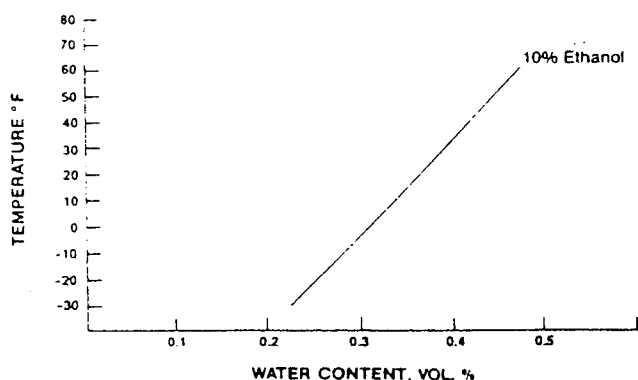
<u>Volume % Denatured Ethanol in Fuel</u>	<u>Approximate Oxygen Content</u>
10.0% by volume	3.5% by weight
7.7% by volume	2.7% by weight
5.7% by volume	2.0% by weight

If you are required to comply with minimum oxygen standards, you should check the applicable regulation for specific requirements and methods of determining compliance.

NOTE: EPA regulations permit the use of ethanol in combination with other oxygenates up to a total oxygen content of 2.7 weight %. As an example, a gasoline blend could contain 5% ethanol (oxygen value 1.765%) and 10% MTBE (oxygen value 0.9%) for a total oxygen content of 2.67%. Such blends may prove advantageous in efforts to reformulate gasoline. However, the advantages will vary among refiners and are beyond the scope of this program guide.

It should also be noted that when blending gasoline/ethanol blends under the "gasohol waiver" that an oxygenate free base gasoline must be used. EPA has, however, ruled that gasoline unintentionally containing up to 2 v% MTBE may be used as the base fuel for gasoline/ethanol blends containing up to 10v% ethanol.

Figure 6
Water Tolerance of
90% Gasoline/10% Ethyl Alcohol Blends^(a)



Water Tolerance: Ethanol has an affinity for water. For instance, it is not necessary to add any gas line antifreeze to a gasoline/ethanol blend since the ethanol will encapsulate trace amounts of water and pull it through the fuel system. Likewise, trace amounts of water in underground storage tanks are eliminated via the same mechanism.

However, ethanol's affinity for water also necessitates that steps be taken to eliminate moisture from the fuel storage and delivery system. If a gasoline/ethanol blend encounters excessive moisture contamination, the water can pull the ethanol out of the blend resulting in

tank water bottoms comprised of water, ethanol, and some hydrocarbon content. The amount of water tolerated by a gasoline/ethanol blend is dependent upon the product temperature. The lower the temperature the lower the water tolerance. This is visually depicted in figure 6.

Additives: Nearly all ethanol producers add corrosion inhibitors to their fuel grade ethanol. This is done to ensure adequate corrosion protection in case the ethanol is added to an unprotected or underprotected fuel.

All gasoline, whether all hydrocarbon or oxygenated (such as gasoline/ethanol blends), contain components that contribute to deposits in the carburetors, fuel injectors, and induction systems of modern vehicles. The type of detergents or deposit control additives as well as the appropriate treat rate is dependent upon the characteristics of the base fuel. Your regular additive supplier should be consulted to identify the appropriate additive and its correct treat rate. Additional information on this topic is contained in RFA Recommended Practice 911201 in the appendix to this section.

Summary

Technical information, industry specifications, and guidelines, if properly followed, are more than adequate to ensure product integrity. Adherence to such guidelines will ensure that you are providing a gasoline/ethanol blend of the highest quality.

Technical Information- Appendix

- D 4806 Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel
- ADM & Pekin Typical Property Sheets
- RFA Recommended Practice 9111201 Ethanol and Gasoline-Ethanol Blends-Fuel Quality Considerations & Recommendations
- Table for Correction of Volume to 60°F
- Proof & Specific Gravity-Ethanol Denatured with 5 Parts Natural Gasoline Per 100 Parts Ethanol
- Test Method for the Determination of Ethanol Content of Denatured Fuel Ethanol by Gas Chromatography
- ASTM D 4814-Standard Specification For Automotive Spark Ignition Engine Fuel
- Gasoline Blends Utilizing Raffinate and Ethanol



Standard Specification for Denatured Fuel Ethanol for Blending with Gasolines for Use as Automotive Spark-Ignition Engine Fuel¹

This standard is issued under the fixed designation D 4806; the number immediately following the designation indicates the year of original adoption or, in the case of revision, the year of last revision. A number in parentheses indicates the year of last reapproval. A superscript epsilon (ϵ) indicates an editorial change since the last revision or reapproval.

1. Scope

1.1 This specification covers nominally anhydrous denatured fuel ethanol intended to be blended with unleaded or leaded gasolines at 5 to 10 volume % for use as a spark-ignition automotive engine fuel. The significance of this specification is shown in Appendix X1.

1.2 The values stated in SI units are to be regarded as the standard. The values given in parentheses are for information only.

1.3 The following precautionary caveat pertains only to the test method portions, Annex A1: *This specification does not purport to address all of the safety problems, if any, associated with its use. It is the responsibility of the user of this standard to establish appropriate safety and health practices and determine the applicability of regulatory limitations prior to use.*

2. Referenced Documents

2.1 ASTM Standards:

- D 86 Test Method for Distillation of Petroleum Products²
- D 512 Test Methods for Chloride Ion in Water³
- D 891 Test Methods for Specific Gravity, Apparent, of Liquid Industrial Chemicals⁴
- D 1152 Specification for Methanol (Methyl Alcohol)⁴
- D 1193 Specification for Reagent Water³
- D 1353 Test Method for Non-volatile Matter in Volatile Solvents for Use in Paint, Varnish, Lacquer, and Related Products⁵
- D 1613 Test Method for Acidity in Volatile Solvents and Chemical Intermediates Used in Paint, Varnish, Lacquer, and Related Products⁵
- D 1688 Test Methods for Copper in Water³
- D 3505 Test Method for Density or Relative Density of Pure Liquid Chemicals⁵
- D 4057 Practice for Manual Sampling of Petroleum and Petroleum Products⁶
- D 4814 Specification for Automotive Spark-Ignition Engine Fuel⁷

¹ This specification is under the jurisdiction of ASTM Committee D-2 on Petroleum Products and Lubricants and is the direct responsibility of Subcommittee D02.A on Gasoline.

Current edition approved Oct. 15, 1992. Published December 1992. Originally published as D 4806 - 88. Last previous edition D 4806 - 91.

² Annual Book of ASTM Standards, Vol 05.01.

³ Annual Book of ASTM Standards, Vol 11.01.

⁴ Annual Book of ASTM Standards, Vol 15.05.

⁵ Annual Book of ASTM Standards, Vol 06.03.

⁶ Annual Book of ASTM Standards, Vol 05.02.

⁷ Annual Book of ASTM Standards, Vol 05.03.

- E 203 Test Method for Water Using Karl Fischer Reagent⁸
- E 260 Practice for Packed Column Gas Chromatography⁸
- E 300 Practice for Sampling Industrial Chemicals⁴
- E 355 Practice for Gas Chromatography Terms and Relationships⁸

2.2 Other Standards:

- United States Code of Federal Regulations, Title 27, Parts 211 and 212⁹
- United States Federal Specification O-E-760b Ethyl Alcohol (Ethanol): Denatured Alcohol: and Proprietary Solvent¹⁰

3. Terminology

3.1 Definitions:

3.1.1 *ethanol, n*—ethyl alcohol, the chemical compound C_2H_5OH .

3.1.2 *gasoline-ethanol blend, n*—a spark-ignition automotive engine fuel containing denatured fuel ethanol in a base gasoline that may be leaded or unleaded.

3.1.2.1 Discussion—Leaded and unleaded is defined in Specification D 4814.

3.1.3 *oxygenate, n*—an oxygen-containing ashless, organic compound, such as an alcohol or ether, which may be used as a fuel or fuel supplement.

3.2 Descriptions of Terms Specific to This Standard:

3.2.1 *base gasoline*—the gasoline component of a gasoline-ethanol blend, but generally excluding gasoline added to fuel ethanol as denaturant.

3.2.2 *denaturants*—in fuel ethanol, toxic or noxious materials added to make it unfit for beverage use.

3.2.3 *denatured fuel ethanol*—fuel ethanol made unfit for beverage use by the addition of denaturants.

3.2.4 *fuel ethanol*—ethanol with impurities (including water but excluding denaturants).

3.2.5 *impurities*—in commercially produced fuel ethanol compounds other than ethanol or denaturants present such as methanol and fusel oil (for example, amyl and isoamyl alcohols).

4. Performance Requirements

4.1 *Denatured Fuel Ethanol*—When fuel ethanol is denatured as specified in Section 5, it shall conform to the following requirements at the time of blending with a gasoline.

⁸ Annual Book of ASTM Standards, Vol 14.01.

⁹ Order as Code of Federal Regulations Title 27 Parts 200-End; from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

¹⁰ Order from Superintendent of Documents, U.S. Government Printing Office, Washington, DC 20402.

Water content, max, mass %	1.25 (Note 1)
Nonvolatile matter, max, mg/100 mL	5
Chloride ion content, max, mass ppm (mg/L)	40 (32)
Copper content, max, mg/kg	0.1
Acidity (as acetic acid CH ₃ COOH), max, mass % (mg/L)	0.007 (56) (Note 3)
Appearance	Visibly free of suspended or precipitated contaminants (clear and bright)

NOTE 4—BATF regulations concerning the preparation, use, and handling of denatured ethanols are published in the United States Code of Federal Regulations, Title 27, Parts 211 and 212. Part 211 contains primarily legal and administrative information, and Part 212 contains technical information on denaturants and denatured ethanols.

5.2 *Prohibited Denaturants*—Although this specification permits only hydrocarbons in the gasoline boiling range to be used as denaturants, specific mention must be made of some materials that have extremely adverse effects on fuel stability, automotive engines and fuel systems. These materials shall not be used as denaturants for fuel ethanol under any circumstances. They are as follows: methanol which does not meet Specification D 1152, pyrroles, turpentine, ketones and tars (high-molecular weight pyrolysis products of fossil or nonfossil vegetable matter). While any significant amount of methanol will lower the water tolerance and increase the vapor pressure of a gasoline-ethanol blend, these effects become more serious when methanol is present at more than 2.5 parts by volume per 100 parts by volume of fuel ethanol. Also, methanol which does not meet Specification D 1152 frequently contains impurities such as turpentine and tars. Similarly, ketone denaturants tend to degrade fuel stability or increase the tendency of a gasoline-ethanol blend to corrode metals and attack elastomers. These effects become more serious if the concentration of a ketone such as 4-methyl pentanone (methyl isobutyl ketone) exceeds one part by volume per 100 parts by volume of fuel ethanol. There is no information available on the effects of denaturants other than those mentioned above, but unless a denaturant, such as a higher aliphatic alcohol or ether, is known to have no adverse effect on a gasoline-ethanol blend or on automotive engines or fuel systems, it shall not be used.

6. Sampling

6.1 Samples may be obtained by an appropriate procedure of Practice D 4057 or Practice E 300, except that water displacement (in section on Sampling for Specific Tests in D 4057) must not be used. Where practical, fuel ethanol should be sampled in glass containers. If samples must be collected in metal containers, do not use soldered metal containers although they are specified in the Sampling Equipment section in Practice E 300. This is because the soldering flux in the containers may contaminate the sample.

6.2 *Sample Size*—A minimum of about 1 L or 1 U.S. qt is recommended. If specific gravity is to be determined by a hydrometer method, additional volume may be required. This depends on the size of the hydrometer.

6.3 *Lot Size*—A lot shall normally consist of the amount contained in a tanker compartment or other bulk container in which it is delivered. If this definition does not apply, the definition of a lot must be agreed upon between the supplier and purchaser.

NOTE 5—See Sections 5, 6, and 7 of Practice E 300 for a detailed discussion of the statistics of sampling.

7. Test Methods

7.1 ASTM test methods have not yet been developed for all of the properties specified. For instance, to determine ethanol content, see the proposed test method in Annex A1. The use of this method is not required and other suitable methods may be used.

NOTE 1—In some cases, a lower water content may be necessary to avoid phase separation of a gasoline-ethanol blend at very low temperatures. This reduced water content, measured at the time of delivery, shall be agreed upon between the supplier and purchaser.

NOTE 2—If denatured fuel ethanol is prepared by the addition of denaturants to undenatured fuel ethanol after it has been produced other than during the dehydration process, the 15.56°C/15.56°C (60°F/60°F) specific gravity in air of the undenatured fuel ethanol shall be in the range from 0.7937–0.7977.

NOTE 3—Denatured fuel ethanol may contain additives such as corrosion inhibitors and detergents that may affect the titratable acidity (acidity as acetic acid) of the finished fuel ethanol. Although the base fuel ethanol may meet the acidity specification, the effect of these additives may produce an apparent high titratable acidity of the finished product. Contact the ethanol supplier if there is a question regarding the titratable acidity of your denatured fuel ethanol to verify that the base ethanol meets the acidity requirements of 4.1.

4.2 *Ethanol Purity*—The fuel ethanol component of denatured fuel ethanol excluding water shall be 98 volume % minimum ethanol (C₂H₅OH), and shall not contain more than 0.5 volume % methanol or total ketones, or both. The addition of materials other than fuel ethanol or the permitted hydrocarbon denaturants and minor amounts of commercially acceptable additives such as corrosion inhibitors is prohibited. Materials noted in 5.2 may be present in trace amounts only.

4.3 *Ethanol Content*—Total fuel ethanol content of denatured fuel ethanol, including impurities as limited in 4.2, must be not less than 95 volume %.

4.4 *Other Properties*—Limits more restrictive than those specified above, or the specification of additional properties such as color, may be agreed upon between the supplier and the purchaser.

8. Denaturants

5.1 The only denaturants used for fuel ethanol shall be unleaded gasoline or rubber hydrocarbon solvent at a minimum concentration of 2 parts by volume per 100 parts by volume of fuel ethanol, as defined by Formula CDA 20 of the Bureau of Alcohol, Tobacco, and Firearms (BATF) of the U.S. Treasury Department. This specification prohibits the use of hydrocarbons with an end boiling point higher than 25°C (437°F) as determined by Test Method D 86, although they may be permitted by BATF regulations. Some erosines, for instance, promote piston scuff in automotive engines. The denaturants permitted by this specification may be included as part of the 10 volume % denatured fuel ethanol blended with a gasoline if they do not exceed 5 parts by volume per 100 parts by volume of fuel ethanol. This is permitted in the United States by law. Any part of these denaturants that are present at concentrations higher than 5 parts by volume per 100 parts by volume of fuel ethanol are considered as part of the base gasoline.

7.2 *Water Content*—Test Method E 203.

7.3 *Nonvolatile Matter*—Test Method D 1353.

7.4 *Acidity*—Test Method D 1613.

7.5 *Appearance*—The product shall be visibly free of suspended or precipitated contaminants (clear and bright). This shall be determined at indoor ambient temperature unless otherwise agreed upon between the supplier and the purchaser.

7.6 *Specific Gravity*—Test Method D 891, Procedure B (hydrometer) is normally used. No formal precision statement is available, but practical experience indicates that precision is no better than 0.0005. Test Method D 891 Procedure C (pycnometer), with an interlaboratory precision (reproducibility) of 0.0002, should be used as a referee method.

7.7 *Chloride Ion Content*—Modification of Test Method D 512, Procedure C.

7.7.1 The modification of Test Method D 512, Procedure C consists of using 5 mL of sample diluted with 20 mL of water in place of the 25 mL sample specified in the standard procedure. The water shall meet Specification D 1193, Type II. The volume of the sample prepared by this modification will be slightly larger than 25 mL. To allow for the dilution factor, report the chloride ion present in the fuel ethanol sample as the chloride ion present in the diluted sample multiplied by five.

7.7.2 The precision of this modified method has not been determined, but for the actual amount of chloride ion found in the diluted sample, it is expected to be similar to the

precision of Test Method D 512, Procedure C.

7.8 *Copper Content*—Modification of Test Method D 1688, Procedure D.

7.8.1 The modification of Test Method D 1688, Procedure D (atomic absorption) consists of mixing reagent grade ethanol (which may be denatured according to the U.S. Bureau of Alcohol, Tobacco, and Firearms (BATF) of U.S. Treasury Department Formula 3A or 30) in place of water as the solvent or diluent for the preparation of reagent and standard solutions. *However, this must not be done to prepare the stock copper solution described in 38.1 of Test Method D 1688.* Because a violent reaction may occur between the acid and the ethanol, use water, as specified, for the acid solution part of the procedure to prepare the stock copper solution. Use ethanol for the rinse and final dilution only.

7.8.2 The precision of this modified method has not been determined but it is expected to be similar to the precision of Test Method D 1688, Procedure D.

7.9 *Ethanol Content*—See Annex A1 for a proposed test method.

8. Keywords

8.1 acidity; automotive spark-ignition engine fuel; gasoline; chloride ion content; copper content; corrosive inhibitors; denaturants; denatured fuel ethanol; ethanol content; ethanol purity; fuel; fuel ethanol; gasoline-ethanol blend; impurities; nonvolatile matter; oxygenate; water content

A1. PROPOSED TEST METHOD FOR THE DETERMINATION OF ETHANOL CONTENT OF DENATURED FUEL ETHANOL BY GAS CHROMATOGRAPHY

A1.1 Scope

A1.1.1 This proposed test method covers the determination of the amount of ethanol in denatured fuel ethanol and may also be used to determine the amounts of other C₁ through C₅ alcohols. This test method does not determine water content: Test Method E 203 is recommended for the determination of water.

A1.1.2 The interpretation of this procedure shall be guided by the provisions of E 260 and E 355.

A1.2 Summary of Test Method

A1.2.1 A two column chromatographic system connected to a thermal conductivity detector is used. A measured volume of sample is injected into the first column containing a polar liquid phase. The light hydrocarbons through methylcyclopentane are vented to the atmosphere as they elute. The column is backflushed immediately after the elution of methylcyclopentane, and the components remaining are directed into the second column, which contains an active solid. In this column, the alcohols elute before the remaining hydrocarbons. Immediately after the alcohols of interest have eluted, the flow through this solid-packed column is reversed to backflush the remaining hydrocarbons. Quantitative results are obtained by comparison of the areas of the recorded alcohol peaks with those obtained from the analysis of mixtures of known alcohol content.

A1.3 Significance and Use

A1.3.1 Denatured fuel ethanol consists of ethanol, water and denaturants and may contain impurities such as methanol, isopropyl alcohol, tertiary butyl alcohol, 1-pentanol (amyl alcohol), and 3-methyl-1-butanol (isoamyl alcohol). This proposed test method provides information on the purity of denatured fuel ethanol in order to help determine its suitability for blending with gasoline for use as an automotive spark-ignition engine fuel.

A1.4 Apparatus

A1.4.1 *Gas Chromatograph*—A gas chromatograph equipped with a thermal conductivity detector with provision for installing a valve in the column oven or other heated zone. Provision must be made to operate a second column at a higher temperature than the first column and the valve.

A1.4.2 *Valve*, eight-port rotary or equivalent.

A1.4.3 *Integrator*—Electronic integration is recommended.

A1.4.4 *Recorder*—A 1-mV recorder with a 1-s full-scale response. If electronic integration is not used, minimum chart width of 250 mm (10 in.) and a minimum chart speed of 1 cm/min (0.4 in./min) are required.

A1.4.5 *Column 1*—A stainless steel column 2.4-m (3-ft) long, 3.5-mm (0.138-in.) inside diameter, approximately 4.75-mm (3/16-in.) (outside diameter packed with 80 to 100 mesh Chromosorb P coated to a 25 mass % level with

tetracyanoethylated pentaerythritol (TCEPE).

A1.4.6 *Column 2*—A stainless steel column 4.6 m (15 ft) long, 3.5-mm (0.138-in.) inside diameter, approximately 4.75-mm (3/16-in.) outside diameter packed with 80 to 100 mesh Porapak P.

A1.5 Reagents and Materials

A1.5.1 *Calibration Mixture*—Mix known amounts, approximately equal to the concentrations expected in the fuel to be tested of the following:

A1.5.1.1 *Methanol*—For the calibration mixture, use about 1 volume %

NOTE A1.1: *Methanol*-Warning—Flammable. Health hazard.

A1.5.1.2 *Ethanol*—For the calibration mixture, use about 90 volume %.

NOTE A1.2: *Ethanol*-Warning—Flammable. Health hazard. Denatured alcohol cannot be made nontoxic.

A1.5.1.3 *Amyl Alcohol*—For the calibration mixture, use about 1 volume %.

NOTE A1.3: *Amyl Alcohol*-Warning—Flammable. Health hazard.

A1.5.1.4 *Isoamyl Alcohol*—For the calibration mixture, use about 1 volume %.

NOTE A1.4: *Isoamyl Alcohol*-Warning—Flammable. Health hazard.

A1.5.1.5 *Methylcyclopentane*—For the calibration mixture, use a measured amount, approximately 7 volume %.

NOTE A1.5: *Methylcyclopentane*-Warning—Flammable. Health hazard.

A1.5.1.6 It is recommended that the mixture be prepared by weighing the components. The conversion to volume percent by use of their densities may involve inaccuracies due to volume change when the components are mixed. The purity of the compounds used must be at least 99 %. This mixture contains highly volatile components and will not retain its stability over a long period, and shall be handled accordingly.

A1.5.2 *Carrier Gas*—Chromatographic grade helium.

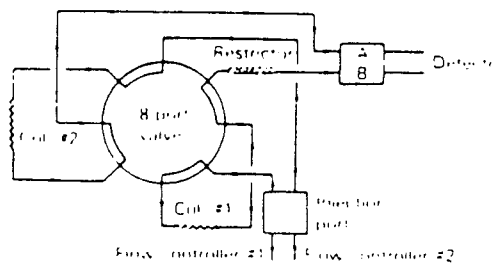
A1.6 Preparation of Apparatus

A1.6.1 Install the valve and columns as shown in Fig. A1.1.

A1.6.2 Place Column 2 in a separate heated zone. Any necessary connecting lines shall be of minimum diameter and length and must also be heated.

A1.6.3 The restrictor shown in Fig. A1.1 is optional and is used to reduce baseline disruption when the valve is operated. It consists of a short length of 0.25-mm inside diameter stainless steel capillary tubing which should approximate the resistance to flow of Column 2.

A1.6.4 Establish the instrument parameters shown in Table A1.1.



Analyze position

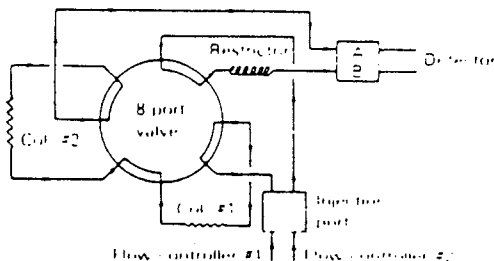


FIG. A1.1 Diagram of Apparatus

TABLE A1.1 Operating Conditions

Carrier gas	helium
Carrier gas flow rate	60 mL/min
Detector type	thermal conductivity
Detector temperature	200°C (392°F)
Injection port temperature	170°C (338°F)
Column 1 temperature	115°C isothermal (239°F)
Valve temperature	115°C (239°F)
Column 2 temperature	200°C isothermal (392°F)
Sample size	2.5 µL (reproducible)

A1.7 Calibration

A1.7.1 *Procedure:*

A1.7.1.1 Chromatograph a calibration blend prepared as in A1.5.1 with the valve in the inject position and the detector on polarity B. Determine the time in seconds required for the complete elution of the methylcyclopentane. Call this time T_1 .

A1.7.1.2 Chromatograph another equal volume sample of the reference mixture with the detector on polarity A. At time T_1 switch the valve to the analyze position. When the last oxygenate of interest has eluted, switch the valve to the inject position. Call this time T_2 . See Fig. A1.2.

A1.7.2 A typical chromatogram is shown in Fig. A1.2. Amyl alcohol and isoamyl alcohol elute after ethanol, but hydrocarbons elute in this region and may prevent the quantitative determination of these alcohols.

A1.7.3 Measure the areas of the alcohol peaks. Calculate the response factor (mass or volume percent per unit of area) to an accuracy of at least three significant figures for each of these components as follows:

$$F = L/A$$

where:

F = response factor,

A = area under the peak for the component, and

L = mass or volume % concentration of the component.

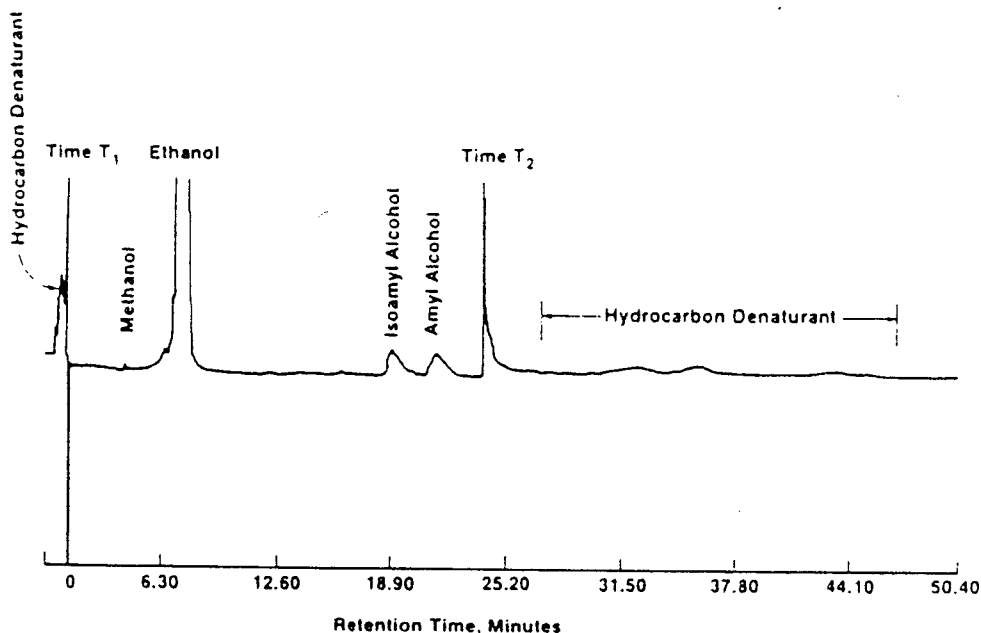


FIG. A1.2 Typical Chromatogram

A1.8 Determination

A1.8.1 Chromatograph the samples using the procedure of A1.7.1. The volume of sample must be exactly the same as that used in calibration.

A1.8.2 Calculate the amount of alcohols present from the areas under their peaks as follows:

$$L_a = FC$$

where:

L_a = mass or volume percent of each alcohol,

C = area for the particular alcohol, and

F = response factor

A1.8.3 The amount of hydrocarbon denaturant can be

estimated by subtracting the sum total of the alcohols from 100.

A1.9 Report

A1.9.1 Report the concentrations of the individual alcohols on an absolute basis to the nearest 0.1 %.

A1.10 Precision and Bias

A1.10.1 *Precision*—The precision of this proposed test method has not been determined.

A1.10.2 *Bias*—There being no criteria for measuring bias in these test-product combinations, no statement of bias can be made.

APPENDIX

(Nonmandatory Information)

X1. SIGNIFICANCE OF SPECIFIED PROPERTIES

X1.1 Denatured Fuel Alcohol

X1.1.1 *Water Content*—Karl Fischer analysis is generally the only consistently reliable procedure for the determination of water in denatured ethanol. Test Method E 203 describes the modifications required to run the test in the presence of alcohols. Specific gravity methods such as D 891 and D 3505, are generally unsuitable for the reasons given in X1.2.1. Blends of fuel ethanol and gasoline have a limited solvency for water. This solvency will vary with the ethanol content, the temperature of the blend, and the aromatic content of the base gasoline. A fuel made by blending 10 volume % fuel ethanol with a gasoline containing 14 volume % aromatics and 0.6 mass % dissolved water (about 0.5 volume %), will separate into a lower alcohol-rich aqueous

phase and an upper hydrocarbon phase if cooled to about 7°C (45°F). As normal spark-ignition engines will not run on the aqueous phase material, such a separation is likely to cause serious operating problems. Because some degree of water contamination is practically unavoidable in transport and handling, and because gasoline-ethanol blends are hygroscopic, the water content of the denatured fuel ethanol must be limited when it is blended with gasoline to reduce the risk of phase separation.

X1.1.2 *Nonvolatile Matter*—This requirement controls a wide range of impurities and contaminants.

X1.1.3 *Chloride Ion Content*—Low concentrations of chloride ions are corrosive to many metals.

X1.1.4 *Copper Content*—Copper is a very active catalyst for the low-temperature oxidation of hydrocarbons. Experi-

mental work has shown that copper concentrations higher than 0.012 mass ppm in commercial gasolines may significantly increase the rate of gum formation.

X1.1.5 *Acidity*—Very dilute aqueous solutions of low-molecular weight organic acids such as acetic (CH_3COOH) are highly corrosive to many metals. It is therefore necessary to keep such acids at a very low level.

X1.1.6 *Appearance*—Turbidity or evidence of precipitation normally indicates major contamination.

X1.1.7 *Ethanol Purity*—The presence of even small quantities of some organic oxygen compounds other than ethanol

may adversely affect the properties of fuel ethanol-gasoline blends.

X1.2 *Undenatured Ethanol*:

X1.2.1 *Specific Gravity*—The density of a water-ethanol mixture is primarily a function of its water content. Normal U.S. industry practice and Federal regulations call for the use of the 15.56°C/15.56°C (60°F/60°F) specific gravity in air as the control method for water content of undenatured ethanol. Because the addition of denaturants will normally affect specific gravity, specific gravity methods are generally not suitable for determining the water content of denatured ethanols.

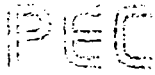
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ADM FUEL ETHANOL TYPICAL PROPERTIES

Composition:	
Ethanol, 199 Proof minimum	95.3%
Natural gasoline, denaturant	4.7%
Properties:	
Gravity, °API	47.8
Specific Gravity, 60°F	0.7890
Pounds/Gal., 60°F	6.57
Distillation Range	
IBP, °F	152°
5%	168°
10%	171°
50%	173°
90%	173°
Dry Point	174°
Reid Vapor Pressure, 100°F., psi	3.5
Blending RVP, 10% in Gasoline, psi	18
Flash Point, TOC, °F	Below -5°
Flash Point, TCC, °F	Below 0°
Color	Colorless to light straw
Non-Volatile Residue, mg./100 ml.	2 to 5
Acidity, as Acetic, % by weight	0.002 to 0.007
Viscosity, 68°F	1.4 cps.
Oxygen Content, Wt. %	33
Appearance	Clear, Free of Suspended Matter

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PEKIN ENERGY COMPANY

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FUEL-GRADE ETHANOL SPECIFICATIONS (DENATURED)

Pekin Energy Company Fuel-Grade Ethanol meets or exceeds all industry standards, including ASTM P.170 specifications and Williams' Pipeline specifications for E-Grade Denatured Fuel Ethanol.

<u>TEST</u>	<u>NON-DETERGENT GRADE</u>	<u>DETERGENT GRADE</u> Note (5)	<u>METHOD OF TEST</u>
Apparent Proof - 60°F	200 min. 203 max.	200 min. 203 max.	Hydrometer
Specific Gravity, 60/60°F	0.7870 - 0.7950	0.7870 - 0.7950	ASTIM D-1298
Water, Mass Percent	0.60 max.	0.60 max.	ASTIM E-203
Fuel Ethanol Content, Volume Percent, Note (1)	95.0 min.	95.0 min.	Gas Chromatography ASTIM D-2/E-44 P170 Method, A or B
Non-Volatile Matter, mg/100 mL	5 max.	Report	ASTIM D-1353
Chloride Ion Content, mg/L	32 max.	32 max.	ASTIM D-512, Meth. C Modified (Note 2)
Copper Content, mg/L	0.08	0.08	ASTIM D-1688, Meth. D Modified Note (3)
Acidity (as acetic acid CH ₃ COOH), mass %	0.007 max.	0.007 max.	ASTIM D-1613
Appearance	Clear and Bright, Visibly free of suspended and/or settled contaminants.		Visual
Color, Platinum - Cobalt	50.0 max.	20.0-70.0	ASTIM D-1209
Hydrocarbon Denaturant gal/100 gal.	5.0 max.	5.0 max.	Gas Chromatography ASTIM D-2/E-44 P170 Method, A or B Note (4)

01/15/88

(SEE NOTES ON REVERSE SIDE)