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Future Truck Program Position Paper

Future Alternatively Fueled Engines

Review of Viable Alternative Fuel Options

Developed by the Technology & Maintenance Council's (TMC)
Future Engine Task Force

ABSTRACT

Various groups are researching and promoting different fuels, various states are encouraging alternative fuel use, and the federal government may mandate alternative fuels for private (i.e. non-government) fleets. A number of different fuels are being considered as alternatives to conventional diesel fuel and gasoline. In addition to the "traditional" natural gas, propane and alcohols (methanol and ethanol), new ones appear periodically, such as DME, DEE etc. It is not possible to predict which ones will be the fuel of choice if alternative fuels have to be used either because of government mandates or lack of availability of diesel fuel. However, liquified natural gas (LNG) and biodiesel *appear* to be favored for Class 7 and 8 line haul applications and compressed natural gas (CNG) *appears* to be favored for smaller vehicles used in local delivery applications.

GENERAL REQUIREMENTS AND CAUTIONARY NOTE

Regardless of how the various scenarios play out, the requirements in this paper apply universally to all possible alternative fuels, present and future. In general, the desire is that use of alternative fuels in "diesel" engines be as close as possible to the use of conventional petroleum based fuels. Unlike the situation with current fuels, wherein users have a single fuel and a standardized refueling infrastructure, the situation with alternative fuels will be one in which fuel users will have a choice of fuels, and different ways to obtain and dispense them. The particular ways chosen will be influenced almost totally by the kind of operation the fleet has or wants to have. Thus, a much more coordinated effort will be required among fleets, fuel providers and fuel system providers.

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SPECIFIC REQUIREMENTS

Refueling Time

Refueling times should be equal to refueling with diesel fuel. However, it is recognized that in some applications this is not necessary. Experience has shown that Class 8 tractors can be refueled with LNG at the rate of 12 – 20 gallons per minute (gpm)[1]; and step vans can be refueled with CNG at a rate of 1.7 – 4.2gpm[2]. Biodiesel fueling rates are the same as for diesel. Individual fleets must assess their tolerance for refueling time. In instances where the duty cycle of the vehicle does not require rapid refueling (e.g. vehicles normally parked overnight and can run all day on a single fueling) refueling times equal to diesel or gasoline would not be required.

Fuel Composition

The "purity" of some fuels may be a concern. Experience[3] has shown that this is a critical issue, affecting engine performance and emissions levels. It is required that either fuel suppliers provide a controlled composition and engine builders and fuel system suppliers ensure their fuel systems on board the vehicle can tolerate a reasonable range of fuel composition variation. The Society of Automotive Engineers (SAE) has developed a standard on CNG (J1616) and is developing a Recommended Practice on LNG fuel composition, and when approved it will be incorporated in this paper.

Reliability

1.Engine—Reliability should not be less than that experienced with current diesel engines. Current heavy duty diesels provide up to one million miles of service before overhaul. Indications are that natural gas engines *may* have longer oil drain intervals and increased time to overhaul than comparable diesel engines.

2. Refueling equipment—The reliability of this equipment should be equal to that of current diesel fuel dispensing systems. Recent experience indicates that reliability of LNG fueling systems is poor.

Fuel Economy

Fuel economy must be such that, with reasonable fuel tank capacities, vehicle range is equal to diesel fueled vehicles. This will require advances in the fuel economy of alternatively fueled engines and/or extra fuel tank capacity.[4]

Fuel Quantity Indication

Accuracy of fuel quantity indicators must be equal to current conventional fuel gages. In one recent alternative fuel demonstration project the accuracy of the LNG fuel indicator was +/-1/4 of a tank**.**

Fuel Dispensers

Refueling dispensers should read in gallons, regardless of the fuel being used. Suppliers of fuel dispensing equipment must simplify and standardize their equipment. Some LNG refueling facilities require a 20-45 minute lead time to cool down so pumping can start. The need for such special procedures should be eliminated, unless a particular fleet's operations can tolerate such a delay. Personnel refueling with LNG are required, in some instances, to wear protective gloves, face shields and aprons. It is highly desirable that the need for such precautions be eliminated.

Standards setting bodies are currently writing standards for refueling nozzles for LNG and as these are approved they will be incorporated as part of this requirement. CNG nozzles and receptacles have been standardized by the natural gas vehicle industry.

Accuracy of fuel dispensers must be equal or close to conventional fuel dispensers, which is about 0.52 precent. (It is reported that CNG fuel dispenser accuracy is 1.5 percent). The SAE also has a task force on LNG fuel metering and measuring, and when its work is completed it will be incorporated in this document.

Training Requirements
Equipment must be designed to minimize training needed for drivers, technicians and other fleet personnel[5].

Maintainability
Fuel systems, both on board the vehicle and at refueling sites should require no more maintenance than current systems require. Currently they are up to twice as costly to maintain[6]. It is imperative that a single vendor stand behind the vehicle fuel system and that the fuel supplier stand behind the dispensing equipment.

Methane Detection
Devices to detect and warn of the presence methane should be on LNG fueled vehicles. CNG has an odorant which is an effective warning.

FOOTNOTES

1. This is the actual and planned second generation rate of a dispenser used at a large fleet, and is considered quite adequate. Houston Metro reports being able to refuel its buses with LNG in eight minutes, equal to the time it takes to refuel their diesel buses. The LNG tractors used in the Wal Mart demonstration project are refueled in four minutes. There are LNG nozzles rated at 50 gpm. Hence the requirement for "equal to diesel" is realistic. The question is how much time does a fleet's operations allow for refueling?

2. This is the fast fill rate (CNG refueling is divided into slow fill and fast fill) and is relatively costly. There are nozzles that are rated at 9.6 – 12 gallons per gasoline equivalent (gge). Gasoline dispensers pump 7-10gpm. In a slow fill system, where the vehicle's duty cycle allows overnight refueling, van type trucks can be refueled in six to nine hours, at considerably reduced cost.

3. In some test fleets natural gas fueled engines have "blown" because of uncontrolled high methane content. In 1992 the Gas Research Institute conducted a survey of major metropolitan fuel suppliers and found methane content ranging from 82.5-98.5 percent. Recent demonstration projects have used 99 percent methane. With this percentage there is lower BTU content. Ninety-three to 95 percent is a desireable range and engines should be designed to run on this percentage range. With today's closed loop natural gas engines this is not as serious a problem as it was in earlier generations on natural gas engines.

4. In LNG demonstration projects with Class 8 tractors fuel economy ranged from 8.5-33 percent below diesel; In CNG projects fuel economy was 8.5-17 percent better than with gasoline; using methanol fuel economy was 10-17 percent worse; and with ethanol it was 7.5 percent worse.

5. One fleet using CNG trains refuelers three hours and drivers four hours. Another trains personnel for a week.

6. In recent demonstration projects maintenance costs for fuel and engine systems for LNG vehicles ran approximately 27-45 percent higher than diesel vehicles. Spark plug life in lean burn engines is apparently limited to about 10,000 miles. CNG fueled vehicles ran about 25 percent higher. These costs are expected to decrease as new generations of components are fielded. ❑