

EVERY™ ALTERNATIVE.

Technical Bulletin 15.11.2009:

Subject: Natural Gas Fuel System-LNG

Liquefied Natural Gas (LNG) is gas which has been cooled to cryogenic temperatures so that it becomes a liquid. LNG is typically 90% or higher methane and must be stored and handled at -260 to -160 °F. LNG is typically not odorized and a methane detection system is recommended or may be required by law. LNG should not be confused with Liquefied Petroleum Gas (LPG) which is a propane and butane mixture that is liquid at normal temperatures and low pressures.

The typical LNG system relies entirely on fuel vapor pressure so that if it's too cold it cannot maintain pressure as the fuel is used.

The basic function of the vehicle fuel system is to store liquid fuel until it is used by the engine. The vehicle fuel system also delivers fuel to the engine in accordance with Cummins' specifications for fuel quality, temperature, and pressure under all operating conditions. Fuel temperature should be between -40 °F and 200 °F at the engine fuel connection. This temperature is controlled by a fuel vaporizer that typically uses engine coolant to warm and vaporize the fuel.

All vehicle fuel systems must be designed and comply to the requirements of various regulatory agencies and no Cummins requirement should be interpreted to contradict or override these regulatory requirements.

Tank and Control System

Most LNG system suppliers provide the cryogenic tank, vaporizer, fill and vent connections, and a pressure management system. These components are often integral to the tank and are pre-plumbed. The system supplier should provide technical and installation recommendations as required.

Most systems rely entirely on tank pressure to deliver fuel. Tank pressure is a function of fuel temperature and the associated vapor pressure. Initial fill pressure can be pumped higher than saturated pressure but will soon drop off as the vapor condenses into the cold liquid and reaches the saturated vapor pressure for a given fuel temperature. Some systems have devices to add heat to the tank if tank pressure is low, but most rely entirely on proper fuel (saturation) temperature and pressure from the fill station.

Cummins recommends that the tank pressure due to saturated fuel vapor pressure be kept at 30 to 40 pounds per square inch (psi) above the minimum pressure on the engine datasheet. In all cases, the pressure at the engine's fuel inlet connection must meet Cummins' minimum fuel pressure requirements for proper engine operation. For example, the ISL G inlet fuel pressure at rated conditions is minimum 70 psi, and maximum 150 psi.

Connecting Lines and Fittings

All lines, valves, and fittings between the tank and the vaporizer carry liquid fuel and must be capable for cryogenic service. Elastomeric materials (rubber, Teflon, nylon, plastics), iron, and carbon steels are not recommended for these lines and fittings. Fittings should be tapered pipe and ferrule type, flareless tube fittings. The OEM must follow the fuel system manufacturer's recommendations for plumbing. Lines between the vaporizer and the engine need only carry vapor at engine inlet conditions. Hose, line and fitting specifications may be dictated by regulatory agencies. Corrosion resistant fittings are recommended to avoid contamination. The fuel system between the tank and engine inlet connection must be sized to deliver fuel with less than 25 psi total pressure drop. If the system pressure drop is excessive,



then pressure drop testing should be performed to isolate the component(s) that are creating the restriction and the system should be modified as necessary.

Vaporizer

The vaporizer must be sized and specified by the system manufacturer. Coolant plumbing considerations are the same as for cabin heaters. No cabin heater control valves should be in a circuit that could shut off flow through the vaporizer. The vaporizer must be sized to deliver gas at a temperature within the limits shown on engine datasheet under all conditions. This will mean that gas will exit at higher temperatures during low gas flow conditions in a typical system and at lower temperatures at high flow.

Pressure Regulator

Since most LNG tanks have a maximum pressure rating over 200 psi, Cummins engines require a regulator that limits the maximum pressure at engine inlet to the maximum value listed on the datasheet. This regulator must be designed for minimum restriction at lower tank pressures.

Fuel pressure delivered at the engine inlet may vary with engine load conditions, tank pressure conditions, and fuel flow rates. However, the fuel pressure at the inlet must be stable within +/- 10 psi in response to transient engine operating conditions, and always should be within the minimum and maximum values indicated on the engine datasheet. For example, the ISL G inlet fuel pressure at rated conditions is minimum 75 psi, and maximum 150 psi.

Low Fuel Pressure Lamp

Cummins requires that the vehicle OEM provide a low fuel pressure indicator lamp in the dash. This lamp is controlled by the engine ECM (electronic control module). The lamp is illuminated when the fuel inlet pressure to the engine is critically low. **Many low power complaints can be attributed to low fuel pressure.**

Low Pressure Fuel Filter

Cummins provides a low-pressure fuel filter for use with all engine installations. The filter acts to prevent fuel contamination from damaging the engine fuel system components. Provisions should be made to assure that pressure can be shut off and relieved for service of the filter element. The filter must be accessible to allow daily maintenance, which involves the draining of the filter. The filter should not be placed to drain on electrical components.

Engine Fuel System

Cummins engines have an electronic fuel system that delivers fuel based on demand to provide precise fuel mixture and speed control. There is an engine-mounted electric shutoff valve in this fuel system to provide quick fuel shutoff if certain engine protection parameters are exceeded such as overspeed and stopped engine (no speed detected). This valve is controlled by the engine electronic control module.

For further information on LNG fuel systems see Cummins AEB 21.17

Cummins Westport manufactures and sells the world's widest range of low-emissions alternative fuel engines for commercial transportation applications and has over 20,000 alternative fuel engines in service around the world.

For further information contact a Cummins Westport representative, or visit www.cumminswestport.com

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