Testimony of Murray Smith, Director, Central Region, Federal Aviation Administration before the House Committee on Science and Technology, Subcommittee on Transportation, Aviation and Materials, concerning alternate fuels for general aviation aircraft. Wichita, Kansas. August 29, 1983.

Mr. Chairman and members of the Subcommittee:

I appreciate the opportunity to present the views of the Federal Aviation Administration (FAA) on the use of alternate fuels in small airplanes. The oil shortage of 1974 made clear the need for fuel from sources other than petroleum. Moreover, despite the general surplus of oil in the world, there are increasing spot shortages of grade 80 aviation gasoline. It is prudent, therefore, that alternate sources of fuel be developed to supplement, and perhaps someday replace, petroleum-derived fuels. The FAA fully supports the aviation community in its search for alternate fuels that can be used safely in small aircraft.

The Federal Aviation Act of 1958, as amended, gives the FAA the responsibility for developing standards necessary to assure safe operation of our air commerce. The FAA is charged with the responsibility of assuring that adequate design standards are available and that no unsafe condition exists in the airplane or its engine. At this time, the regulations covering the use of fuels are considered adequate for the approval of alternate fuels and to assure safe operation under all

operating conditions. As additional alternate fuels become available, new minimum requirements may be necessary. If it becomes necessary to develop new standards, we have the responsibility to determine that the airplane and engines used in service meet those standards.

It might be well to take a moment to review the FAA organization and certification process for engines and aircraft. There are four Certification Directorates within the FAA, with the following assigned responsibilities:

New England Region	- Engine and Propeller
Central Region	- Small Airplane (less than 12,500 lbs.)
Southwest Region	- Rotorcraft
Northwest Mountain Region	- Transport Airplane

Final responsibility for certification rests with the appropriate Directorate, with each Directorate having Aircraft Certification Offices which deal directly with the public. For a new engine or aircraft design, the applicant applies to the local FAA Aircraft Certification Office for a Type Certificate, commonly called a TC. During the certification process, the FAA reviews the applicant's technical data and participates in the aircraft or engine testing which is required by the applicable Federal Aviation Regulations or FAR's. If all the

requirements are complied with, the aircraft or engine manufacturer is issued a Type Certificate.

The next step in the approval process is to assure that aircraft or engines produced conform to the type design, and this is accomplished by reviewing the manufacturer's quality control system. Upon satisfactory completion of the review, the manufacturer is issued a Production Certificate or PC.

If an applicant other than the original holder of a Type Certificate wants to modify a product (engine or aircraft) which has already received a TC, he will be issued a Supplemental Type Certificate or STC after satisfactory demonstration to the FAA that the modification(s) will not affect the airworthiness of the product.

The use of fuel made to a specification which is different from the specification approved as part of the engine and airplane type design requires FAA approval under the STC process. Two STC's are required for approval of an alternate fuel, one for the engine and one for the airplane, because the engine and airplane have separate Type Certificates and both may be affected by the use of the alternate fuel.

Federal Aviation Regulation Part 33 provides the requirements for engine certification and Part 23 the requirements for small

airplane certification. In addition, there is an FAA Advisory Circular, AC20-24A entitled, "Qualification of Fuels, Lubricants and Additives," which provides suggested procedures for approval of alternate fuels under the Federal Aviation Regulations.

Basically, FAR 33 for engines requires a 150 hour endurance test, a detonation test, and other tests which are deemed necessary to demonstrate that the engine will operate safely with the candidate fuel. The 150 hour test is one of accelerated severity which includes longer periods of time at maximum power settings than normal engine operation. Accordingly, the Advisory Circular provides for the acceptance of 500 hours of normal flight as being equivalent to the 150 hour endurance test required by FAR 33.

In addition, there are tests required under FAR 23 for small airplanes to demonstrate safe operation of the aircraft fuel system. These include at least the following:

a) Engine cooling
b) Comparative Rate of Climb
c) Engine Restart
d) Hot Weather Operation
e) Carburetor Heat Rise, and,
f) Assurance that the Engine Produces Rated Power.

Additional tests may be necessary depending upon the fuel characteristics being examined. Also, compatability of the fuel with the materials used in the engine and aircraft fuel system must be shown.

One of our ongoing projects in the area of alternate fuels began on June 14, 1983. Our Chicago Aircraft Certification Office, or ACO, met with representatives of the State of Illinois to review the feasibility of approving 190 proof ethyl alcohol or ethanol (which is principally obtained by grain fermentation) for use in a Cessna Model 182 airplane. The Small Airplane Directorate and the Engine and Propeller Directorate participated in this meeting. Preliminary evaluation of the project indicates that compliance with the applicable Federal Aviation Regulations will assure safe operation of the engine and airplane with this alternate fuel. The applicant has identified various modifications to the airplane and engine that will be necessary but have not been fully developed at this time. Our Chicago ACO is working closely with the State of Illinois concerning approval procedures.

In a few cases, FAA has also granted an experimental airworthiness certificate to an organization for a specific airplane involved in innovative alternate fuel work. Union Flights has been granted such a certificate for experimental

work with straight methyl alcohol or methanol (which is principally obtained by partial oxidation of natural gas, oil, coal or any combustible material). We have also granted an experimental certificate to Beech Aircraft, so it can pursue its work with liquid methane. Some applications for Supplemental Type Certificate approval of methanol have been received and are in a very preliminary stage. No such applications have been received for liquid methane, yet.

Because today's engines are optimized for operations with gasoline, modifications or perhaps even complete engine redesigns will likely be necessary to permit efficient use of alternate fuels. Aircraft fuel supply and delivery systems may also have to be modified for satisfactory use of alternate fuels.

For any alternate fuel, a specification must be developed to control the fuel quality and the additives which may be necessary for safe operation. In the case of the alcohols, for example, the percentage (or proof) of the alcohol in the fuel must be defined as well as the permissable water content. In the case of ethanol, the type and amount of the denaturant to be added must also be specified. Both alcohols burn with an almost invisible flame, which compounds the seriousness of a fire in the event of an accident. Accordingly, a fuel additive would be required so that a visible flame is produced, thus

making a fire more readily combatible. An additive to properly lubicate upper engine parts will probably be necessary for both alcohols as well. The effect of these and other possible additives on the engine and aircraft parts, and on the operation of the aircraft will have to be determined, as well as the effects of long term fuel storage.

Various design problems are also anticipated when using ethanol, methanol or liquid methane as an alternate fuel. For instance, both ethanol and methanol require the fuel to be heated, or else an alternate starting fluid must be used to achieve acceptable engine starting characteristics. Methanol is very corrosive of the materials commonly found in present day general aviation fuel systems. Ethanol's low vapor pressure (or ability to produce vapors) compared to gasoline may produce explosive mixtures in fuel tanks, thus requiring additional design considerations such as fire protection or altering the fuel to change the vapor pressure. The low heating value (or less heat energy per pound) of alcohol fuels compared with that of gasoline may also decrease aircraft range. Liquid methane presents other concerns. Because it is gaseous in its natural state, it must be pressurized and stored in special fuel containers. All of these problems must be resolved to assure proper and safe operation of aircraft using these fuels.

Assuming engineering ingenuity will resolve the problems I have mentioned, other issues must still be addressed. A specification must be developed for each alternate fuel to define the design and production limits of the fuel. Each engine and airplane must be tested to this fuel specification limit to assure that the engine will continue to comply with the FAR's and is safe for operation.

Once this has occurred, the equivalent of a Production Certificate, mentioned earlier, must be evaluated to assure acceptable quality of the fuel being produced. A production and distribution system will have to be established which assures that the alternate fuel being produced complies with all the requirements of the fuel specification and will continue to comply with those requirements.

In addition to the efforts of Union Flights in methanol, Beech in liquid methane, and the State of Illinois on use of ethyl alcohol in small aircraft, the FAA has also been involved in the evaluation of automotive gasoline (autogas) in small airplanes. The first Supplemental Type Certificate for autogas was granted to the Experimental Aircraft Association approximately one year ago. Since then, STC's have been expanded to cover the use of autogas in various small aircraft with particular engines. In addition, the Mississippi Agricultural Aviation Association is conducting a service

evaluation of autogas which is being monitored by the Central Region Directorate. The service evaluation is for a 1 year period for agricultural aircraft operating in Mississippi.

We recognize that autogas is not considered an alternate fuel in the context of energy independence; however, these approvals have set the stage for identifying problems that must be resolved for the safety approval of other fuels.

In an effort to gain a better understanding of how autogas is distributed and tested to conform to appropriate specifications, the FAA held a public meeting on April 5, 1983. The meeting was very well attended, and informative on the use of autogas in small airplanes. The minutes of this public meeting are available if you would like a copy for the record. The main points which were made at the meeting were the following:

1. Technical evaluation of the autogas approvals made to date were adequate within the specific confines of the particular engine, aircraft and fuel parameters. However, significant concern as to the general suitability of autogas in light aircraft was expressed by industry representatives. All future approvals should be granted based on test data with each engine/airplane combination. There was no method presented that would allow simplifying future approvals where there are significant differences from models already approved.

2. The distribution system of autogas differs substantially from that of aviation gas. It was determined that the pilot/owner cannot readily assure that the autogas he buys meets American Society for Testing and Materials (ASTM) Specification D-439. A system will have to be developed to enable the pilot/owner to determine that the autogas he purchases meets Specification D-439 and is free of contaminated materials.

3. The current ASTM Specification D-439 is for automotive fuels used in ground vehicles, and the ASTM Committee for D-439 only considers the automobile environment. To assure that any changes to D-439 will not adversely affect the use of this fuel in an aircraft, it would be necessary to specify the ASTM specification by revision date in the type design data.

4. As the fuel system becomes more complex (i.e., different materials, fuel pumps, low-wing aircraft, etc.) the sensitivity to vapor lock and material incompatibilitly to additives increases. Accordingly, each airplane engine and aircraft must be tested using the alternate fuel to ensure compliance with applicable regulations. Results of tests must be carefully evaluated to assure continued safe operation of the airplane.

As you can see Mr. Chairman, the FAA Directorates responsible for general aviation aircraft and engines are committed to a cooperative effort with industry to find alternate fuels for

general aviation aircraft. Our experience to date indicates that the FAA's current regulations and testing procedures are adequate to process applications for STC's for alternate fuels in a timely manner. They are also adequate to meet our ultimate goal, assuring that any STC which is approved for the use of alternate fuels will not compromise aviation safety. As work in this area increases, we will make any necessary modifications to our rules and procedures to assure that we can continue to meet these goals.

That concludes my prepared statement, Mr. Chairman. At this time, I would be happy to respond to your questions.